

Document reviewed	
Title of the draft being reviewed:	Draft Guidelines for the establishment of baseline environmental data
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General Comments	
<p>We are aware that these draft documents refer to draft Regulations which have not yet been finalised and, in some cases, also refer to other Standards and Guidelines which may not yet have been drafted or agreed. Following consideration of stakeholder comments, the draft Standards and Guidelines will need to be reviewed again once the relevant exploitation Regulations have been agreed, and other relevant draft Standards and Guidelines are available.</p> <p>As an example, as the EIA, EIS and EMMP are based on data from the baseline, it will be important to ensure the data required for EIA, EIS and EMMP (as laid out in Regulations, Standards and Guidelines) is included in this baseline document.</p> <p>Many of the parameters listed in this document to be measured are essential for the establishment of an environmental baseline. Furthermore, standardisation of these essential parameters are vital to enable comparability between data at the regional level, which is a requirement for operationalising regional environmental management plans (REMPs). Therefore, we recommend that this document should be split into standards and guidelines, where the standards represent the essential requirements for establishment of the baseline, and the guideline provides extra detail on the standards. Such, standardisation of essential parameters for the baseline to ensure comparability should also include data processing and not only sampling</p> <p>We recommend additional clarification about the link between this document and ISBA/25/LTC/6/Corr.1 and Rev.1, as well as addressing any inconsistencies between the requirements of these documents in terms of data requirement for establishing an environmental baseline. For example, IBSA/25/LTC/6/REV.1 mentions eDNA, which is not mentioned in this document.</p> <p>We recommend that the same level of detail and information is provided in different sections throughout this document, by adding additional detail to various sections where necessary.</p> <p>We recommend that including a glossary of terms would make this document more accessible, particularly given the highly technical nature of the document.</p>	

We would recommend making the sections more defined to reduce the overlap between sections. For example, much of the important information regarding benthic sampling is throughout different sections, and it would streamline the document if it was included together in the benthic section.

We note that paragraph 2 of this document indicates that these guidelines focus primarily on deep-sea polymetallic nodules found in the central and NW Pacific and Indian Oceans and further iterations will be issued in the future to cover polymetallic seafloor massive sulphides and cobalt-rich ferromanganese crusts. We support this recognition that further iterations of this document will be required to ensure that it is resource-specific. However, PMS and PMCs are not only mineral types, but also habitats. Other key habitat types can be found in a contract area, and be potentially impacted by mining activities e.g. seamounts/PMCs. Methodologies for sampling such habitats are not currently considered in this document. For example, in the macrofauna section on page 44, paragraph 253 specifically notes 'both macrofauna living on nodules and those in the sediment should be collected', and the methods listed below focus on these habitat types. Therefore, should a contractor need to sample macrofauna on a seamount in their nodule claim area, there are currently no standards or guidelines for such sampling in this draft. We recommend that this should be considered throughout the document.

We recommend that definitions of Impact and Preservation Reference Zones should be included, as well as referring to these zones using consistent language throughout the document. A visual representation of IRZ/PRZs would be useful to understand what they are.

We note that although this document highlights the need for the temporal nature of the data to allow natural variability to be captured, for many habitats it could take decades to detect natural variability. We recommend that consideration is given to how this could be reflected in the document.

We understand that recovery of habitats and species is not mentioned in this document as it is guidance for establishing an environmental baseline. However, in order to determine the recoverability of habitats in later stages of the process (e.g. EIA), data will be required on crucial features for monitoring habitat health and effects of disturbance. As the starting data for this is supposed to come from the baseline, data to determine crucial features for monitoring habitat health and effects of disturbance should be included in this document.

We are pleased to see the inclusion of power analyses in this document. Across the sections, several different references for Power Analyses have been used;

- Lines 282 and 1570 refers to Jumars, 1981 (General guidance/Benthic Sampling)
- Line 1320 refers to Sweetman et al 2019 (Biogeochemistry)
- Line 2326 refers to Cohen (Seabirds)

We recommend that it would be useful to clarify whether these are preferred references to be used in these instances, or just different examples.

The chemistry section provides a thorough and detailed guide of measurements to be taken and methods to be followed. We recommend that the physical oceanography section might usefully include similarly detailed guidance.

Specific Comments		
Page	Line	Comment
4	87-89	We recommend including the following additional language: <i>Appropriately designed sampling is the cornerstone of environmental surveys and monitoring. If a sufficient number and spatial coverage of samples are not taken with the correct equipment and follow the Best Available Techniques and Good Industrial Practice then all the subsequent data and analyses are flawed or compromised.</i>
5	106	We recommend adding in 'biological' after 'oceanographic' in this list
5	111	We recommend adding in here some clarification on expectations on timescales for baseline data gathering.
5	125	We recommend removing ' <i>substantial</i> ', as there can be topography at small scales: "The arrangement should consider typical ocean current directions and substantial topographic features as these that will have an influence on the direction and distance sediment plumes generated by the mining collector may disperse and resettle".
5	125	We recommend including references here to current standards and SOPs for current meter gathering (or from models and then that brings in calibration and validation). Examples can be found here: https://www.cefas.co.uk/premium/publications/post-incident-monitoring-guidelines-subsea-oil-releases-and-dispersant-use/tg06/ Venkatesan et al, Front. Mar. Sci., 20 December 2018 https://doi.org/10.3389/fmars.2018.00469
5	128	Although relevant and we support their inclusion, the available information on these biomes/habitats are the least impacted. We recommend that benthic habitats from abyssal plains to the surrounding seamounts should be included. We recommend addition here of biogeography of the seafloor, with the example reference of Watling et al, 2013 A proposed biogeography of the deep ocean floor. This study is builds on the Global Open Ocean and Deep Sea (GOODS) classification, developed by a UNESCO workshop in 2009.
5	136	We recommend that products from the re-analysis of numerical models are used to explore natural processes at various length and time scales e.g. from ECMWF https://www.ecmwf.int/en/research/climate-reanalysis/ocean-reanalysis or NOAA https://psl.noaa.gov/data/gridded/reanalysis/
6	142	We recommend including the temporal scale in relation to eddy fields sampling.
6	144-157	We support this stratification approach and recommend that an additional step is required to identify zones for each strata. In the figure on line 158, changing 'nodule coverage' to 'strata type' and then 'low' and 'high' to 'low nodule coverage' and 'high nodule coverage' might help, particularly when this document is issued in the future in different iterations for PMS and PMC. Also, Impact Reference Zones and Preservation Zones should be considered when designing the nested stratified sampling scheme, as this document notes that sampling is required in IRZs and PRZs (e.g. line 802-805). We note that as per

		ISBA/25/LTC/6/Rev.1, 'The impact reference zone should be the site where the test-mining and related direct impacts are to occur. The preservation reference zone should be carefully located and far enough away not to be affected by testing activities, including effects from seabed-disturbance and discharge plumes [...] Their species composition should be comparable to that of the impacted areas'. If in order to meet the definition of an IRZ or PRZ, enough of these zones cannot be identified at this the start of this sampling stage, then we recommend that the process needs to be undertaken again over a wider area.
7	159-162	When talking in general about time-frames for sampling to collect the baseline, we recommend noting in this document that in order to collect sufficient data to establish an environmental baseline, it is expected to take a large proportion of the exploration contract time.
7	171-172	We are pleased to see the inclusion of climate change in this document. In this paragraph we recommend that it would be useful to clarify to what extent these natural stressors are recommended to be considered (e.g. by providing more specifics as to what level of assessment is suggested, and with what data). This may also be useful in guidance on long-term monitoring.
7	172	We recommend that all potential hydrodynamic forcing processes should be included such as turbidity currents, benthic storms created from hurricanes at the surface as well as large scale region currents created from multi-year variability e.g. El Nino.
8	208-210	We recommend clarifying the wording in this paragraph, which may currently be confusing. It may also be useful to include relevant extra detail for specific variables (where this occurs across this document), instead of the reader having to go to ISBA/25/LTC/6/Rev.1.
8	212-214	We agree with this statement and welcome its inclusion.
8/9	245 and 251	We recommend that methods to facilitate this exchange with contractors and the scientific community are included, such as the use of data from ISA DeepData.
9	264-271	We recommend adding additional clarification here in terms of expectation of whether data should be compared against existing, published, models or whether new models should be produced (or both).
9	281-284	This is the first mention of data replication and power analysis, which should be used to support the sampling design. We recommend that this should be detailed earlier in the document, in relation to data collection methods, prior to paragraph 14 (page 6) as such principles are relevant to all data.
10	317	We recommend that details of the specific 'established metadata methods' should be included or referenced. Recommendations could be provided by ICES: https://www.ices.dk/community/groups/Pages/DIG.aspx?
12	362-363	Beyond this focus on the masking effect of noise (both here and in the measured variables H and I), we recommend that the document should also consider what is needed to allow impact assessment of mining operations. The document does not currently include mention of impact associated with displacement which is of equal importance to masking. We recommend that the document should include collation of AIS data from any shipping that should be included in a baseline as well

		<p>as collation of spatial and temporal marine mammal abundance and density in the area to be mined (even if this is also covered in the REMPs) - for the purposes of site level mitigation and monitoring.</p> <p>We recommend that this section would benefit from clarification on what is being considered in the baseline i.e. is it later environmental assessment / management? It may also be useful to reflect here the need to consider all potential environments (tropical to Arctic) so if there were specific geographically limited mammal species associated with any mining areas, these would need to be highlighted.</p>
12	367	We recommend adding further detail here (e.g. clarifying the terms ‘many’ and ‘achieved wherever possible’).
12	376-381	<p>We recommend a more detailed experimental design, such as:</p> <ol style="list-style-type: none"> 1) Use historical bathymetry and model data to estimate a 1st order estimate of impact zone 2) Use this (in conjunction with benthic specialists) to identify sensitive receptors 3) use the SPR (source-Pathway-receptor framework) to identify pathways 4) Use a logarithmic approach to maximise sampling. <p>(See comments above about sampling design).</p>
12	383	The CTD itself should be sampling at least 1Hz (pressure, temperature, conductivity)
13	448	We suggest also including the Copernicus website as a reference
14	458-484	We recommend that this section may benefit from increased clarity on what needs to be measured and provided, and what is simply a recommendation (e.g. what is a standard, and what is a guideline).
14	461	We note that this ‘mechanical’ method may now be considered dated as it is prone to fouling in storms causing high levels of suspended particulate matter (SPM) and also still has issues of stall speed.
14	470	We recommend including here the need to calibrate and validate.
14	472	We recommend that this paragraph should include information on how to measure particles (size) and their fall velocity.
14	474-475	We recommend re-wording this paragraph to provide a recommendation (in the form of a standard or guideline) of the inclusion of graphical representation of data analyses, following the proposals from Joseph (2014).
14	482	We agree with this statement and welcome its inclusion
14	484	We recommend also including here episodic events - storms/turbidity currents.
14	486	We recommend that in this paragraph (and throughout the document) it would be helpful to clarify what part of the stated methodology, if any, is a baseline guideline or standard.
14	487-491	We recommend that this could be removed or refined to provide specific requirements of the use of IOC manuals only.
17	577-593	We recommend that more detail is included to specify the methods for underwater noise measurements. (i.e. at lines 580-582, the guidelines should specify the equipment suitable for deployment in deep waters, not just provide list of all possible equipment for underwater noise measurements).

		<p>We recommend that the sentence beginning at line 578 could benefit from rewording, to clarify what ‘sound’ is being discussed. Is this referring to ambient or anthropogenic? Ambient noise includes both natural and anthropogenic sources (the later ones are generally remote, like shipping) and provides the baseline levels in the absence of /prior to the human activity (DSM) being assessed. The (generally higher) noise levels corresponding to the human activity (DSM) would then be estimated (e.g. through modelling). The noise can be both monitored and modelled (models can include natural sound sources as well, such as wind), although in the ocean this can be quite challenging due to large spatial scales (and thus the number of discrete sound sources, e.g. all the individual ships, that need to be included) and because of the deep waters (and the depth variation of the physical properties of water and their effect on sound propagation). In deep water, the speed of sound vertical profile is indeed the most important factor that determines the propagation of sound. The SOFAR channel is a horizontal layer of water in the deep ocean at which depth the speed of sound is at its minimum and that essentially acts as a waveguide for sound, a sort of “channel” that allows sound to propagate at large distances with minimum loss – thus measuring the vertical sound speed profile allows determining the depth of this channel at a given location. We suggest referring to ‘ambient’ noise, based on the explanation above. We also suggest adding in that the speed of sound vertical profile is the most important factor that determines the propagation of sound, based on the explanation above, and therefore should be measured.</p> <p>We also recommend that the requirements of variable H are aligned with those required for obtaining measurements required for marine mammal data.</p> <p>We also recommend the inclusion of this reference:</p> <p>Good Practice Guide for Underwater Noise Measurement, National Measurement Office, Marine Scotland, The Crown Estate, Robinson, S.P., Lepper, P. A. and Hazelwood, R.A., NPL Good Practice Guide No. 133, ISSN: 1368-6550, 2014.</p>
15	506-508	We recommend clarifying as follows: <i>The estimation of turbulence intensity should be made by either direct or indirect methods using data from the velocity shear probe or data from CTD or Acoustic Doppler Current Profiler (ADCP), Acoustic Doppler Velocimeter (ADV) or Doppler Current Profiler (DCP) (Thorpe, 2007).</i>
17	600-601	We agree with this statement and welcome the inclusion of pre- and post-cruise calibrations.
17	602	We recommend that the IAPSO Standard Sea-Water should also be used, to ensure link back to the independent standard.
22	818	We suggest assessment of nutrients could also be included here, not just metals, in order to fully understand the biogeochemistry (e.g. carbon cycles).
25	945	We recommend that consideration of the units for all required parameters should be included throughout the document, as here, in order to assist with standardisation and comparability of data.
31	1187	We recommend clarification here on whether the references included are being recommended as best-practice.

36	1422	We recommend this sentence on bioturbation is included in the biological communities section as well.
37	1428	We recommend inclusion of grain size measurements for the water column is also included here. Particle Size Analysis of both the in-situ sediments AND the sediments in the water column is essential. This is because the settling velocity of the suspended sediments is a key parameter to determining the size, shape and degree of the plume footprint. Also, a key research issue is the formation of colloids from individual particles which may have behaviour properties, in terms of settling velocity, that differ from individual particles.
38	1468	We recommend specific habitat classifications (if available) are identified to ensure consistency between contractors. We also recommend adding a sentence to recommend the use of any/all habitat classification models that have been developed in the region. By including any/all, this should future proof the document as more classifications become available, particularly in the light of such work coming out of REMPs. An example of such a current classification for the CCZ is McQuaid KA, et al. 2020. Using habitat classification to assess representativity of a protected area network in a large, data-poor area targeted for deep-sea mining.
38	1480 - 1482	Regarding non-physical data, we would recommend specific repositories, such as ISA DeepData, are detailed here to support comparison of data between contractors' baseline studies for the mining areas. Where non-physical data is linked to physical data in ISA DeepData, we recommend the location of the physical sample is also listed. We recommend that this section requires further detail, as the reference provided does not fully cover physical sample storage.
38	1492	We recommend changing to nekton and plankton as some organisms have early life stages as plankton and transition to nekton later in life. This would ensure that all life stages are considered, and it is also more practical as it is difficult to distinguish the planktonic and the nektonic stages in some species. The term 'Sea mammal' is rarely used in the literature and so it is recommended to use term 'marine mammal' instead throughout the document.
38	1503	We recommend the following edit: 'The benthos is the biota living in, <i>on</i> or near the seafloor as an adult'.
39	1515	We suggest the following addition to this sentence: 'Metals <i>and other contaminants</i> released during mining operations may impact organism physiology and therefore it is important to understand the potential toxicity of these'.
39	1518	We recommend changing to 'nekton and plankton' as noted in the comment above on line 1492.
39	1518	We recommend this is re-phrased to remove the focus on sensitive/protected species only. Noise, light and mining operations would impact all species moving within the contract areas – and sensitivity can be determined from the baseline later, for example in the EIA, and monitoring efforts can be targeted accordingly.
39	1522	We suggest this paragraph is edited to follow a similar level of detail/information as - and follow the format of - previous paragraphs on other ecosystem components, in order to enable clarity on the importance of monitoring seabirds

		including food web linkages. We also recommend removing the final sentence suggesting that they are easier to study than any other marine vertebrates. We also suggest consideration of merging the seabird paragraph with the paragraph above on sensitive marine species.
39	1524 - 1525	We suggest the removal of the word 'other', (as metals are not necessarily toxic, although some are).
39	1527	This paragraph only relates to two elements of temporal sampling requirements (ecotoxicology and pelagic migration), which are not the only two parameters for which temporal sampling is necessary. We recommend inclusion of additional information to consider the other variables noted in paragraph 21, or a more general statement, such as temporal sampling is necessary to capture variation in biological communities and factors which influence them over time.
39	1528	We recommend that other life history traits should be considered, such as growth rates, longevity, fecundity, reproduction, recruitment rates, size at first maturity, maximum body size. The development of a functional/life-history traits database would be useful and should also be considered. These data would enable the estimation of a number of indices in biodiversity within and amongst assemblages using a broad range of metrics. This would be very useful for operationalising REMPs - and therefore underlines the importance of standardisation.
39	1531	We recommend removing ' <i>it is likely that</i> ' – as comparisons with distant sites will definitely be required.
39	1532	We recommend that the methodology used to compare with distant sites should consider stratification by horizontal distance and by depth.
39	1545 - 1551	We recommend that this paragraph should also consider the spatial impact. The spatial sampling of the water column may need to cover a greater area and be determined by the current velocity and direction at specific depths. Reference zones may need to be further away for pelagic sampling compared with the benthos.
40	1552	We recommend that the statement on AUVS is edited to clarify whether use of AUVS is recommended, where relevant.
40	1554	We recommend that a standard should be developed and used in tandem with these guidelines specifying methods which will ensure reproducibility and comparability across sites.
40	1554 - 1555	We recommend clarifying the meaning and aim of the text in brackets '(sediment and nodules)', including why other types of substrates are not considered. Benthic sampling should include all types of substrates found in the geological features identified in section III, A, 14 (page 6).
40	1566 - 1569	We recommend that other preservation techniques for specific sample analysis requirements should be included here. Storing 'as cold as possible' is not best practice for some types of analysis (e.g. differences in preservation requirements for molecular versus morphological taxonomy). For example, see Glover et al. 2016 An end-to-end DNA taxonomy methodology for benthic biodiversity survey in the Clarion-Clipperton Zone, central Pacific abyss.

40	1576	We recommend that reference sites should also be considered, as well as mining sites and include a protocol that ensures reproducibility and comparability with other sites including non-impact areas.
40	1578	We recommend that the terms ‘secondary or indirect impacts’ should be defined in this document, including reference to any other ISBA document where the definition is already included.
40	1580	We recommend considering the generalised approach proposed by Woodall et al 2018, including methodology for biological, chemical and physical data collection. Woodall, L.C et al. 2018. A multidisciplinary approach for generating globally consistent data on mesophotic, deep-pelagic, and bathyal biological communities. <i>Oceanography</i> 31(3):76–89, https://doi.org/10.5670/oceanog.2018.301 .
41	1598	We recommend that primary production and chlorophyll-a should both be measured/mapped. Primary production and chlorophyll-a are different things. Although primary production and chlorophyll are linked, they can respond differently to environmental pressures. Chlorophyll concentration (used as a proxy for phytoplankton biomass) provides information on the standing stock of phytoplankton at a given location and time (expressed as mg Chl m ⁻³). Primary production is a process: the rate at which phytoplankton population is fixing carbon (mg C m ⁻² h ⁻¹). Furthermore, the amount of chlorophyll in the water at a given time is the result of phytoplankton production, minus losses (by grazing or viral lysis). Primary production can therefore reflect a number of environmental pressures, which cannot be detected through changes in chlorophyll alone. Primary production is often calculated using mathematical models and is driven by nutrient and light availability, temperature and grazing. While in-situ sampling of phytoplankton can indeed be used to calibrate PP output from satellite imagery; the text suggest that phytoplankton biomass and primary production are the same thing.
42	1641	See comment above (for line 1598) - the measurements should include more than just phytoplankton measurements to estimate primary productivity.
42	1648	We recommend that such data is caveated with such information in baseline studies - ‘organisms visible in images’ is not a consistent definition.
42	1673	We recommend rephrasing this sentence as not only fish are scavengers and scavengers are also not active predators.
42	1673	Other forms of carrion and organic material, such as jellyfish carcasses, are also important in fueling secondary production on deep-sea ecosystems. Sweetman Andrew K et al. 2014 Rapid scavenging of jellyfish carcasses reveals the importance of gelatinous material to deep-sea food webs <i>Proc. R. Soc. B</i> .
43	1676	We suggest considering standardising the approach to defining these strata/ physiographic units - i.e. OBIA of MBES to provide segments of homologous bathymetry, slope, rugosity and (if available) backscatter intensity. (See previous comments on strata in sampling design).
43	1679 - 1681	We recommend video is also included as a requirement to allow calculation of densities of megafauna along a transect.

43	1684 - 1685	We suggest this sentence is altered to clarify that video should be used to allow extent and distribution of megafaunal communities forming specific habitats to be determined.
43	1695	This will work for a self-propelled system (AUV, ROV) but a towed system will need to go in the direction of travel of the ship doing the towing.
43	1695	We also note that transects should be placed in areas where the randomising start location and direction does not cause them to cross habitat boundaries.
43	1701 - 1703	We suggest this is edited to state that the geophysical acoustic data are collected first, with a map of the topography, bedforms and broad substrate types determined ahead of assigning the zones/strata for randomising the sampling locations and transects, to align with the nested sampling design on page 6.
43	1703	We recommend that methods should be proposed to apply to these data to inform transect length i.e. power analysis, or species accumulation curves. Further clarity could also be provided on how such analysis informs transect length.
43	1704	We recommend including a reference for the requirement for a sample to have the aim of encountering 500+ individuals.
43	1704	If density of morphospecies is the final data type required for monitoring (line 1740) then it may be useful to consider if proposing to base the sample area on previous data (500+ individuals) is an appropriate method. Changing sample swept area between sites/stations risks losing the ability to robustly compare between them. We suggest considering setting a total swept area required for each sample as a standard (based on literature).
43	1704	We understand this sentence to be defining a preset transect length per physiographic unit, and using the same length for each replicate at each time interval. Whether this is set using information from previous data, using the 500 individual criterion or other data-derived criteria, or from preliminary investigations in the area to be monitored, we recommend that it should be clear in this paragraph that it should be backed up by/based on monitoring aims. It should also be considered when deciding on an appropriate length for each physiographic unit, how patchy the habitat is, and how patchiness is being dealt with. We recommend reflecting in this section that transects in the deep sea are likely to be long and should not cross habitat boundaries if the whole transect is to be used as one sample unit.
43	1705	The ground covered should be standardised within physiographic unit by standardising elevation and length and camera zoom. We suggest the text could be edited to state this more clearly.
43	1705	The very valid and useful approach of mosaicking HD video is specified here, but straight line transects are defined as the acquisition method previously. See previous comments about the sample being defined as the total swept area at a station, rather than transect distance. We therefore recommend clarifying here whether a mosaicking approach would be applicable here.
43	1715 - 1716	We recommend including here that this should only be done if the habitat is the same along a transect - if not, each different habitat section should be treated as a sample unit.
43	1717	We recommend specifying here a scale or a "ground-resolution" (i.e. number of pixels:1mm) to be achieved. This is particularly important if the imagery is required

		for identification of smaller megafauna (i.e. minimum of 10mm).
43	1717	This is an important point. The elevation above sea bed (2m) and 10 MP camera, without mention of optical (not digital) zoom level may not be sufficient to consistently identify 10mm sized fauna at even Phylum level. The required pixel ground resolution is a better determinant than camera CCD size. This will be dependent on camera elevation and lens and CCD resolution, and light.
43	1725 - 1727	We suggest considering the standardisation proposed by Howell et al. 2019 Howell KL et al. (2019) A framework for the development of a global standardised marine taxon reference image database (SMarTaR-ID) to support image-based analyses. PLoS ONE
43	1726	We recommend that the species ID should follow established morphotaxonomies where possible. However, in the absence of comprehensive existing catalogues, area and physiographic unit specific catalogues should be created by the contractor and followed in further surveys to ensure continuity and comparability in taxonomic identification between individual surveys. This would then feed into larger catalogues maintained by the ISA.
43	1726	Morphotypic and taxonomic ID are two differing approaches. We recommend that both approaches be specified, (i.e highest taxonomic resolution nested within a morphologically based label hierarchy). Or Operational Taxonomic Units might be better to specify here, given the difficulty in identification of deep-sea megafauna from imagery.
44	1729 - 1730	We recommend that requirements for data management should be specified more explicitly. The use of the DeepData database should be clearly outlined, and specific data management protocols mentioned. Data should be archived in a consistent, useable, and accessible format to avoid issues in comparability of data, as apparent within other industries. This is relevant for between contractors, as well as the global and regional level (e.g. REMPts).
44	1743	We note that this reference (ISA Technical Study No. 13: Deep Sea Macrofauna of the Clarion -Clipperton Zone) provides information on different studies that have used various sampling techniques, but does not specify a standardised methodology. We recommend that the information detailed in IBSA/25/LTC/6/Rev.1 should be checked against what has been provided in this document. The specific methodology regarding macrofauna on P24 could usefully be detailed within the main text of this document and not via referencing.
44/4 5	1754 - 1768	We recommend that indicating sieve size(s) to be used would help ensure standardisation.
44	1754 - 1755	We recommend adding here that the surface water should be siphoned off into a sieve as well, and photographs taken of the intact grab and cross-section, making note of any bioturbation and depth of any changes in sediment colour and/or smell to identify vertical changes in sediment type and depth of the anoxic zone.
45	1777	We recommend this sentence should also state ' <i>to the lowest possible taxonomic resolution</i> '.
45	1784 -	Technical Study 7 provides methodology for sampling and processing nematodes for molecular barcoding but does not consider other meiofauna. We recommend

	1786	that other meiofauna should be included in this section.
46	1800 - 1801	We recommend this part of the process should be the same for macrofauna as well.
46/4 7	1838 - 1847	We recommend that sieve sizes should be specified rather than suggesting survey team to select. This is necessary to enable comparisons to be made between contractor samples, contract areas, as well as globally and regionally (e.g. REMPs).
47	1871	We recommend that a sampling area is defined for all benthic macrofauna sampling. The sampling area should be consistent between sampling programmes (e.g. between different operators/fields) as it greatly impacts the ability to compare and combine datasets.
48	1913 - 1915	We recommend further expert consideration as to whether these methods are comparable.
49	1952	We suggest trawling is the most efficient method for sampling and quantifying demersal fish, though notably more destructive. More detail would be useful here, so that the requirements and options are clear. In addition, we recommend including some consideration of the trade-off between sampling robustness and impact of destructive sampling methods.
49	1955	We recommend clarifying this sentence, as longlines are complementary to trawls and can be used in areas where bottom-contact trawling is not possible. Additionally, longlines are more effective in sampling sharks and many gadiformes fish (e.g. grenadiers) that are one of the most common fish inhabiting these abyssal areas. Grenadiers are more mobile than other abyssal fish species and tend to avoid cameras and/or trawls. Using traps would be useful to sample other scavengers, such as crabs and synphobranchid eels.
50	1968	We suggest coordinated and targeted physical specimen sampling efforts, and development of processing pipelines that include access to experts and effective archiving should be considered. For example, see Howell et al. 2020: Howell (2020) A Blueprint for an Inclusive, Global Deep-Sea Ocean Decade Field Program.
50	1976 - 1982	We recommend ensuring consistency between relevant documents – this paragraph refers to the use of epibenthic sledges; yet this gear is not mentioned as a sampling tool in section 2: Macrofauna; but it is recommended in ISA technical Study 13 as a device to include as part of the sampling for baseline studies.
51	2041 ...	We recommend that the macrofauna and meiofauna sections should make reference to stable isotope analyses.
54	2149 - 2153	We recommend that ecosystem function should also be considered throughout (eg protection targets or Environmental Quality Standards), as is done for terrestrial mining and inputs to freshwater. The protection goal or definition of harm should be clearly articulated.
54	2152	We do not recommend the proposed approach - and would instead recommend other documented risk assessment methods, which use hierarchical tiered

		assessment frameworks, which can provide more certainty and confidence in the decision making. These are based around risk as well as evidence. For example, see the UK approach for tiered ecological risk assessment: https://www.claire.co.uk/useful-government-legislation-and-guidance-by-country/210-assessing-risks-to-ecosystems-info-ra2-5 (noting that these examples are adopted for terrestrial situations but could be developed for DSM).
54	2153	We recommend that the approach as described cannot be generic, but should be situation specific.
54	2155 - 2156	We recommend providing examples of sediment physico-chemical properties and specifics on which bioassays are recommended. There are currently no appropriate toxicity testing methodologies or stipulated biomarkers for assessing deep-sea mining.
54	2158	We recommend reviewing the LoEs provided in lines 2155-2158 in consideration of the specific nature of deep-sea sampling. Baseline data on background non-stressed levels within deep-sea indicator species will be needed to compare against. However, the biochemistry and physiology of species will also change once they have reached the surface (with many organisms not surviving). Therefore, elevated biomarkers will be very difficult to measure.
54	2159 - 2160	The most suitable quantitative methods should be specified and it should be clarified if baseline data collection will be in- or ex-situ.
54	2161 - 2163	Determining metal type from the mineral resources will not support understanding of the toxic risk nor consider metal speciation or bioavailability in the local environment, since biological toxicity is influenced by salinity, redox, temperature, presence of organic compounds, humic acids etc.
54	2165	We recommend that the reference provided (ECHA, 2008) is not applicable as it is about chemical product safety and registration.
54	2172 - 2179	We note that the references here are to evidence from 1969 and 1989 - and we are not aware that these methods have been tested at deep-sea depths.
54	2180 - 2190	For many commonly-studied metals, existing acute toxicological data [lethal concentrations (LC50) and effective concentrations (EC50)] are available, but only for shallow water biological species (e.g., Crompton, 1997). These data identify concentrations of metals which are lethal to 50% of the exposed population over a designated period, conventionally 72 or 96 h. Alternatively, more recent toxicological studies have adopted a variable exposure duration that matches a desired sub-lethal endpoint. The US EPA ECOTOXicology Database https://cfpub.epa.gov/ecotox/ is an online resource that summarises all available metadata included within each ecotoxicology publication, and this database is updated quarterly. However, interrogation of this database at the end of 2013, has shown that no data were available for any deep-sea taxa. Through DSM, the toxic effects of metals will act potentially at in situ deep-sea temperatures and pressures (high pressure up to 60 MPa, low temperature down to 2°C), which are very different from those of laboratory exposures reported in the ECOTOX database (conventionally set at standard conditions of a temperature of 20°C and a pressure of 0.1 MPa). There is a paucity of data comparing the toxic

		limits of metals in solution at low temperature (10°C) and high hydrostatic pressure (10 MPa) with those recorded under standard conditions of temperature and pressure (20°C and 0.1 MPa).
54	2190	We recommend that the references to ECHA are not relevant here.
55	2203 - 2204	We suggest replacing the word ‘whale’ with ‘marine mammal’. We also suggest the addition of ‘marine reptiles’. These changes could also be made in other relevant sections of this document.
55	2203 - 2215	<p>We recommend that this section should match the level of detail in the section for seabirds.</p> <p>We recommend referring to the latest SCANS survey (to ensure futureproofing of the document).</p> <p>We recommend amending to “<i>use of both towed and static acoustic monitoring ...</i>” - as towed hydrophones and PAM are both acoustic monitoring.</p> <p>We recommend clarifying here (especially in the light of the baseline data informing the EIA) what noting the abundance of mammals will tell us when it comes to impact assessment, especially if it’s for an uncommon/rare species. How much of that abundance data is random and how much is repeating pattern that can be monitored? How much data would be needed to produce useful trends for impact assessment?</p> <p>We also recommend including consideration of all potential environments (tropical to Arctic) so if there were specific geographically limited mammal species associated with any mining areas, these would need to be highlighted.</p>
55	2204	We recommend that this sampling is relevant to pelagic sharks only. These methods are not suitable for deep water sharks, but sampling of these sharks should also be included.
55	2205	We recommend that timing of the survey should be carefully considered to account for the seasonal migrations.
55	2210 - 2212	We recommend that PAM equipment should be carefully chosen so it can record a wide range of marine mammal vocalisation frequencies (high, mid and low frequency).
55	2213	We recommend that group size should be recorded too - abundance and densities should be calculated post survey.
56	2272	We recommend clarifying whether ‘the same sampling locations’ refers to the same general area or exact location - returning to exact locations is not possible with ship deployed equipment in deep water.
57	2287 - 2290	Image quality standards can be applied to ensure only comparable imagery is used for comparisons (e.g. as per http://www.nmbaqcs.org/media/1643/nmbaqc_epibiota_interpretation_guidelines_final.pdf)
58	2323	We recommend clarifying here that ‘the number of replicate samples will depend on the density or richness of the taxon of interest and its variance’ will be the case if the samples have been stratified in such a way to not need to consider other

		variables (i.e. depth, habitat, pressures). If not, the number of samples and replicates will need to account for these variables too (see previous comments on sampling design).
58	2337	We recommend simplifying as follows ‘ <i>An ornithologist should be present on surveys and use standardised protocols for seabird observation and collection to ensure data quality</i> ’. In addition, we suggest including in any such protocol that any dead birds are kept for further scientific study.
58	2339	We recommend rephrasing ‘...identification at sea is not an easy task ...’, in order to explain reasons why this is the case.
58	2340	We recommend clarifying why only these identification guides are referenced specifically – or are they provided as examples?
58	2344	We again recommend consideration of approach suggested by: Howell et al 2020: A Blueprint for an Inclusive, Global Deep-Sea Ocean Decade Field Program. Front. Mar. Sci. 7:584861. doi: 10.3389/fmars.2020.584861
58	2348 - 2350	We recommend that arrangements are in place with museums/collections facilities for voucher specimens in advance of data collection.
Although edits to format, grammar, spelling or punctuation have not been requested, some edits are noted below where the meaning is considered to be inaccurate based on the existing wording.		
7	217	Also, it should be established if observations <i>from</i> similar seasons ...
8	243	Box cores for macrofaunal <i>samples</i> should not be subsamples
9	272	model or collection <i>of</i> more samples
	368	Variability in physical parameters should be determined using different sampling <i>methodologies</i> as follows
23	840	benthic geochemical system, and thus, can also <i>be</i> excluded from baseline observations.
38	1492	large gatherings of surface nekton plankton
39	1512	knowledge of ecosystem functioning enables and understanding
39	1527	Temporal sampling is necessary to capture seasonal variability in tissue -metal and other contaminant concentrations <i>in tissue</i> for ecotoxicology studies
Additional rows can be added to this table by selecting “Table” followed by “insert” and “rows below”		

Comments should be sent by e-mail to ola@isa.org.jm