

# EMB Future Science Brief on Deep Sea Research and Management Needs

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## Deep Sea

Research and  
Management Needs



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European  
**MARINE BOARD**  
Advancing Seas & Ocean Science

## European Marine Board Future Science Brief nº12 “Deep Sea Research and Management Needs”

- Explores the **complexity of the deep sea** and its role in ocean health today
- Highlights the **critical ecosystem services and functions** it provides
- Underscores the **risks to ocean health** in the face of climate change and direct human impacts in the deep sea
- Navigates the **complex legal landscape and management issues**
- Identifies **significant knowledge gaps** in biological, biogeochemical, physical, and geological deep-sea sciences, and in the spatial and temporal variability of the deep sea
- **Recommendations** for sustainable deep-sea protection and better collaboration

# EMB Working Group: Deep Sea and Ocean Health



## Working Group Members

**Chair:** Sylvia Sander, Helmholtz-Zentrum für Ozeanforschung Kiel (GEOMAR), Germany

**Co-chair:** Christian Tamburini, Institut Méditerranéen d'Océanologie (MIO), CNRS, France

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- **Bhavani Narayanaswamy**, Scottish Association for Marine Science and Marine Alliance for Science and Technology Scotland (MASTS), UK
- **Ellen Pape**, Universiteit Gent, Belgium
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- **Miguel Semedo**, Centro Interdisciplinar de Investigação Marinha e Ambiental (CIIMAR), Portugal
- **Pedro Vélez Belchí**, Instituto Español de Oceanografía (IEO), Spain
- **Riwan Leroux**, Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), France & EMB Young Ambassador
- Observers: Sarah de Rijcke & Renate Reitsma, [Fluid Knowledge](#), Leiden University
- Communication support: GEOMAR

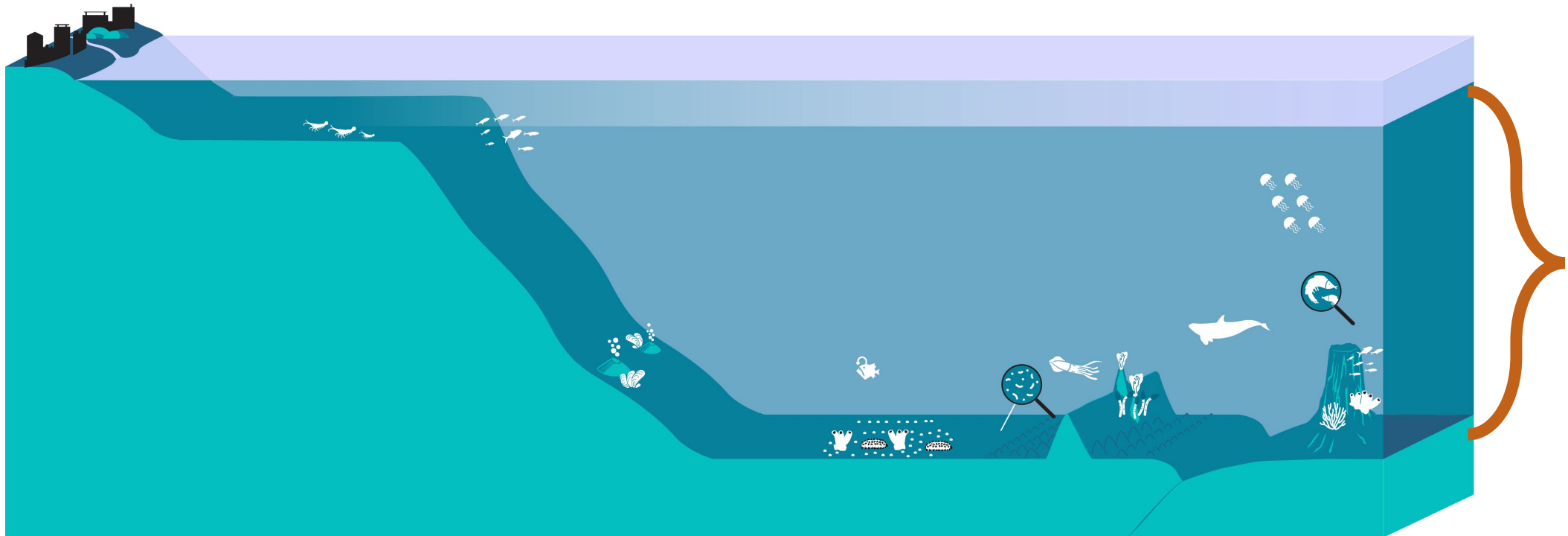
**Kick-off meeting February 2023**

**Second in-person meeting April 2024**



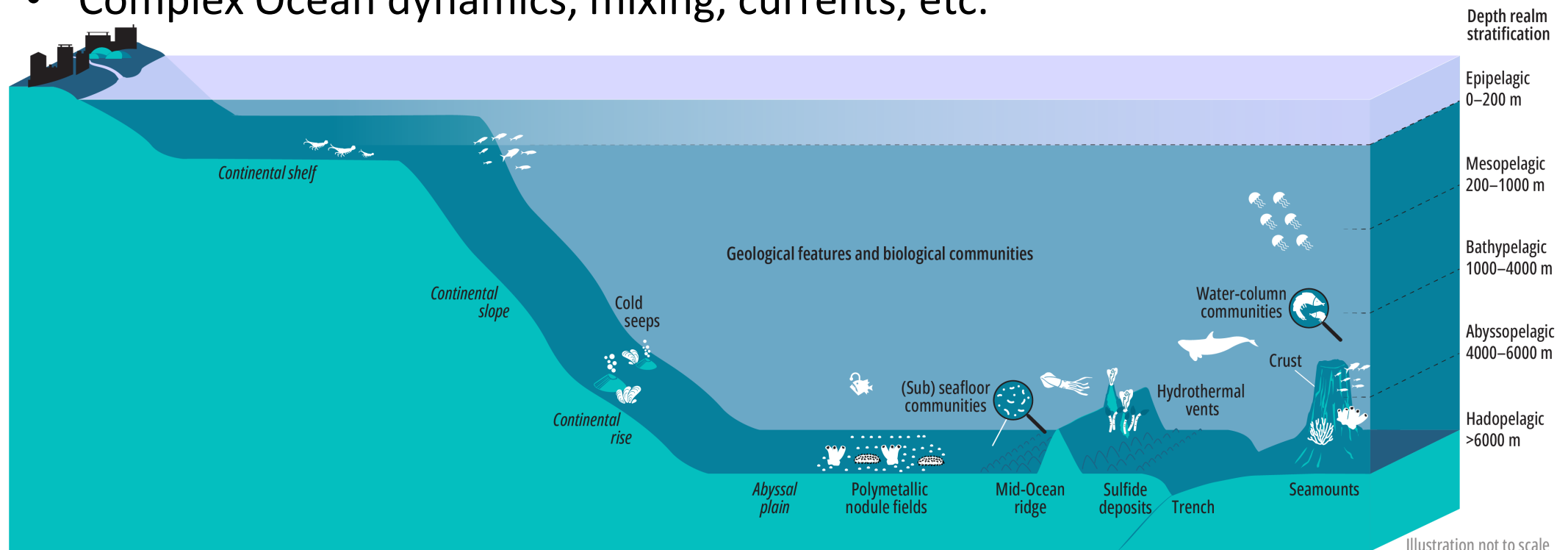
# What is the deep sea?

Below 200 m depth (max. ~11,000 m depth)  
90% of total Ocean volume



# What can you find in the deep sea?

- Diverse topography (seamounts, plains, canyons, trenches, etc.)
- Only 30,000 deep-sea species described to date
- The largest and most frequent biological movement on Earth (*diel vertical migration*)
- Volcanoes, earthquakes
- Complex Ocean dynamics, mixing, currents, etc.



# How do we benefit from the deep sea?

## Ecosystem services

### Cultural services



Stewardship  
and  
heritage value



Existence  
value



Historical  
archive



Biodiversity  
value

### Regulating services



Carbon  
sequestration



De-  
toxification



Climate  
regulation

### Provisioning services



Non-living  
resources



Food  
resources



Genetic  
resources

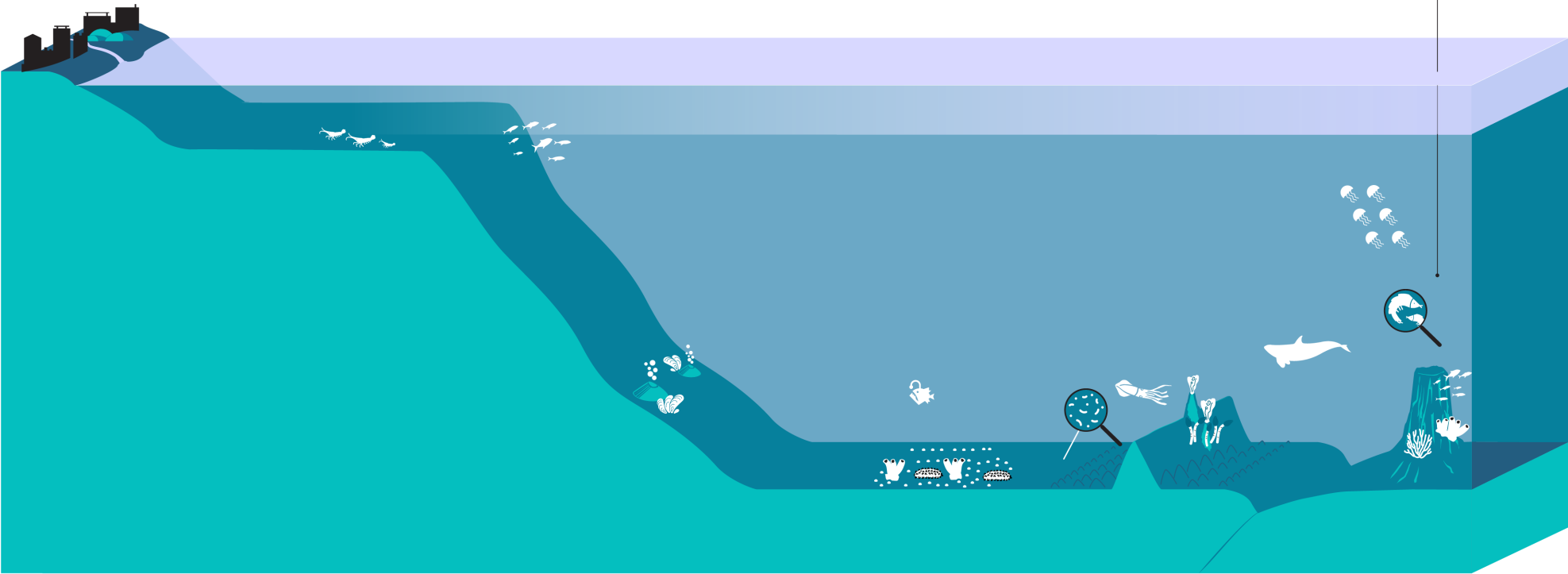
### Supporting services



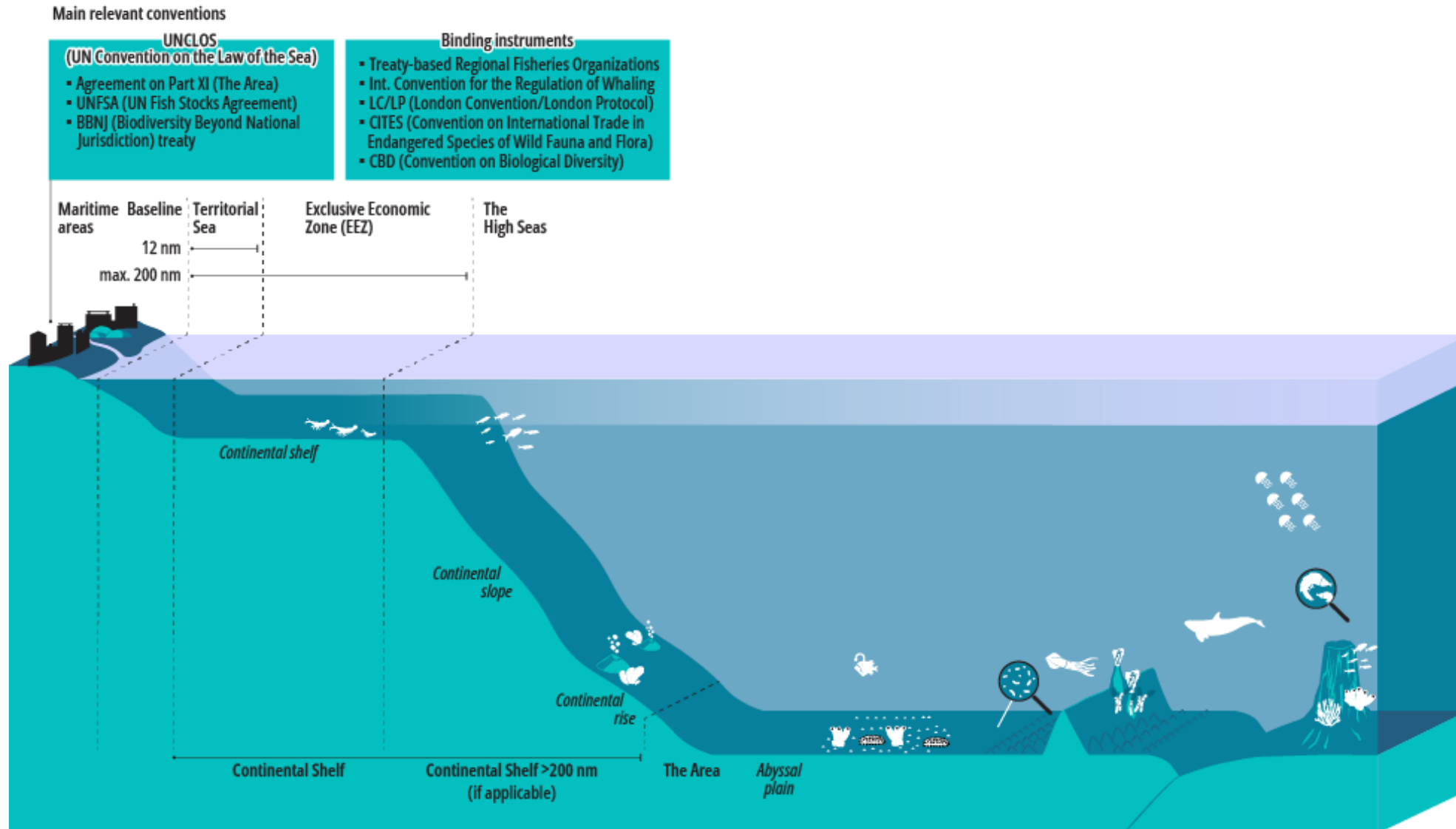
Habitat  
and trophic  
support



Biogeochemical  
cycling



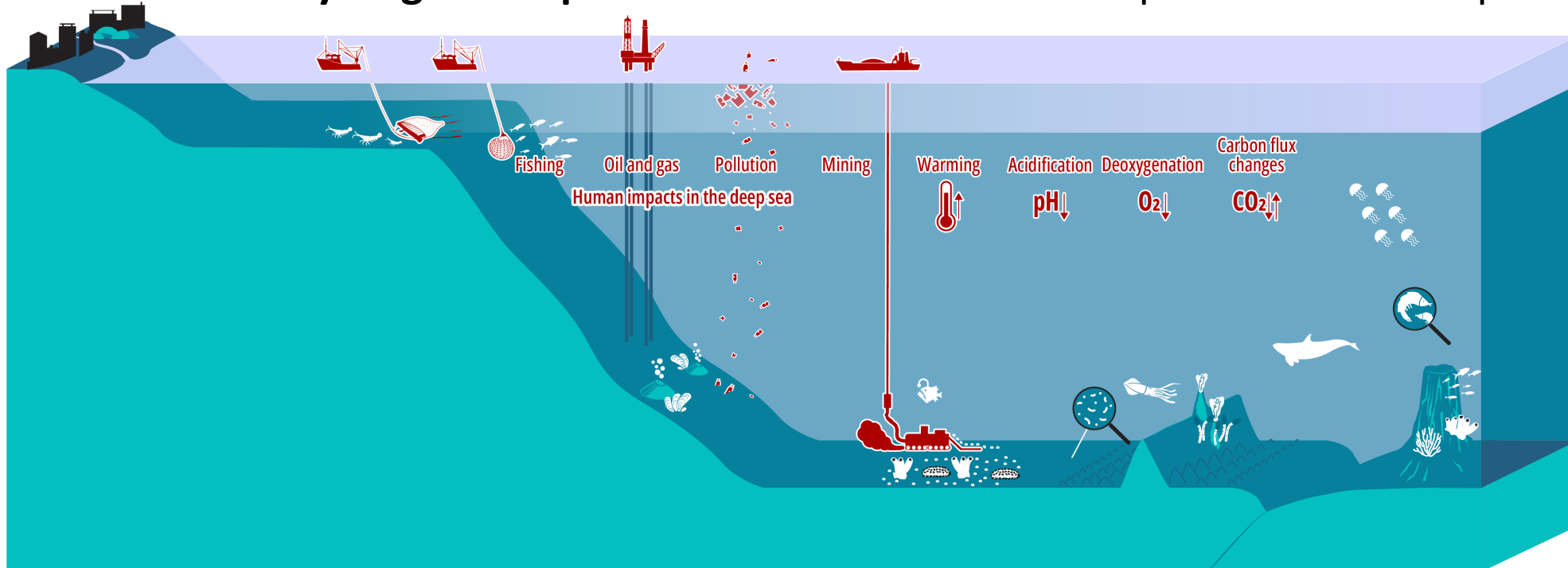
# How do we manage the deep sea?



Credit: Andrés Alegría/ EMB

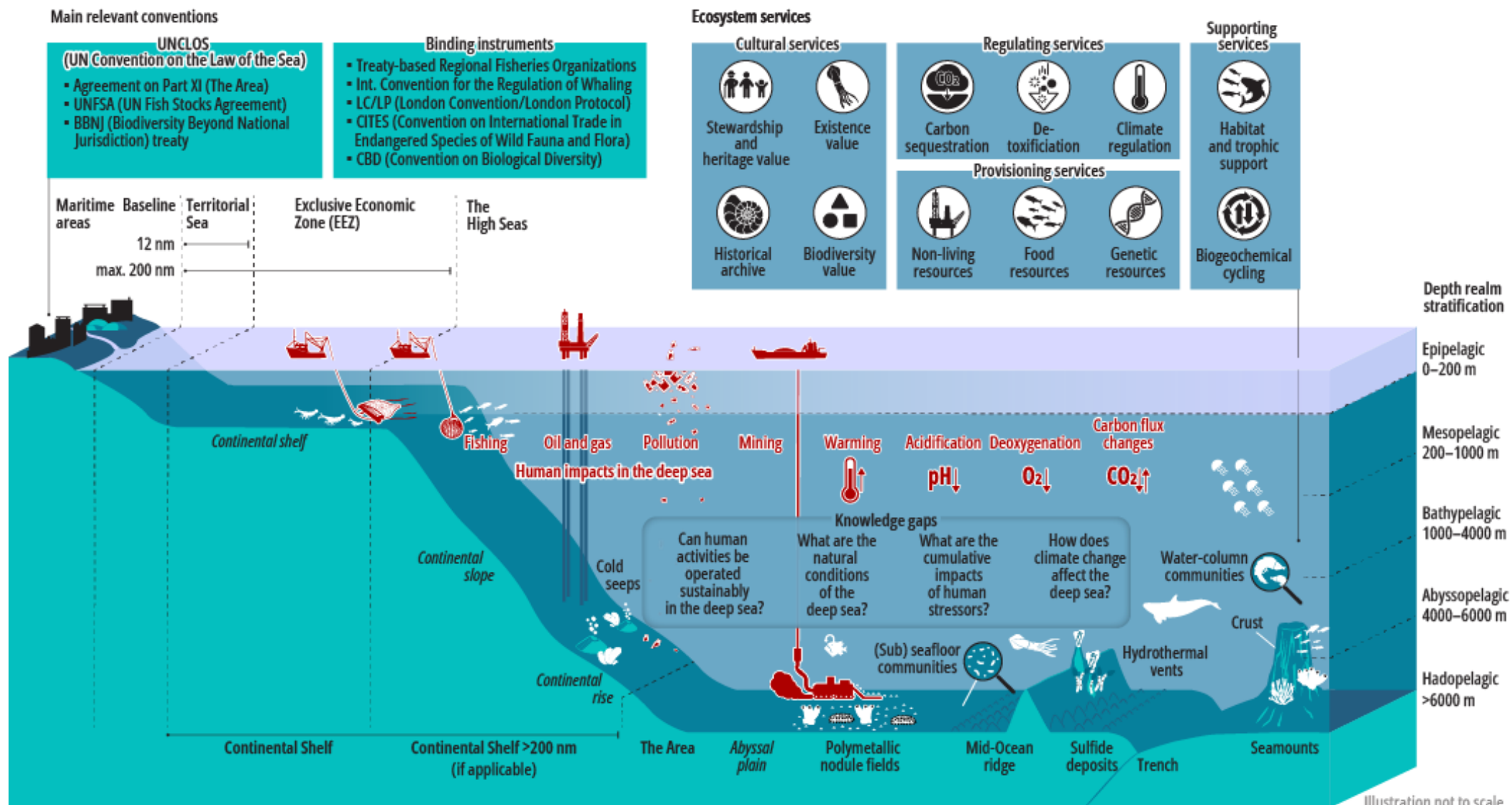
# How do we impact the deep sea?

- **Climate change stressors:** Warming, acidification, and deoxygenation
- **Overexploitation and habitat destruction:** deep-sea fishing, bottom trawling, and resource extraction
- **Pollution:** microplastics, heavy metals, chemicals, and underwater noise
- **Emerging and future industries:** deep-sea mining and marine carbon dioxide removal (mCDR)
- **Cumulative and synergistic impacts:** combined and often amplified effects are poorly understood

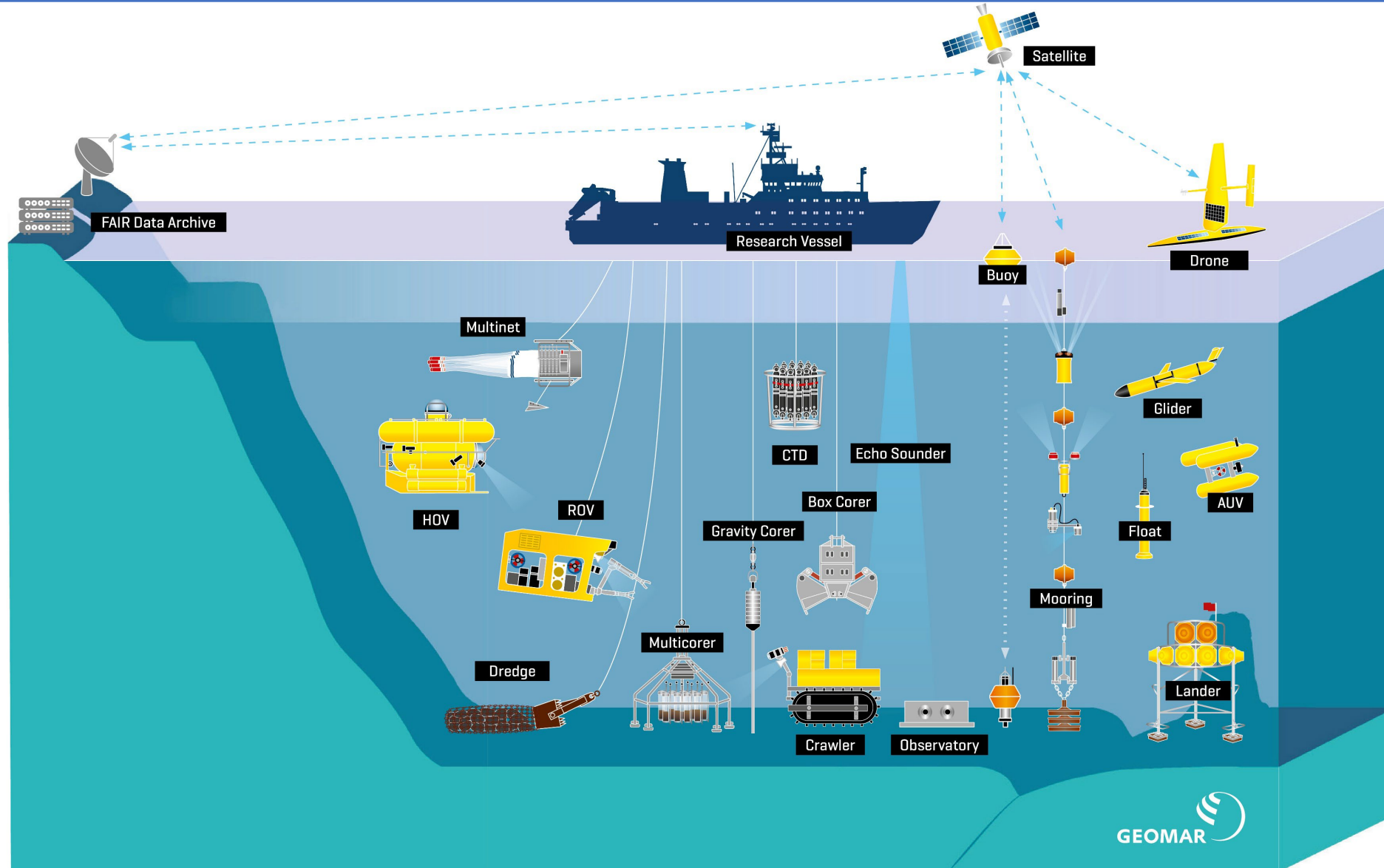




# The complexity of the deep sea



# Tools to study the deep sea



# Challenges to study the deep sea

- Remote, vast and, by definition, deep
- Access: logistically and technologically challenging (thus expensive)
- Snap-shots vs long-term observatories
- Difference in pressure and temperature
- Training and support of specially trained deep-sea experts from around the world
- Data and sample management (unarchived, non-digital legacy data)



Image credit: Alfred-Wegener-Institut / Thomas Ronge ([CC BY 4.0](#))

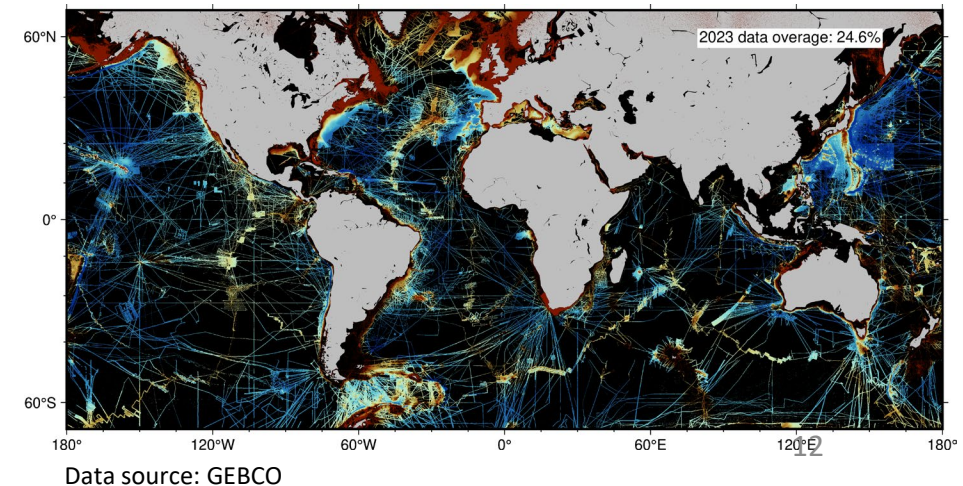


# Examples of deep-sea knowledge gaps

- Biological deep-sea science:
  - Biodiversity, incl. microbial diversity
  - Biological carbon pump: lack of integrative view
- Biogeochemical deep-sea science:
  - Hydrothermal vents role in trace metals
- Physical deep-sea science:
  - Rate of changes in Meridional Overturning Circulation (MOC)
- Geological deep-sea science:
  - High-resolution of uneven seabed
- Deep-sea spatial and temporal variability:
  - Gradients from few micrometres to hundreds of kilometres, and from seconds to decades



Image credit: GEOMAR

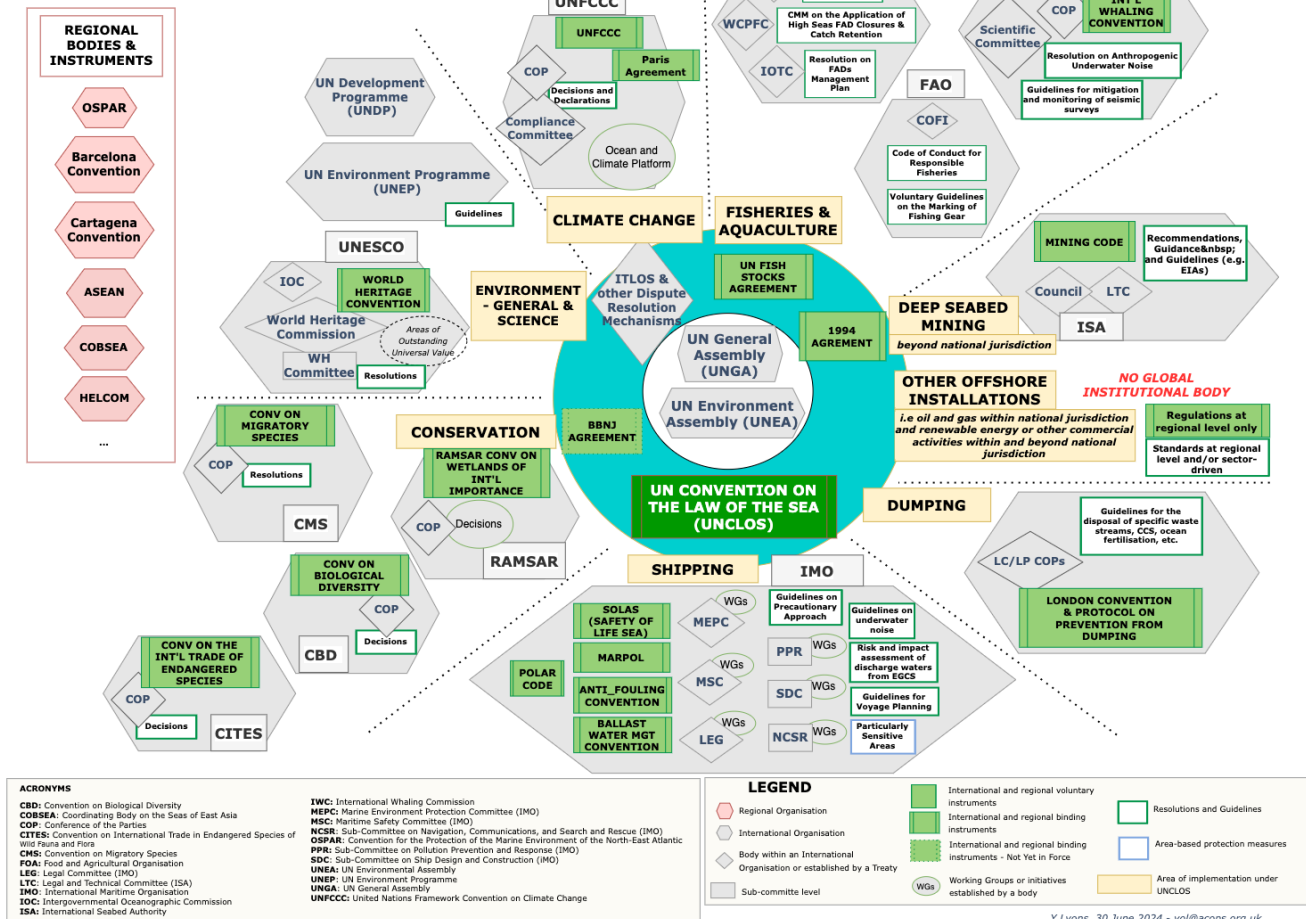


# Challenges in managing the deep sea

- Lack of unique legal definition
- UNCLOS: EEZ, ABNJ, High Seas, The Area, Common Heritage of Humankind
- EU context: 24 Member States with maritime territories and the division of competences between the EU and its Member States
- Other international legal rules, both binding and non-binding (IMO, CBD, RFMOs)
- 2023 BBNJ Agreement

## INTERGOVERNMENTAL BODIES THAT DEVELOP INTERNATIONAL ENVIRONMENTAL STANDARDS TO PROTECT THE MARINE ENVIRONMENT\* WITHIN THE GLOBAL OCEAN GOVERNANCE FRAMEWORK

\* Non exhaustive. Only a selection of the most relevant processes for standard setting in the context of Environmental, Social and Governance (ESG) frameworks.



Y Lyons, 30 June 2024 - yol@ecops.org.uk



# Blind spots in deep-sea management and governance

- Lack of baseline knowledge thereby preventing conclusive Environmental Impact Assessments (EIAs) and evidence-based management
- Need for stronger commitment and greater alignment in the implementation of existing laws
- Inability to adapt management and governance structures in response to evolving environmental, socio-economic, and political conditions
- Problem-shifting between legal regimes



Image credit: IFREMER



- Recognized need for global, sustainable Ocean management and protection (e.g. UNOC declarations)
- Improve baseline knowledge through research
- Management and governance in place (e.g. BBNJ Agreement, EU legislation)
- Mitigation of impacts
- Capacity building and Ocean literacy

*Article 27 of the 1948 Universal Declaration of Human Rights: “everyone has the right freely to participate in the cultural life of the community, to enjoy the arts, and to share in scientific advancement and its benefits”*

- Science capacity more equitable across regions
- General lack of understanding of the benefits derived from the deep sea

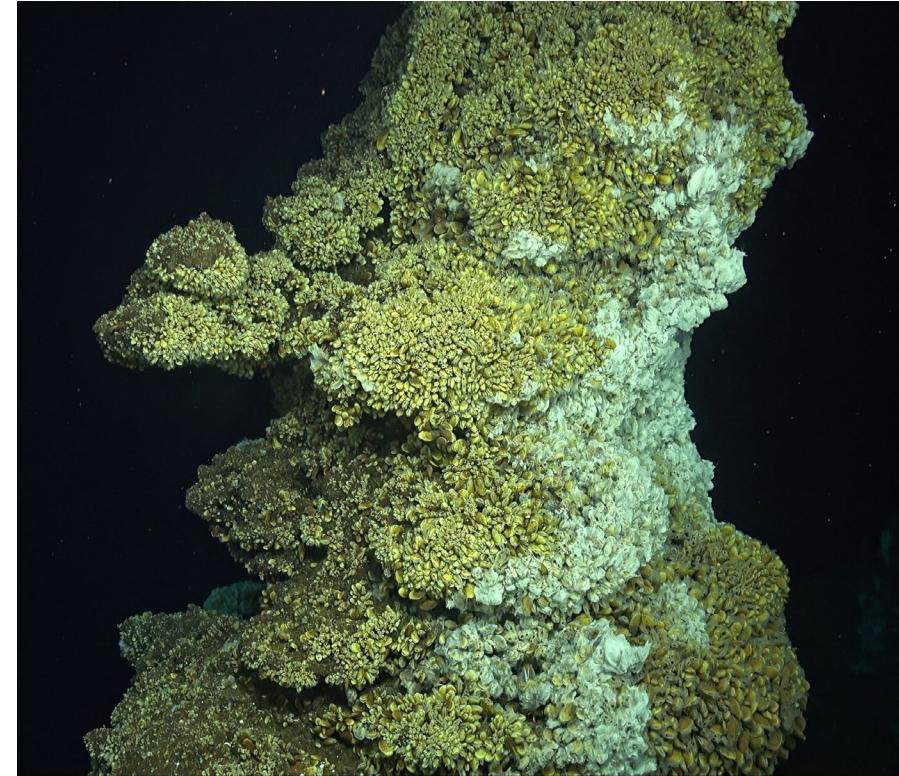


Image credit: Riwan Leroux

# Recommendations for Policy And Management : to Sustain Ocean Health for Future Generations

RECOMMENDATION		OUTCOME	METRIC	SUGGESTED TIMELINE
1	<b>Effectively govern human activities in the deep sea</b> Target: the EU and European nations	Effective regulations addressing the impacts of human activities on deep-sea ecosystems in areas within (and beyond) EU jurisdiction and the Area have been implemented.	<ul style="list-style-type: none"> <li>Entry into force of the BBNJ Agreement and alignment with national policies.</li> </ul>	<ul style="list-style-type: none"> <li>Within one year EU-wide ratification of the BBNJ Agreement.</li> <li>Continuous efforts to enforce the BBNJ Agreement and align with national policies by 2030.</li> <li>Continuous efforts to include deep sea in Ocean governance frameworks.</li> </ul>
2	<b>Establish an international scientific committee for deep-sea sustainability and protection</b> Target: International science-policy initiatives (e.g. IPOS, DOSI, GESAMP, IOC/UNESCO)	An independent, multidisciplinary scientific committee with the task to provide advice on the sustainability and protection of deep-sea ecosystems to EU and international regulatory bodies has been established.  Members participating in the International Platform for Ocean Sustainability (IPOS). Committee provides recommendations for funding essential scientific projects.	<ul style="list-style-type: none"> <li>Formation of the committee and launch of scientific projects to identify</li> <li>priority areas for deep-sea protection to promote Ocean sustainability within and beyond national jurisdiction.</li> <li>Publication and reporting of results to the BBNJ Scientific Body, to the ISA and other relevant (inter-)national bodies.</li> <li>Identification of areas to establish monitoring networks (see Recommendation 5).</li> </ul>	<ul style="list-style-type: none"> <li>Committee established within one year.</li> <li>Scientific projects for identification of protected areas and monitoring areas launched within 2<sup>nd</sup> year.</li> <li>Identification of protected areas and monitoring areas by 2029, accounting for the “30 by 30” framework.</li> <li>Scientific projects for identification of possible sustainable uses of the deep sea launched within 2<sup>nd</sup> year.</li> </ul>

# Recommendations for Policy And Management : to Sustain Ocean Health for Future Generations

	RECOMMENDATION	OUTCOME	METRIC	SUGGESTED TIMELINE
3	<p><b>Contribute to develop and implement deep-sea Environmental Impact Assessment methodologies</b></p> <p>Target: International science-policy initiatives (e.g. IPOS, DOSI), in collaboration with EU and international regulatory practices (e.g. BBNJ Agreement)</p>	<p>Effective impact and risk assessment, and monitoring methodologies for human activities in the deep sea have been developed and are being implemented.</p>	<ul style="list-style-type: none"> <li>• Creation of standardised environmental impact assessment protocols and integration of these protocols into EU and international regulatory practices.</li> </ul>	<ul style="list-style-type: none"> <li>• Methodology developed within five years.</li> <li>• Methodology compliance required for new European Framework Programme project proposals.</li> <li>• Methodology integrated into regulatory practices within 10 years.</li> </ul>



# Recommendations for Funders, Research and Monitoring: to Increase our Understanding of Ocean Health Over Time & Space

	RECOMMENDATION	OUTCOME	METRIC	SUGGESTED TIMELINE
4	<p><b>Support transdisciplinary research programs to better understand the role of the deep sea in Ocean (and human) health</b></p> <p>Target: National and European research funders e.g. through projects like GEOMAR's FUTURO</p>	<p>Transdisciplinary research programs, including natural and social sciences and humanities, law, indigenous knowledge, engineering and technology have been launched and are operational.</p>	<ul style="list-style-type: none"> <li>• Funding and initiation of at least three major</li> <li>• Transdisciplinary research projects focused on deep-sea ecosystems and the role of the deep sea in Ocean and human health.</li> </ul>	<ul style="list-style-type: none"> <li>• Projects initiated within three years.</li> <li>• Initial findings published by the end of the Ocean Decade 2030.</li> </ul>
5	<p><b>Invest in long-term monitoring in the deep sea</b></p> <p>Target: National and European research funders e.g. through the European Ocean Pact</p>	<p>Long-term, regional, and basin-scale multidisciplinary monitoring programs have been established to characterise the environmental baseline and continuously capture changes in deep-sea ecosystems. Data gained through long-term monitoring inform policies that can impact society, such as the effectiveness of protected areas.</p>	<ul style="list-style-type: none"> <li>• Strategies to measure, e.g. Essential Ocean Variables, and the needed technologies are in place, with data collection and analytical protocols standardised and implemented.</li> <li>• Existing long-term monitoring projects remain operational.</li> <li>• Deployment of at least three new long-term monitoring observatories in the deep sea in identified critical areas (see Recommendation 2).</li> </ul>	<ul style="list-style-type: none"> <li>• Projects initiated within three to five years.</li> <li>• Monitoring programs operational and baseline data available by 2030.</li> <li>• Integration of data from existing and new projects to inform policies by 2030.</li> <li>• First effectiveness evaluation of protected areas by the 10-year mark.</li> </ul>

# Recommendations for Funders, Research and Monitoring: to Increase our Understanding of Ocean Health Over Time & Space

	RECOMMENDATION	OUTCOME	METRIC	SUGGESTED TIMELINE
6	<p><b>Launch large-scale and long-term multi-disciplinary natural sciences projects to increase knowledge of global deep sea processes</b></p> <p>Target: National and European research funders</p>	<p>Understanding of geological, physical, biological and biogeochemical deep-sea processes have been significantly advanced.</p>	<ul style="list-style-type: none"> <li>• Launch and funding of at least five multidisciplinary minimum 10-year-long natural sciences projects to increase knowledge of deep-sea processes.</li> <li>• Publication of at least 100 peer-reviewed papers enhancing knowledge of geological, physical, biological and biogeochemical deep-sea processes in our changing deep sea.</li> </ul>	<ul style="list-style-type: none"> <li>• Projects initiated within three to five years.</li> <li>• Continuous publication of findings throughout the lifetime of the projects.</li> </ul>
7	<p><b>Support research efforts in specific critical research fields</b></p> <p>Target: National and European research funders</p>	<p>Critical knowledge gaps in specific ecosystems and research disciplines have been filled.</p>	<ul style="list-style-type: none"> <li>• Invest in genomic sequencing and taxonomy to boost biodiversity research.</li> <li>• Fund projects on subject matter including, but not limited to, increasing our knowledge on:               <ul style="list-style-type: none"> <li>(i) the metabolic consequences of species adaptation to climate change through experimental studies;</li> <li>(ii) cumulative and synergistic impacts on deep-sea species;</li> <li>(iii) the (mid-water) biological carbon pump,</li> <li>(iv) the rate of change of deep sea temperatures;</li> <li>(v) the Meridional Overturning Circulation (MOC) and its impact on upwelling and downwelling processes; and</li> <li>(vi) abiotic and biotic seafloor processes and their connectedness to Ocean processes.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Continuous.</li> <li>• Subject matter to be updated by the Scientific Committee for Deep-Sea protection (see Recommendation 2).</li> </ul>

# Recommendations for Global Capacity Building: to Better Understand and Manage the Deep Sea

	RECOMMENDATION	OUTCOME	METRIC	SUGGESTED TIMELINE
8	<b>Enhance educational, training and research opportunities for all current and future scientists addressing their unique regional challenges</b> Target: International cooperation and multilateral action (e.g. IOC/ UNESCO)	Implement science as a fundamental human right on a global scale.	<ul style="list-style-type: none"> <li>Launch of a platform or calls to fund co-designed research projects in underrepresented areas.</li> </ul>	<ul style="list-style-type: none"> <li>Kick-off of the first call at the entry into force of the BBNJ treaty, and not later than 2026.</li> <li>Continue efforts beyond the Ocean Decade.</li> </ul>
9	<b>Foster the transfer of marine technology and develop training programs</b> Target: International cooperation and multilateral action at the framework of the BBNJ Agreement	Access to and use of marine technology in underrepresented nations improved.	<ul style="list-style-type: none"> <li>Transfer and implementation of advanced marine technologies and training programs, increasing the number of deep-sea research initiatives by underrepresented nations by 50%.</li> </ul>	<ul style="list-style-type: none"> <li>Kick-off of technology transfer and training programs starting at the entry into force of the BBNJ treaty, and not later than 2026.</li> <li>Continue efforts beyond the Ocean Decade.</li> </ul>
10	<b>Continue to promote the Findability, Accessibility, Interoperability, and Reusability (FAIR) Data Principles</b> Target: International cooperation and multilateral action, in collaboration with Ocean data initiatives	Widespread adoption of the FAIR Principles.	<ul style="list-style-type: none"> <li>Integration of FAIR-compliant sample and data management systems in all European research institutions.</li> </ul>	<ul style="list-style-type: none"> <li>100% accessible and reusable deep-sea research samples and data by 2030.</li> </ul>



# Summary of Recommendations

1. **Policy:** Bring deep-sea management and protection into action
2. **Science:** Deepen understanding of deep-sea biodiversity, ecosystems, and functions across space and time
3. **Capacity and literacy:** Equip the next generation of scientists, and raise global awareness of the deep sea's role in Ocean and planetary health

**We can't sustainably use and protect what we do not understand !**

