September 2025: meeting report

UK Deep-Sea Mining Environmental Science Network

Background

This meeting was organised by the Department of Environment, Food and Rural Affairs (Defra) on Wednesday 24 September 2025, and was held virtually.

Meeting objectives

The aim of this meeting was to provide a forum through which participants could share how their research contributes, either directly or indirectly, to the following three thematic areas that relate to ongoing negotiations at the International Seabed Authority (ISA):

- Environmental Goals and Objectives, and Closure Plans
- Impact Reference Zones and Preservation Reference Zones
- Test Mining and Pilot Mining.

The meeting also updated Network members on recent environmental policy negotiations on deep sea mining (DSM). It closed with a discussion session designed to generate ideas for a future strategy for the Network.

To guide this meeting, participants were encouraged to re-familiarise themselves with the purpose of the Network, as set out on the Network webpage.

Attendance

There were over 40 attendees at this online event. Participants included government officials from Defra, the Foreign, Commonwealth and Development Office (FCDO) and the Department for Business and Trade (DBT), as well as members of the Network.

The meeting was convened by Defra, supported by the Joint Nature Conservation Committee (JNCC) and the Centre for Environment, Fisheries and Aquaculture Science (Cefas), and chaired by Defra's Lead Marine and Fisheries Scientist.

Meeting overview

Introduction

The meeting opened with a welcome by Defra's Lead Marine and Fisheries Scientist. Reflections were sought on the September 2025 launch event for JPI-Oceans MiningImpact3: 'Ecological Aspects of Deep-Sea Mining'. Defra funds UK participation in MiningImpact3 through the National Oceanography Centre, Natural History Museum, Scottish Association for Marine Science and University of Southampton.

Defra officials provided an update on the most recent International Seabed Authority (ISA) Council Session on the development of the draft exploitation regulations for deep-sea mining, to provide context for the later discussion.

JNCC and Cefas then presented short introductions to each of the three policy areas of interest, shaped by some guiding questions to help identify UK research relevant to these areas and to facilitate the later discussion sessions. These guiding questions are replicated below (in 'Meeting outcomes') and were shared with participants ahead of the meeting.

Research presentations

Four short talks on recent deep sea mining research were delivered by UK scientists. These talks covered a range of subjects, including food quality, oxygen production, environmental goals and objectives, and impacts and long-term recovery from mining disturbances.

Breakout discussions

Small-group discussions were convened using a World-café format, facilitated by JNCC and Cefas, and covering the following three thematic areas:

- Environmental Goals and Objectives, and Closure Plans
- Impact Reference Zones and Preservation Reference Zones
- Test Mining and Pilot Mining.

For each area, discussion was framed around two related questions:

- What scientific evidence is needed to address policy questions in these thematic areas?
- What UK research relates to these thematic areas? This could be ongoing, planned or completed research.

Key outcomes are summarised in the 'Meeting outcomes' section below.

Strategic discussion on the Network

In the final session of the day, participants were invited to consider further what future evidence is needed to inform policy work in each thematic area, particularly highlighting evidence needs that are not currently linked to any ongoing or planned research.

Network members were also invited to discuss next steps for the Network, including suggestions for future topics for Network meetings, and mechanisms for Network members to connect with each other in addition to these meetings.

Meeting outcomes

Key outcomes from the discussion groups are described below.

Policy area 1: Environmental Goals & Objectives, Closure Plans

Guiding questions

- How to define ambitious yet achievable environmental and closure objective(s), meaning what condition should the marine environment be in after mining activity and at the end of the closure period?
- What indicators and targets would be appropriate in a deep sea setting to monitor success of reaching environmental goals?
- What restoration or rehabilitation techniques are currently known or being researched or developed? When can a technique be considered successful, given long timescales for restoration processes in the deep sea?

Summary of the discussion

When considering a goal for the condition of the marine environment following the end of mining activity, at the end of the closure period or both, the group reflected on potential alignment with other relevant institutions, organisations and legal frameworks (for example, the UN Convention on Biological Diversity, Biodiversity Beyond National Jurisdiction Agreement (BBNJ), the IUCN Red or Green List). This included looking to those other institutional frameworks for relevant values, goals, objectives and standards, and to mechanisms that identify biodiversity-rich areas such as Vulnerable Marine Ecosystems (VMEs) and Ecologically and Biologically Significant Areas (EBSAs). It was noted that goals and objectives may also drive unwanted behaviours (for example minimising spatial scale may result in high intensity but low footprint mining).

The group agreed that exploitative activities will inherently cause environmental impacts, and as such the concept of ‘tolerable losses’ was also discussed. In the context of deep-sea mining, it is unrealistic to expect a mined site to return to pre-activity baseline levels, but there is currently no framework for agreeing on the extent of ecological loss that could be considered tolerable or permissible. The difference between a highly biodiverse and a functional ecosystem should also be considered in this discussion. Agreeing on a ‘tolerable loss’ would help shape an understanding of what scientific evidence is required to identify environmental goals and objectives, and inform management accordingly.

In terms of the length of time that monitoring should be required following the end of mining, there were concerns that extensive monitoring periods may go beyond the lifespan of the contractor companies that caused the environmental impacts. The group therefore explored whether progress along an agreed trajectory towards an objective could be sufficient. Monitoring over a shorter timeframe also raised concerns, especially considering the ‘intermediate disturbance hypothesis’. This hypothesis suggests that an initial response to disturbance could give false assurance of satisfactory ecological recovery, with an increase in species diversity masking a loss of functionality, rare or unique species, and changes to community composition.

Further concerns related to the regulatory pathway that link monitoring data to the objectives, and how to ensure that long-term monitoring data are used and interpreted correctly. The group identified water quality, the proportion and distribution of remaining habitat after a mining operation, total plume extent, local biodiversity indices and toxicology reports as potential indicators to measure if objectives had been met. The group further mentioned that proper baselines (either a reference or pre-activity condition), consideration of connectivity and energy flow, and the ability to pick up impacts that may currently be poorly understood or unknown are important for designing indicators.

The challenges of obtaining samples from the deep sea were highlighted, including the sampling effort and design needed for statistically robust results, and standardisation for replicability and comparability. Contractors may be incentivised to undertake limited monitoring as this will identify only the biggest changes whilst being cheaper than more extensive monitoring.

Significant knowledge gaps such as toxicology and sedimentation plume impacts were highlighted. It was also noted that artificial substrates, including artificial nodules and basalt blocks, and coral restoration techniques are being researched as potential mechanisms for rehabilitation. A precautionary approach to deploying these methods was recommended, given existing scientific uncertainties.

Policy area 2: Impact Reference Zone (IRZs) and Preservation Reference Zones (PRZs)

Guiding questions

- How many, and what size of, reference zones are required to sufficiently capture natural variability?
- Are there any insights into the spacing of IRZs and PRZs, meaning how to ensure that PRZs are representative but not influenced by nearby IRZs?
- When can IRZs and PRZs be considered sufficiently representative of each other to allow comparison between the areas during monitoring?

Summary of the discussion

Participants explored scientific, practical and policy dimensions of IRZs (Impact Reference Zones) and PRZs (Preservation Reference Zones). An ongoing confusion around PRZ definitions was noted. While regulations provide a relatively clear framework, supporting documents and conservation perspectives often differ, making interpretation challenging.

PRZ design should balance representativeness with minimising sampling impact. Multiple samples within sites were recommended, as greater distances between samples can lead to significant differences in community composition - one cited study found notable variation at 200 km. However, sampling across thousands of kilometres is likely unrepresentative.

Design considerations included contract area size, existing variability and baseline evidence. Targets and indicators were seen as critical for determining whether trait similarity is sufficient, with suggestions to distil existing data into key monitoring indicators

while retaining species-level detail for trait-based approaches. Caution was advised against overcomplicating zone design.

Practical and regulatory challenges were also highlighted. Variability in nodule distribution, geology and geography significantly influences IRZ and PRZ design and comparability. Some suggested stricter regulation of parameters and clearer justification for monitoring regimes against broader objectives. The dual role of PRZs – as control sites and conservation zones – was debated, with recommendations to separate these functions.

Policy discussions focused on spatial scale. The suitability of locating PRZs in APEIs (Areas of Particular Environmental Interest) was contested, with mixed views depending on whether the PRZ's purpose is preservation or reference. While some supported APEIs as additional monitoring zones, others warned against misuse and stressed that PRZs should serve as local baselines. Overall, the need for clearer guidance and more robust monitoring frameworks was emphasised.

Policy area 3: Test Mining and Pilot Mining

Guiding questions

- What spatial or temporal scale is required to give confidence that subsequent commercial production will not cause harmful effects to the marine environment?
- How to ensure that any testing is representative of the diversity of environments that are likely to be exposed to direct or secondary impacts of commercial production?
- What are the potential cumulative effects (between or within specific impact pathways, for example noise, chemical toxicity) that should be considered during testing?

Summary of the discussion

Key to this discussion was the suggestion that current baseline understanding is insufficient. Caution was expressed around the difficulty in registering changes against the environmental baseline when the data are not sufficient to inform understanding of natural variability of the ecosystem. It was suggested that baseline collection of data should continue for the next 10-20 years, noting that inter-annual variability is significant and there is a need to see several El Niño cycles to understand their effect on environmental baselines. There is also limited data on benthic-pelagic coupling and how this varies over spatial scales. The above recommendations represent an idealised situation, but it was acknowledged that proposals for Test and Pilot Mining will need to be evaluated in the absence of such detailed and lengthy time series. In such evaluations, there is still a need for a definitive justification for recommending rejection of inadequate proposals, which forms a major part of the reasoning for developing applicable Standards and Guidelines.

This is coupled with the issue that Test Mining might only take place for limited periods, so may not deliver sufficient, relevant data to model impacts of longer-term mining operations. It might be valuable to request contractors to periodically re-sample their test sites. Similarly, control and impact sites should be replicated spatially and temporally, though noting that this would be both expensive and time consuming.

It was posited that the goals of Test and Pilot mining need to be clearly defined, and may be different. It was also noted that different approaches may be taken depending on the element of the mining process being tested.

Priorities and next steps

The UK holds significant and world-renowned expertise in environmental research related to deep-sea ecosystems. This research could be of an even greater value in filling critical gaps in relation to deep sea mining if it is more strategically developed. The group agreed the Network was valuable in bringing science and policy experts together to feed into these strategic discussions. Future Network meetings (both online and in person) will continue to encourage strategic links within UK science and between science and policy to contribute to the development of a robust and sufficient evidence base for evaluating potential impacts of deep-sea mining.

Opportunities to develop these links may include:

- the provision of regular updates, via the Network meetings and email bulletins, on current issues and key gaps in environmental knowledge for the ISA
- developing a list of key priorities from a UK policy perspective and inviting Network members to identify existing evidence and research that may be relevant, building on the British Geological Society deep-sea mining evidence review
- selecting key topics as a focus for future network meetings, to share relevant expertise and ideas to support UK government technical briefs on these topics (for example, Closure Plans, environmental Goals and Objectives)
- sessions on making science relevant to policy
- holding collaborative meetings with individuals with expertise relevant to other industries to identify similarities and differences in environmental management approaches in other sectors.

The next Network meeting is anticipated in Spring-Summer 2026, to be held in person.

An email bulletin will continue to be sent to Network members on a roughly bi-monthly basis.

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