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Development of a standardized procedure for the development, approval and review of regional environmental management plans

Recommendations on technical guidance for the development of Regional Environmental Management Plans in support of the Standardised Procedure and Template

Issued by the Legal and Technical Commission

I. Introduction and background

Regional Environmental Management Plans (REMPs) for the Area contribute to protecting marine environments while also enabling the responsible extraction of mineral resources. As noted in the REMP Standardised Process and Template document (ISBA/29/C/10), these recommendations focus on the sections of ISBA/29/C/10 where detailed scientific and technical guidance are considered useful to underpin the development, establishment and review of regional environmental management plans. These recommendations aim to support each individual REMP in achieving the required evidence level and scientific robustness to inform decision-making for appropriate levels of environmental protection on a regional scale from mining activities, by, *inter alia*:

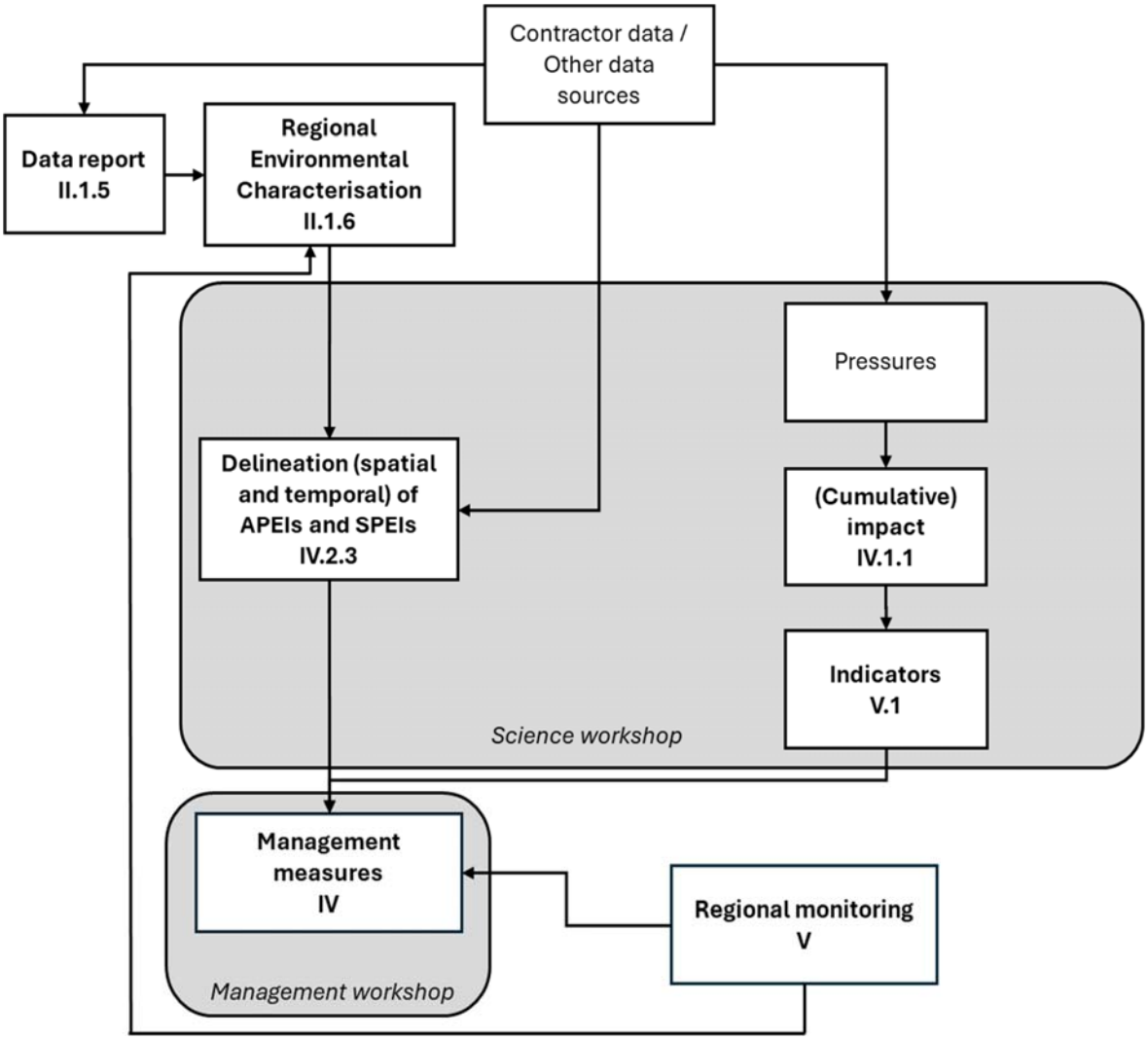
- providing detail on expert deliberations included in the development of the REMP and the criteria used for selection of experts;
- providing geographical and environmental context for environmental management;
- detailing criteria for a regional network of area-based management measures that are i) representative of the full range of habitats, biodiversity, sensitive ecosystems and biological communities, within the management area; and/or (ii) important for the maintenance of ecosystem structure and function; and
- considering non-spatial management measures

By clearly outlining and elaborating on the LTC's scientific and technical approaches, these recommendations will also help external experts and other stakeholders who engage in and contribute to the REMP process.

These recommendations provide more detail for the structures set out within the Standardised Procedure (ISBA 29/C/10), which includes the Template. **Bold** headings in this document align with the headings in the Standardised Procedure document. They also complement ISBA/29/C/10 in providing wider information on the REMP framework, comprising elements discussed in these recommendations, as shown in Figure 1.

Fig 1: Major elements in the development of a REMP

Relevant sections in these recommendations are noted below the boxes. Boxes without sections noted contain important inputs to the process though these are not detailed in the REMP.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II. Standardized procedure recommendations

2.1 Compilation of available data and information

Environmental baseline data on the region serve as the evidence base for the REMPs. These will be compiled in the Data Report (DR) and will underpin the Regional Environmental Characterisation document (REC). Potential data sources include global and regional data repositories, other public data repositories, the ISA's DeepData database (https://www.isa.org.jm/deepdata-database/) and supplementary data of published scientific literature. The Recommendations for the guidance of contractors for the assessment of the possible environmental impacts arising from exploration for marine minerals in the Area (ISBA/25/LTC/6/Rev.3) will be relevant for identifying patterns and trends at a regional scale that can inform environmental management.

2.1.1 Contractor data and information submitted to the Authority

DeepData hosts a large amount of contractor data on mineral resource assessment (geological data) and environmental baseline / assessment data; data types contained therein should follow the recommendations provided in ISBA/25/LTC/6/Rev.3.

2.1.2 Other data and information

A range of non-contractor data and information may be available to inform a REMP. These could include scientific projects, regional initiatives, peer-reviewed articles and publicly accessible databases. An indicative, non-exhaustive overview of other potentially useful public data repositories and the data types they contain is provided in Annex V.

2.1.3 Traditional knowledge of indigenous peoples and local communities

References to traditional knowledge of indigenous peoples and communities will need to be considered once the Council finalizes the applicable references within the draft exploitation regulations. This is a placeholder.

2.1.4 Other information

Any other information relevant to the indicative elements for the REMP, including other types of marine uses.

2.1.5 Data report

The data report (DR) provides an annotated compilation of data pertaining to the REMP region, in particular spatial data. It will include global and regional scale data sources, as well as consider the types of information available from more localised contractor studies. It should include data sources and results on the following topics:

1. Bathymetry
2. Geography including geomorphology
3. Geological structures
4. Oceanography
5. Biology including biological productivity
6. Biogeographic classification
7. Climate including climate change
8. Human uses
9. Areas defined for management and/or conservation objectives
10. Socio-cultural data
11. Sites of underwater cultural heritage

2.1.6 Regional Environmental Characterisation

The Regional Environmental Characterisation (REC) provides a synthesis of the environment present in the REMP region, highlighting patterns and trends in components of the environment that will inform regional-scale discussions within the workshops.

The REC is expected to provide an overview of

1 Background, scope and purpose of the document
2 Approach
a. Data sources
b. Data compilation and analysis methodology where appropriate
3 Contract areas for exploration and exploitation of mineral resources
4 Bathymetry, geography and geology
5 Physical oceanography
6 Chemical oceanography
7 Pelagic biology and ecology
8 Benthic biology and ecology
9 Human uses and potential impacts to the marine environment, including cumulative effects
10 Socio-cultural significance
11 Existing management regimes
12 References

2.2 Expert deliberation processes

Experts should be brought together, including through workshops, and selected by the Commission on the basis of an expert and stakeholder mapping exercise, in accordance with these recommendations.

Workshops on REMPs will be convened by the Secretariat under the auspices of the ISA, in line with relevant decisions of the Council and the Commission. These will identify possible elements to be considered for inclusion in the draft REMPs to maintain ecological balance of the marine environment, including a description of a potential network of managed areas and sites comprising Areas of Particular Environmental Interest (APEIs) and/or Sites of Particular Environmental Interest (SPEIs). Workshops seek the views of recognized experts in the relevant fields and engage dialogue with all stakeholders, including through pre-workshop, workshop, and post-workshop processes.

Workshop processes in general will be undertaken, subject to availability of financial resources, in two phased approaches. The first phase is the undertaking of scientific workshop(s), the second relates to management workshop(s). Workshop outcomes will contribute to the first draft of the REMP to be developed by the Commission.

Participants for the workshops are invited through ISA's nomination and selection process, through a set of selection criteria for science-based and management assessment workshops as listed below in 2.2.1 and 2.2.2. Stakeholder mapping exercises will be conducted to ensure the effective participation of stakeholders and experts in relevant fields.

The selection of nominees by the Commission for each workshop is based on the expertise and experience of the nominees as relevant to the workshop objectives, taking into account equitable geographic representation, gender balance and developing states representation.

2.2.1 Science-based workshops

2.2.1.1 Criteria for selection of scientific workshop nominees

For science-focused workshops, the selection criteria usually include:

a) good scientific knowledge and research experience in the region concerned, ideally with authorship of peer-reviewed reports and publications relating to deep-sea biology, oceanography, geology and environmental impact assessment related to deep-sea mineral resources

b) Access to relevant unpublished environmental data, including biological, physical and chemical oceanography, and geological data in the region concerned;

c) Good experience and expertise relating to spatial planning and scientific design of area-based management tools (such as marine protected areas), as well as non-spatial management measures; and

d) Stakeholders and persons with expertise in, and relevant data for, the area concerned, including traditional knowledge, and representatives of other resource users and coastal States.

2.2.1.2 Expected focus of scientific workshops

Scientific assessment workshop(s) will focus on scientific synthesis and description, in particular using data from the DR and REC, with objectives to:

a) Define the appropriate regional environmental management plan area, drawing upon information on the geology, biogeography, and oceanography of the region;

b) Review and analyse environmental data, including physico-chemical oceanographic, geological and biological data;

c) Synthesize environmental data, especially ecological characteristics and patterns including faunal distribution, faunal dispersal capabilities and distances, genetic connectivity, patterns of biodiversity, community structure, ecosystem function. Development of ecological proxy variables;

d) Describe current mineral exploration activity and resource distribution;

e) Review and describe current exploration activity within contract areas along with distribution of resources

f) Describe potential overlaps with other legitimate users and ABMTs established by competent bodies

g) Develop understanding of pressures, impacts and environmental risks

h) Evaluate effects (including cumulative and in combination) at the regional scale;

i) Provide descriptions of areas that could be protected from exploitation in order to aid in achievement of the effective protection of the marine environment;

i. identification and description of potential area-based management tools;

ii. identification of potential non-spatial management measures or options; and

j) Identify knowledge gaps and propose options to address them.

2.2.2 Management assessment workshop(s)

2.2.2.1 Criteria for selection of management workshop nominees

For management-focused workshops, the selection criteria include the following:

a) Good experience and expertise relating to spatial planning and scientific design of area-based management tools (such as marine protected areas), as well as non-spatial management measures;

b) Good environmental knowledge of the region concerned, ideally with authorship of peer-reviewed reports and publications;

c) Good understanding of the Authority's rules, regulations and procedures related to environmental management;

d) Expertise in appropriate maritime agencies or organisations (such as Regional Fisheries Management Organisations (RFMOs)) rules, regulations and procedures related to environmental management;

e) Expertise in cumulative / in combination impacts and regional-scale environmental assessment; and

f) Stakeholders and persons with expertise in / knowledge of the region concerned, including traditional knowledge, and representatives of other resource users and coastal member States.

2.2.2.2 Expected focus of management workshops

Management workshop(s) will focus on identifying specific management measures and implementation framework for developing elements for inclusion in the REMP. In particular, the workshop(s) will have objectives to:

a) Develop management measures at a regional scale;

b) Development of area-based management measures;

c) Development of environmental monitoring at the regional scale, through collaboration among contractors, sponsoring States and other stakeholders; and

d) Development of the strategic framework for assessment of cumulative impacts at the regional scales.

After the workshops, the report will be provided to the Commission for further consideration and subsequent development of the draft REMP.

2.2.3 Formal stakeholder consultation

Stakeholder consultation should take place to ensure that concerns and interests of stakeholders are considered and acknowledged during the preparation and drafting of the REMP. This can help ensure the REMP is comprehensive, complete and takes into account various stakeholder perspectives.

Stakeholder consultation should be conducted in a meaningful manner. It should provide appropriate access and reasonable opportunity for those consulted to raise enquiries and to share their views. The Commission should identify stakeholders consulted, issues raised and how such issues have been incorporated (or otherwise) into the REMP document.

2.3 Establishment of a regional environmental management plan

After the approval of the draft REMP by the Council, the Commission will facilitate the implementation of the REMP. The Commission, with assistance from the Secretariat, may identify priority activities and a timeline for the implementation of the REMP, taking into account resource availability. The Commission will explore opportunities for collaboration with existing scientific initiatives and programmes that may benefit the implementation of the REMP.

The Commission and the Secretariat will promote the participation of developing member States in the implementation of REMPs, through capacity building activities of the Authority.

2.5 Review of the REMP

A review of the REMP will be conducted at least every five years after its approval, or earlier under certain conditions as specified in the Standardized Procedure. The review should focus on

1) Review of progress in the implementation of the REMP,

2) Review of newly available scientific information and data and implications of such information and data for regional environmental management, and

3) Identification of updates and further actions, if needed, to the management

measures of the REMP in order to advance the goals and objectives of the REMP.

As part of the regular review process, the DR and REC will be updated with new information and data. The newly available information and data will be used to validate or update the scientific assessment, such as habitat classification or risk assessment that informed the development of the REMP. The review will also consider new contract areas as well as areas relinquished by the contractors and assess the conservation values of such areas. Where necessary, expert deliberations will be organized to support the review.

III Template recommendations

3.1 Geographical scope

Defining geographical scope (spatial extent of the REMP area) is a fundamental, step in the REMP development process, ensuring that the REMP area has environmental and functional integrity. It further ensures that the REMP is established solely in the Area and sets out the area in which area-based management tools (ABMTs) can be developed. Deciding the scope through the workshop process encourages collaborative decision-making.

The REMP geographical scope should therefore take into consideration the limits of the Area alongside the different types of large-scale geological settings for deep-sea mineral occurrence. such as abyssal plains, oceanic spreading ridges, fracture zones and seamounts, related to ecological structure and function such as:

- large area of similar habitat coverage;
- self-sustaining biological populations and
- a broad range of habitats.

3.1.1 Geographical and geological features used for development of scope

A REMP area may be defined using the position of the different types of geological settings for deep-sea minerals occurrence such as abyssal plains, oceanic spreading ridges, fracture zones and seamounts. This section will include a description of the data and information used to develop the definition of the region, including their location, depth range and the rationale for their use.

If appropriate consideration should be given to:

a) seafloor topography;

b) seafloor substrate (e.g. rock, sediment);

c) limits between geologically uniform regions;

d) distribution of the mineral resource(s);

e) distribution of geological features such as active volcanoes, hydrothermal vents and submarine mass flows; and

f) age of oceanic crust and seamounts.

This information should be extracted and presented in the DR where available.

3.1.2 Biogeographical areas

A REMP area definition will also include analysis of what biogeographic regions the REMP area may encompass. These are widely viewed as essential tools for oceans management in that they classify large areas into distinct (geographical) regions that contain groups of taxa and physical features that are largely distinct or unique from their surroundings at a certain scale. As such, they reflect biological units with a degree of common history and coherent response to perturbations and management actions. For the REMP, using biogeography in the definition of scope will aid in making sure

that biological gradients are not interrupted and that ecological functions are not constrained.

Global provincial classifications are based on combinations of environmental factors (such as oceanographic conditions and depth in the water column) and biological knowledge of distributions and abundance patterns of taxa, and include consideration of depth zones: epipelagic, mesopelagic, pelagic and benthic; and bathypelagic, abyssal and hadal. Examples of such provinces for areas of particular relevance to mineral resource management are the mesopelagic for plankton and nekton (in relation to water column discharges) and the lower bathyal and abyssal for deep-sea benthic communities (in relation to seafloor operations).

3.1.3 Oceanographic setting

Water masses, biological productivity, and currents of the region indicate areas of similar environmental characteristics, which should be included in developing the geographic scope of the REMP. This could include:

a) Physical Oceanography

- Water mass distribution;
- Regional surface and mid-ocean circulation;
- Bottom currents / seafloor topography driven currents (seamounts, ridges); and
- Physical water properties (pressure, temperature, salinity, turbidity).

b) Chemical Oceanography

- Chemical water properties (nutrients, dissolved oxygen, pH, dissolved/particulate organic carbon);
- Oxygen Minimum Zone (OMZ) depth; and
- Local chemical environment.

c) Biological productivity

- Surface biological productivity and particulate organic carbon (POC) flux to the seafloor; and
- Chlorophyll-a maximum depth.

3.2 Regional setting

This section should include a summary of key environmental information for the REMP, as compiled in the DR and REC. This section will be supported by maps and geographic information system (GIS) files. It is not intended to repeat large parts of the DR or REC, but to highlight the *key patterns or trends* that are important for regional-scale management.

3.2.1 Environmental characteristics

This section summarises the main characteristics of the pelagic and benthic marine environment in the region. It includes descriptions of environmental baseline data and results of other data analyses in the region, gathered through the stakeholder deliberations covered in Section III of the Standardized Procedure, and outlined further in this Guidelines document. As noted above in section 2.1, where appropriate, this should be based on the key variables and parameters included ISBA/26/LTC/6/Rev.3, and characteristics should be relevant to identifying patterns and trends at a regional scale.

3.2.1.1 Physico-chemical characteristics

This section will cover the main characteristics of meteorology and air quality, physical oceanography, and chemical oceanography:

a) Meteorology and air quality (general weather patterns and occurrence of natural climatological phenomena);

b) Physical oceanography (e.g. thermohaline conditions, optical properties and turbidity, surface, midwater and bottom currents regime, tides, waves, turbulence, and oceanographic fronts, eddies and climate change projections, including spatial variation); and

c) Chemical oceanography (e.g. structure, depth and development of the oxygen minimum zone, nutrients, particle loads, temperature and dissolved gas profiles, vent-fluid characteristics if applicable, turbidity, salinity, density, particulate and dissolved organic matter, pH, chemical composition).

3.2.1.2 Geological characteristics

This section will include a description of key regional geological and topographic structures and seabed substrate characteristics.

The geological setting should include a general description of the geological structures and topography related to the mineral resources, observed in that region. These can include one or more of the following:

a) For abyssal plains, the REMP should describe the depth range and variations in topography or geomorphology that influence nodule distribution and abundance. (e.g. occurrence of ridges, seamounts, characteristics of slope, submarine mass flows, etc.).

b) For oceanic ridges, the REMP should identify and describe any geological structures within the region, including morphology, depth range, variations in topography including slope and flank characteristics, and the geological setting of sulphide deposits.

c) For seamounts, the REMP should identify and describe the seamounts with their location, size, shape, slope and flank characteristics and information about sediment cover. The depth of the oxygen minimum zone should be characterised as well.

The characterization of seabed substrate should be focused on the type of substrate and its characteristics, related to the type and extent of deep-sea minerals. This description should include information that is important context for the distribution of the mineral resources and associated habitats. If appropriate one or more of these substrate types should be included in the REMP:

a) For polymetallic nodule fields, this may include the topography and geomorphology of the seafloor, gradients and/or slopes of the abyssal plains, the type of nodules substrate such as sediments or rocks, the types of sediments and its grain size, and the description of the nodules regarding spatial distribution, abundance and size range.

b) For polymetallic hydrothermal sulphide deposits, this may include information on depth and location of the site, distance to the ridge axis, characteristics and distribution of deposits, hosting rocks and hydrothermal vents (active or inactive), the temperature and composition of the hydrothermal fluids. The age of the oceanic crust should be taken into account as well.

c) For cobalt-rich ferromanganese crusts, this may include the range of water depth of crusts accumulations on the seamount, characteristics of the crust surface (rough - smooth) and crust location and coverage (continuous or discontinuous).

3.2.1.3 Biological characteristics

The description of biological characteristics for the region will emphasise information relevant to identifying patterns and trends of biological communities and ecosystems at a regional scale that are important in determining the management elements of the REMP. These will encompass, *inter alia*, a description of pelagic and benthic biological and ecological properties including biodiversity, community composition, abundance, biomass, life history characteristics, relevant behaviour, including feeding rates, connectivity, trophic relationships, resilience, and ecosystem functions and services.

This description should also include:

- Spatial (horizontal and vertical) and temporal (including seasonal and interannual) variability;
- Potential environmental drivers of spatial and temporal variability;
- Any work on ecosystem models and appropriate ecosystem indicators;
- Potential endemism (restricted to just the site, resource substrate or region);
- Taxa known to be highly sensitive to disturbance, or are considered rare, threatened or endangered; and
- Migratory and highly mobile species where foraging ranges, migration pathways, and/or management units overlap with the region.

The description should be structured by depth zones (at least surface (0-200 m depth, including seabirds), water column (200 m depth – ca. 50 m above the seafloor) and benthic (the seafloor including the water layer ca. 50 m above the seafloor)) and with the consideration of how these depth zones are connected.

3.2.1.4 Natural stressors

This section should include details of any region-scale natural stressors (e.g., volcanic activity).

3.2.2 Information on human activities in the region

REMPs should consider human activities also occurring / likely to occur in the region, that would be relevant for the achievement of the REMP goals and objectives.

a) Minerals resource-related activities

Details of mineral resources related activities should be described, including but not limited to:

- location of mineral exploration and exploitation contracts in the REMP region;
- location of reserved areas; and
- major transit paths for vessels used in exploration and exploitation contracts in the REMP region,

b) Other human activities

This section should cover other legitimate marine uses in the region, including but not limited to:

- cable installation and operation;
- pelagic and demersal fisheries;
- other abandoned or functioning industry installations, such as telecommunications nodes or oil and gas wells; and
- marine scientific research.

c) Other anthropogenic stressors

This section should cover other anthropogenic stressors, including but not limited to:

- climate change (including ocean acidification);
- pollution; and

- illegitimate use of the region (e.g., Illegal Unreported and Unregulated (IUU) fishing, piracy).

3.2.3 Cultural heritage

Details should be provided of any cultural heritage and interests in the region. A full cultural heritage impact assessment is not expected here, but there should be consideration given to potential issues at a regional scale. There are 3 stages that can be addressed in the REMP process:

- Describing cultural heritage assets and their settings, including cultural experience;
- Assessing potential impacts of future exploitation (the degree to which any change would impact on cultural significance); and
- Identifying measures in the REMP that would mitigate potential future impacts and protect important cultural heritage assets.

3.2.4 Summary of knowledge gaps

While some data gaps and uncertainties are described in the REC (and also under some of the headings above), it is recommended to include a separate summary here of the main information gaps and uncertainties (due to data quality or quantity) collectively at the level of the geographical scope of the REMP with regard to environmental data and information.

3.2.5 Designations and management systems

This section should include identified descriptions, designations, management systems or standards elaborated by international organizations or agreements.

Identified areas of potential or particular ecological interest (e.g., Ecologically or Biologically Significant Areas, Vulnerable Marine Ecosystems, Key Biodiversity Areas) should be described and included on maps (or referenced to the DR).

IV Management of region

This section includes the key elements and analyses carried out in formulating management measures, as well as the management outcomes for the network of areas and sites of particular environmental interest (APEIs / SPEIs).

This should include area-based management tools and other management measures to be applied across the region based on the science-oriented deliberations and management-oriented deliberations of relevant sections of the Standardised Procedure Document and the goals and objectives in the relevant section of the Template.

It should also include consideration of environmental risks through sequential understanding of pressures and impacts. While these details may not need to be fully elaborated in the REMP itself, they form a set of essential processes that need to take place in order to develop management measures. These processes for developing management measures, and the conclusions of analyses needed for development of measures, are mainly detailed in the workshop reports.

In the text below, the considerations are typically kept fairly general and high level. The environmental characteristics of each region differ, and hence the nature and extent of potential management measures (and their specific design) will depend on what is most appropriate to achieve the environmental objectives for a region.

4.1 Area-based management

4.1.1 Regional Network Analyses

Effective spatial planning requires two types of criteria and scales of analysis: (1) network or regional criteria that provide guidance on the representativity, adequacy, spatial configuration, connectivity and other broader criteria guiding the development

of the entire collection of sites; and (2) criteria that provide guidance on the priority, size, shape, and orientation of individual sites. The scale of benefits derived from individual protected areas will depend on their location, design, size, and relationship to other forms of management. Protected area networks magnify the benefits of individual sites and protect the large-scale processes that maintain healthy populations, such as connectivity, gene flow and genetic diversity.

Criteria that can help identify the ecological considerations that are central to designing protected area networks include:

- Representativeness - protected area networks should represent the range of diversity (from genes to ecosystems) and the associated physical environment within the given region;
- Replication - all habitats in each region should be replicated within the network and distributed spatially throughout the network;
- Viability - protected area networks should incorporate self-sustaining, geographically dispersed component sites of sufficient extent to ensure population persistence through natural cycles of variation. These sites should be independent (as far as possible) of activities in surrounding areas;
- Precautionary design - decisions should be based on the best information currently available, rather than delaying the process to await more and better information. Where information is limited, designers should adopt a precautionary approach;
- Permanence - network design must provide long-term protection to effectively conserve diversity and replenish resources;
- Maximum connectivity - protected area network design should seek to maximize and enhance the linkages among individual protected areas, groups of protected areas within a given region, or networks in the same and/or different regions;
- Resilience - protected area networks must be designed to maintain ecosystems' natural states and to absorb perturbations, particularly in the face of large-scale and long-term changes (such as climate change) and
- Size and shape - individual protected area units within the network must be of sufficient size to minimize adverse impacts from activities outside the protected area (avoiding the "edge effect").

Individual site criteria include:

- Uniqueness or rarity - areas or ecosystems that are unique or that contains rare species whose loss could not be compensated for by similar areas or ecosystems. These include (a) habitats that contain endemic species; (b) habitats of rare, threatened or endangered species that occur only in discrete areas; (c) nurseries or discrete feeding, breeding or spawning areas;
- Functional significance of the habitat - discrete areas or habitats that are necessary for: (a) the survival, function, spawning/reproduction, or recovery of species; (b) particular life history stages (for example, nursery grounds or rearing areas); (c) rare, threatened or endangered marine species;
- Three-dimensional structural complexity - ecosystems that are characterized by complex physical structures created by significant concentrations of biotic and abiotic features. In such ecosystems, ecological processes are usually highly dependent on these structured systems. Further, such ecosystems often have high biodiversity, which is dependent on the structuring organisms;
- Special importance for connectivity - areas that are required for a population to survive and thrive;
- Vulnerability, fragility, high sensitivity or slow recovery - areas that contain a relatively high proportion of highly sensitive habitats, biotopes or species that are functionally fragile (highly susceptible to degradation or depletion by human activity or by natural events) or with slow recovery;
- Biological productivity - area containing species, populations or communities

with comparatively higher natural biological productivity;

- Biological diversity - area contains comparatively higher diversity of ecosystems, habitats, communities or species or has higher genetic diversity;
- Naturalness - area with a comparatively higher degree of naturalness as a result of the lack of or low level of human-induced disturbance or degradation.

Potential individual sites will be assessed against the site criteria, using an agreed form of ranking that describes the degree to which a specific criterion is met, based on confidence levels in available scientific information

4.2.3 Area-based management in REMPs

Two scales of area-based management are used for REMPs.

A REMP's primary coarse-filter area-based management tool is the creation and designation of a 'coarse filter' network of **areas of particular environmental interest (APEIs)**, providing a regional approach targeting broad ecosystem features and gradients. The selection of APEIs in a region is meant to preserve large, representative and self-sustaining areas of the ecosystem using network criteria. Given this scale of assessment, it is widely accepted that maintenance of a diverse representation of physical environments should be used to maintain the bulk of species diversity. It has also been also suggested that maintaining areas of high physical and ecological heterogeneity through a coarse filter approach offers increased resilience under changing climatic conditions. Some of these are described in Table 1, which shows examples of network criteria alongside large-scale parameters that will define assessment, and also suggested assessment approaches.

In the case of the Clarion Clipperton Zone (CCZ), the size, shape and configuration of individual APEIs were developed so that each APEI should:

- Take into account biophysical gradients which affect the biogeography of marine biodiversity in the planning region;
- Protect a full range of habitat types found within each subregion;
- Be large enough to maintain minimum viable population sizes for species potentially restricted to a subregion, subregions being characterized by differential environmental and biological data;
- Be surrounded by a buffer zone to ensure that biota and habitats in the protected area are not affected by anthropogenic threats occurring outside the APEIs; and
- Have straight line boundaries to facilitate rapid recognition and compliance.

Based on a detailed consideration of environmental data, faunal distribution, faunal dispersal capabilities and distances, and ecological proxy variables, it was determined that a core area of each APEI for the CCZ should be at least 200 km in length and width, surrounded by a buffer zone 100 km in width. These distances may be different for each other REMP but should fulfil the same requirements.

Table 1: Examples of APEI criteria and general assessment approaches

APEI Criteria	Parameters	Assessment Approach examples
Representativity	Size and shape of area Spatial extents of habitats and ecosystems Range of habitats and ecosystems represented Rare, distinctive or important species and habitats within the biogeographic region Biodiversity Environmental gradients Ecosystem integrity	Spatial analysis of habitat / community / ecosystem components Distribution of habitat / community / ecosystem across region Habitat type assessments Biodiversity statistics (composition, abundance etc)
Replication	Size and shape of site Position of replicates within sites Area represented related to amount of habitat in the region Range of habitats / ecosystems	Number of replicates of habitats Statistical analyses of variability
Permanence	Range of habitats Connectivity Size and shape of areas	Time-series analyses Physical models (e.g. plumes) Metapopulation, dispersal distance and connectivity analysis
Viability; Maximum connectivity	Range of habitats Size and shape of area	Metapopulation, dispersal distance and connectivity analysis Migration corridors
Resilience	Biodiversity Ecological significance Long-term protection Ecological linkages; connectivity Size and shape	Species diversity Functional group diversity Ecological traits Disturbance & recovery models
Precautionary design	Size and shape (buffers)	Distribution of potential human impacts
Size and shape	Size and shape (buffers)	Spatial analysis of ecosystem extent vs. relative areas

Examples of APEIs include:

- Areas of representativity (multiple habitats, topography, faunal communities)
- Fracture zones
- Seamounts

For finer spatial scales of management, a ‘fine filter’ approach is used that allows designation of **sites of particular environmental interest (SPEIs)** that may be of particularly high values or at particularly high risk, and is focused on conserving individual rare or specialized taxa that are not necessarily protected in APEIs.

Some assessment approaches for these considerations are described in Table 2, which shows examples of site criteria to suggested assessment approaches.

Table 2: Examples of SPEI criteria and general assessment approaches

SPEI Criteria	Assessment Approach examples
Uniqueness or rarity	Species diversity, species rarity; endemism; habitat rarity
Functional significance of the habitat	Observation of nursery areas / rearing areas / spawning grounds; life history analysis;
Structural complexity	Ecological traits analysis; habitat models; MBES; SSS
Connectivity	Metapopulation, dispersal distance and connectivity analysis
Vulnerability, fragility, high sensitivity or slow recovery	Representativity analysis; species diversity; species rarity; endemism; pressures / impacts analysis
Biological productivity	Species diversity; biomass
Biological diversity	Species diversity
Naturalness	Species diversity; pressures / impacts analysis

Examples of SPEIs include:

- Hydrothermal vents
- Deep-sea coral reefs/coral gardens
- Sponge gardens/deep-sea sponge aggregations
- Sea pen fields
- Xenophyophore aggregations

This general combination of coarse and fine filter approaches is commonly used in both marine spatial and conservation planning in numerous national and international processes.

4.2.4 Spatial extent of the APEI network

The spatial extent of protection needed to be provided by the APEIs and SPEIs to aid in the fulfilment of the REMP goals and objectives will vary between REMPs as well as how the nature and extent of management measures are structured. Different habitats will require different levels of protection.

Development of an understanding of extent of protection usually involves at least the following considerations:

a) The spatial coverage of a habitat occurring in a particular region (the more habitat available, the smaller the proportion that needs to be protected);

b) The regional and global conservation status of the habitat (the better the status / the better the trend, the smaller the proportion that needs to be protected);

c) Biodiversity / ecosystem functioning of the habitat (the higher the biodiversity / ecosystem functioning, the bigger the proportion that needs to be protected); and

d) Criticality of the habitat for species of conservation concern (e.g. a critical habitat for a part of the life cycle of a red-listed species) (the greater these relationships, the bigger the proportion of the habitat that needs to be protected).

Ability to define protection levels will also depend upon the quality and quantity of underlying data. Ultimately, it would be an aim for protected areas could be determined (or modified on the basis of new data) using spatial planning software (e.g., Marxann, Zonation), or prioritisation applications (e.g., Prioritizir in R). In the early stages of planning and implementing a REMP, however, expert opinion is the most realistic option given a data-limited situation.

4.1.2 Assessment of cumulative / in combination effects

It is important to not only understand individual impacts, but also the combined impacts that are expected to occur. Effects from these impacts should be assessed both spatially and temporally at a regional, rather than local, scale.

Combination of effects can occur in two ways:

a) cumulative effects arising from multiple mining operations in the REMP region and

b) in combination effects arising from all industrial sectors operating in the region.

These may be the same if mining is the only expected industry in the region.

Some effects may act synergistically to increase the level of impact while others may act antagonistically to reduce the overall level of impact.

The significance of these effects can then be evaluated, particularly using any management measures provided for the APEIs and SPEIs, of the impact on the selected habitats, species or community groups.

4.2.5 Conditions imposed on mineral resource related activities by the International Seabed Authority

Conditions may be imposed on mineral resource related activities, for example, the current CCZ EMP conditions that the 13 APEIs should not be affected directly by physical activity or indirectly by mining effects. However, this does not provide restrictions on other activities, as the protection network was designed for solely mining purposes and objectives within the ISA mandate.

4.2.6 Non-spatial management

This section includes any management measures that are not solely area based. These may include aspects such as requirements for equipment, operations etc.

4.2.6.1 Temporal management

This section comprises details of any temporal, including seasonal, measures that should be applied to seabed mineral activities (e.g., to take into account migration of marine mammals and other megafauna).

4.2.7. Other management measures, if any

This section should include any other management measures, or options that might need to be considered in future (e.g., areas where precaution might need to be applied given particular circumstances, conditions that could be necessary in any areas of potential mining to ensure the REMP is not compromised etc.).

V Regional monitoring

A robust monitoring approach based on the goals and objectives of the REMP should be designed and implemented at the regional scale to deliver reliable information regarding the conditions observed in the region to aid in assessing the performance of management measures under the REMP and providing a long-term spatial and temporal perspective on natural variability. This will allow monitoring programmes to track changes at a regional scale, whether related to natural fluctuations or related to exploratory and testing activities, or commercial mining.

The scope and elements of regional monitoring under each REMP may vary depending on regional contexts and the design of any regional-scale monitoring. Implementation will need to consider the availability and mobilisation of resources.

The objectives of a regional approach to environmental monitoring can include:

a) Observation of natural and human-induced variabilities in the region, in order to determine regional systems based on the best available scientific knowledge;

b) Provision of a strong scientific basis for the ISA to, as necessary, revise region-specific environmental goals, objectives, policies and thresholds as well as direct the setting and review of individual contract-specific environmental goals, objectives, policies and thresholds;

c) Evaluation of a cumulative regional overview of the environmental impacts of mining;

d) Identification of major gaps in knowledge that require further sampling or investigation;

e) Provision of feedback for regional-level environmental assessments in order to inform any required modification at the regional level;

f) Provision of guidance on the advancement of regional environmental objectives through relinquishment of parts of the exploration contract areas; and

g) Detection of the extent of environmental impacts that arise from mining activities at a regional scale in order to inform decision-making at the ISA.

5.1 Strategy for regional environmental monitoring

This section should describe measures for monitoring the state of the environment and/or potential changes in a specific region. It will include:

a) Identification of monitoring objectives, and regional scale indicators based on the REMP objectives

b) Future research priorities covering survey / sampling areas, sampling methodologies, and data analyses, to address current data gaps

c) Integration of information coming from all relevant sources, such as contractors, scientific literature, DeepData, global databases and other relevant information

d) Measures to incentivise marine scientific research, through international cooperation

e) Options for collaboration with and between contractors

The strategy could involve three hierarchical and standardised steps, shown below.

1) Define monitoring objectives for the REMP

Objectives for the regional monitoring programme have to be agreed as a starting point for the definition of spatial and temporal monitoring efforts and have to be consistently aligned with goals and objectives previously defined and modified in the respective REMP.

2) Define targets, indicators, metrics and thresholds

Indicators developed from the regional objectives can be specified by a **metric** and a **threshold.** All indicators, associated metrics and thresholds should be developed utilising the most current, best-practice environmental information from the REC, and therefore updated in light of new information.

In the early stages of a REMP, before exploitation, data may be limited for defining indicators. Their development may rely on qualitative ecosystem models (better known as qualitative mathematical models or signed digraphs). Such models can be used to link ecosystem species and communities to the activities and pressures of concern. They can describe and predict impacts on ecosystem structure and identify components of high risk or uncertainty, the latter being important to monitor in order to assess the likely success of potential management options and measures. As the

knowledge base grows for an individual REMP, semi-quantitative or quantitative models may also be used.

Suitable indicators can start to be selected using four key questions:

- Is the indicator measurable using current technology?
- Can changes in the indicator values be interpreted?
- Will the indicator lead to improved management or policy?
- Will the indicator inform decisions for multiple objectives?

Selection of ecological and ecosystem indicators can be informed by variables measured through existing global observation networks. Examples of such variable include Essential Ocean Variables (EOV) and Essential Biological Variables (EBVs).

3) Define spatial and temporal scales of sampling

Critical elements in the selection and sampling design are the identification and quantification of appropriate **temporal and spatial scales** of variation, which should drive the definition of appropriate **data resolution for monitoring**.

5.2 Knowledge gaps and research priorities

This section should identify the key knowledge gaps in the implementation of the REMP and provide information about the priorities for future research and / or monitoring to address these knowledge gaps.

5.3 Other aspects

This section should include:

a) Measures for capacity-building and training

b) A communication and public information strategy

VI Review of the progress in the implementation of the Regional Environmental Management Plan

This section should outline the review process to be taken place at the latest every five years following the adoption of a REMP. A comprehensive review process is essential to determine if the content of the REMP provides a satisfactory assessment of the project and can contribute to the decision-making process.

The review will be undertaken to determine its suitability or need for amendment, on the basis of the best available data and information and in alignment with the rules, regulations and procedures of the Authority.

The review should be:

1 Process-Specific

- Adjustable to the specific situation without compromising the integrity of the process;
- Including criteria applicable to various steps that are appropriate for the specific situation without compromising the integrity of the process;
- Including sufficient data collection effort to characterise and prioritise residual risks;
- Including a variety of assessment and reporting efforts as appropriate for the situation; and
- Including stakeholder consultation.

2 Performed with Scientific Integrity

- Applying Best Available Scientific Evidence;
- Using actionable information and outputs; and

- Using best expert judgement and sound data collection and analysis, subject to independent verification and validation.

3 Sustainability Focused

- Supporting sustainable development;
- Including assessment, evaluation, and analysis of potential consequences for socioeconomic, physiochemical, and biological environments;
- Aligning with efforts, goals, and standards of regional and global organizations;
- Adhering to regional and global instruments guidance.

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ANNEX I: APEI DESIGNATIONS

Provide a list of APEIs, including:

- Maps
- Coordinates (turning points)
- Description of APEI, including reasons for designation (representativity, unique fauna etc)

ANNEX II: SPEI DESIGNATIONS

Provide a list of SPEIs, including:

- Maps
- Coordinates (turning points)
- Description of SPEI, including reasons for designation (representativity, unique fauna etc)

ANNEX III: SUMMARY OF KNOWLEDGE GAPS AND RESEARCH PRIORITIES

ANNEX IV. OUTLINES FOR THE DATA REPORT AND REGIONAL ENVIRONMENTAL CHARACTERISATION

The outlines below should be used to guide the preparation of Data Report and Regional Environmental Characterisation. The availability of data and information and the level of detail may vary in different regions and for different parameters. The sources of data included in the Data Report and Regional Environmental Characterisation will be referenced in the documents.

a) Outline for the Data Report

1 Background and scope of the report

2 Bathymetry

3 Geography including geomorphology

- Distribution of geological structures (e.g. abyssal plains, oceanic ridges, fracture zones and seamounts)
- Topography and geomorphology of the seafloor
- Seabed substrate (e.g. sediment types, thickness and composition)
- Distribution of deep-sea minerals (e.g. distribution of polymetallic nodules, hydrothermal vents, polymetallic sulphides deposits, age of oceanic crust and location and coverage of crusts)

4 Oceanography

- Metereology and climatology (e.g. monsoon and ocean climatology)
- Physical oceanography (e.g., physical water properties, water masses, surface, midwater and bottom currents, fluxes of particulate organic carbon)
- Chemical oceanography (e.g. productivity, nutrients, depth of oxygen minimum zone, chemical water properties)

5 Biology including biological productivity

- Regional distribution of taxa (e.g. Ocean biodiversity information system (OBIS) data and DeepData)
- Habitat suitability models (e.g. predictions of habitat suitability for cold-water octocorals)
- Occurrence of vulnerable marine ecosystems (VME) indicator taxa in the region
- Global and regional patterns in benthic biomass
- Migratory connectivity for oceanic megafauna
- Connectivity models

6 Biogeographic classification

- Global open ocean and deep seabed (GOODS) biogeographic classification
- Global mesopelagic biogeography
- Pelagic provinces of the world
- Longhurst marine provinces

- Bioregions
- Global seascapes
- Biogeography of hydrothermal vents, seamount classification etc.

7 Climate including climate change

8 Human uses and potential impacts

- ISA contract areas for the exploration and exploitation of mineral resources
- Demersal and pelagic fishing
- Global and regional patterns of megafaunal fishing bycatch
- Commercial shipping
- Undersea cables construction and operation
- Cumulative impacts models

9 Areas defined for management and/or conservation objectives

- Regional fisheries management organizations (RFMOs)
- Regional Seas Conventions
- Particularly Sensitive Sea Areas (PSSAs)
- VME areas closed to bottom fishing activities
- Convention on Biological Diversity ecologically or biologically significant areas (EBSAs)
- Marine protected areas (MPAs)
- Key Biodiversity Areas (KBAs)
- Important bird areas (IBAs)
- Important marine mammal areas (IMMAs)

10 Socio-cultural

- Archaeological sites
- Human remains
- Traditional navigation routes

11 Sites of underwater cultural heritage

b) Outline for the Regional Environmental Characterisation

1 Contract areas for exploration and exploitation of mineral resources

2 Bathymetry, geography and geology

- Bathymetry
- Distribution of geological structures (e.g. abyssal plains, oceanic ridges, fracture zones and seamounts)
- Topography and geomorphology of the seafloor
- Seabed substrate (e.g. sediment types, thickness and composition)

- Distribution of deep-sea minerals (e.g. distribution of polymetallic nodules, hydrothermal vents, polymetallic sulphides deposits, age of oceanic crust, and location and coverage of crusts)

3 Physical oceanography

- Metereology and climatology
- Physical oceanography at regional and local scales (e.g. physical water properties, water masses, surface, midwater and bottom currents, local flow environment, fluxes of particulate organic carbon)
- Climate change projections

4 Chemical oceanography

- Chemical oceanography at regional and local scales (e.g. primary productivity, nutrients, oxygen minimum zone, chemical water properties, local chemical environment)

5 Pelagic biology and ecology

- Regional and local distribution of pelagic and fauna (e.g. species composition, abundance and regional and local distribution patterns of plankton, air-breathing fauna, mid-water nekton, sharks and commercially important fishes, microorganisms)
- Temporal variation in the distribution of pelagic fauna (e.g. seasonal and inter-annual changes in biological communities and populations)
- Trophic relationships
- Connectivity (e.g. migration patterns, population genetic studies)
- Ecosystem function

6 Benthic biology and ecology

- Regional and local distribution of benthic fauna (e.g. species composition, abundance and regional and local distribution patterns of microorganisms, benthic meiofauna, macrofauna and megafauna)
- Temporal variation in the distribution of benthic fauna (e.g. seasonal and inter-annual changes in biological communities and populations)
- Trophic relationships
- Connectivity (e.g. migration patterns, population genetic studies)
- Ecosystem function

7 Human uses and potential impacts to the marine environment, including cumulative impacts

- Demersal and pelagic fishing
- Commercial shipping
- Undersea cables construction and operation
- Cumulative and in combination impacts

8 Existing management regimes

- Regulations of different activities, including area-based management tools established by international and regional organisations

9 Socio-cultural

- Archaeological sites
- Human remains
- Traditional navigation routes

ANNEX V: POTENTIAL DATA SOURCES

In addition to ISA's DeepData database, data needed to evidence the REMPs can be found in national, regional and global data repositories. Below you can find an overview of example data repositories and the type of data contained therein that can be consulted in the data compilation stage of the REMP development and review.

In many countries, a National Oceanographic Data Centre (NODC) provides facilities to archive data sets related to marine sciences (e.g. NODC in the United States of America: https://www.ncei.noaa.gov/). These NODCs collaborate in the framework of the Intergovernmental Oceanographic Commission (IOC) (https://www.ioc.unesco.org/) of UNESCO.

Some other, specific examples of online resources for downloading environmental data on a global scale are:

Bathymetry:

- SRTM30_Plus (see https://topex.ucsd.edu/WWW_html/srtm30_plus.html)
- ETOPO1 (see https://www.ncei.noaa.gov/products/etopo-global-relief-model)
- GEBCO (see https://www.gebco.net/data_and_products/gridded_bathymetry_data/)
- Other bathymetric data made available from other sources including Contractors.

Sea Surface Temperature:

- AVHRR Pathfinder SST (see https://www.ncei.noaa.gov/products/avhrr-pathfinder-sst)

Water column temperature and salinity:

- Argo float data (https://argo.ucsd.edu/data/)

Marine biodiversity:

- Ocean Biodiversity Information System (see https://obis.org/)
- The Global Biodiversity Information Facility also hosts marine biodiversity data (https://www.gbif.org/)

Phytoplankton biomass and productivity:

- OceanColour-CCI (https://www.oceancolour.org/)
- NASA Ocean Color Web (see https:// Vertically Generalized Production Model (VGPM; https://sites.science.oregonstate.edu/ocean.productivity/)
- oceancolor.gsfc.nasa.gov/)

- Vertically Generalized Production Model (VGPM; https://sites.science.oregonstate.edu/ocean.productivity/)

Sea Surface Height:

- AVISO sea surface height and geostrophic current data (https://www.aviso.altimetry.fr/en/data/products/sea-surface-height-products.html)
- AVISO significant wave height data (https://www.aviso.altimetry.fr/en/data/products/windwave-products.html)

Sea Surface Wind:

- Quikscat (https://podaac.jpl.nasa.gov/QuikSCAT)
- AVISO Surface Wind data (https://www.aviso.altimetry.fr/en/data/products/windwave-products.html)

Data from these repositories will be mostly useful to support predictive modeling (see below), which can be used for habitat mapping, modelling of plume impacts as well as for the assessment of cumulative impacts derived from e.g. climate change and its effects on benthic-pelagic coupling (see HYbrid Coordinate Ocean Model or HYCOM, https://www.hycom.org/).

In addition to these global data repositories, other potential (meta)data sources include:

- **Remote data collection and observatories**. Examples of remote data collection and observatories include the Global Ocean Observing System (GOOS, https://www.goosocean.org), together with its regional nodes, and specific programs such as the Deep Ocean Observing Strategy (DOOS, https://www.deepoceanobserving.org/), the European Multidisciplinary Seafloor and water column Observatory (EMSO, http://emso.eu/) and the Argo float program (https://argo.ucsd.edu/).

- Many **science and fisheries advisory organizations** are national, but some are regional and encompass large areas of open ocean and deep sea, such as the International Council for the Exploration of the Sea (ICES, https://www.ices.dk/) in the Northern Atlantic and the North Pacific Marine Science Organization (PICES, https://meetings.pices.int/) in the Pacific. These organizations hold potentially relevant environmental data and information.

- Also the **UN Food and Agriculture Organization** (FAO, http://www.fao.org/) holds large amounts of data, but often aggregated to a level of detail that becomes too coarse-grained to be used for purposes other than fisheries management. FAO's database on VMEs (http://www.fao.org/in-action/vulnerable-marine-ecosystems/about-vme-database/en/) is a compilation of information on management measures taken to reduce current or potential impact on areas where VMEs are known or likely to occur, and is linked to data providers, which are mainly regional fisheries management organizations (RFMOs).

- **Museums** are traditionally the keepers of biodiversity information, storing physical specimens since centuries. The progress in database and communication via Internet has prompted many

museums to digitize specimen data and make this information available through the World Wide Web (e.g., the Natural History Museum of London (https://data.nhm.ac.uk), the Smithsonian Institution (https://www.si.edu/), the California Academy of Sciences (https://www.calacademy.org) following the standards of the Global Biodiversity Information Facility (GBIF), Darwin Core (https://dwc.tdwg.org/) and Ocean Biodiversity Information System (OBIS).

- **(International) scientific research programs** generate large datasets. The currently obligatory data availability statement in the resulting scientific papers states how these data can be accessed. Data are typically available online via publicly accessible data repositories like Pangea (https://www.pangaea.de/) or DRYAD (https://datadryad.org/stash). In case of genetic data, Genbank (https://www.ncbi.nlm.nih.gov/genbank/), The Barcode of Life Data system (BOLD, https://www.boldsystems.org/), the sequence read archive (SRA, https://www.ncbi.nlm.nih.gov/sra) or the European Nucleotide Archive (ENA, https://www.ebi.ac.uk/ena/browser/home) are the most commonly used data archives. Alternatively, data are made available as supplementary material to the scientific papers in which the research is published or these can be requested to the authors via email. Examples of scientific research programmes include**:**

    - InterRidge (http://www.interridge.org/),
    - A transatlantic assessment and deep-water ecosystem-based spatial plan for Europe (https://www.eu-atlas.org/)
    - Integrated Assessment of Atlantic Marine Ecosystems in Space and Time (iAtlantic, https://www.iatlantic.eu/)
    - Atlantic Ocean Research Alliance Coordination and Support Action (https://www.atlanticresource.org/aora/)
    - Deep-sea Sponge Grounds Ecosystems of the North Atlantic
    - Marine Ecosystem Restoration in Changing European Seas (https://www.atlanticresource.org/aora/)
    - Global Ocean Biodiversity Initiative (http://gobi.org/)
    - Conservation & restoration of deep-sea ecosystems in the context of deep-sea mining (DEEP REST, https://deep-rest.ifremer.fr/)
    - The JPIOceans Joint Action Ecological Aspects of Deep-Sea Mining (https://www.jpi-oceans.eu/en/ecological-aspects-deep-sea-mining; https://miningimpact.geomar.de/)

- **Conservation organizations** hold species information to support their conservation programs, and often work closely together with environmental managers. Examples include UNEP-WCMC species+ database (https://resources.unep-wcmc.org/products/WCMC_PT003) and the IUCN Red List (http://www.iucnredlist.org/).

- Increasingly, **industries** are holders of useful information based on direct observations of species occurrences from their transport systems during business operations.