Meeting Summary: Defining "Significance" in Environmental Impact Assessment for Deep-Sea Mining

March 26-28, 2014, Scripps Institution of Oceanography

A group of 22 experts from eight countries (Appendix 1) met to explore existing approaches to environmental impact assessment (EIA) of deep-sea mining, with a focus on manganese nodules, massive sulphide deposits, cobalt crusts and phosphorite nodules or deposits. The workshop participants considered challenges and practical options for evaluating significant environmental impact related to deep-sea mining in light of direct, indirect, and cumulative impacts to the deep ocean. Participants represented the fields of deep-sea biology, law and policy, economics, regulation, industry and conservation, and considered both national and international jurisdictions. The workshop, led by Kathryn Mengerink (Environmental Law Institute), Ashley Rowden (New Zealand National Institute of Water and Atmospheric Research) and Lisa Levin (Scripps Institution of Oceanography), represents an effort of the Deep-Ocean Stewardship Initiative (DOSI), with financial sponsorship from INDEEP. The resulting report and planned publications are intended to provide guidance to the International Seabed Authority and to individual States currently facing decisions about and enacting regulations for deep-sea mining.

Meeting Overview

During the first day participants gave presentations and discussed key mineral resources, existing environmental impact assessment requirements, and biological, legal, policy, and industry considerations related to significant impacts. Prior to the meeting participants were asked to respond to a questionnaire (Appendix 2). This was summarized on Day 1 (Appendix 3) and provided a leaping off point for breakout group discussions. Breakout group discussions were held on Day 2 and 3 with plenary after each to share information.

On Day 2, the groups participated in the following breakout sessions:

DEFINING AND DESCRIBING SIGNIFICANT IMPACT

All participants addressed the issue of defining and describing significant impacts, with each breakout group focusing on one of the following resources: manganese nodules, seafloor massive sulfides, cobalt crusts, and phosphorite deposits. The breakout groups addressed the following questions:

- How do we best define and describe the concept of significant environmental impact as it relates to deep-sea mining (recognizing the need to exclude pass/fail numbers or thresholds)?
- Can we define characteristics of the deep-sea habitats that make it susceptible to specific types of mining?
- What are the most important/key/optimal factors or parameters that we need to measure to inform the decision about whether an impact is significant or not?
- How do we measure these parameters (e.g., processes, functions, emergent properties)? What are the pragmatic approaches needed?

TRIGGERS, THRESHOLDS AND MATRICES

In this session, the breakout group explored the challenges of understanding and determining triggers and thresholds for environmental impacts and explored how evaluation matrices can help determine significant impacts. Questions addressed included:

- Can we express levels/threshold that are indicative of significant environmental impact from deep sea mining?
- Can we identify impacts that should not be permitted to happen and provide a reason?
- What are the indicators for significant impacts?
- Can we put a matrix together that defines major considerations and scales of variables, considering uncertainty?

MONITORING, ADAPTATION AND PRECAUTION

In this breakout session, participants considered the relationship between significant impacts, monitoring, adaptation, and the precautionary approach. Questions addressed include:

- How do we appropriately address monitoring and management adaptation?
- What precautionary measures could be put in place [without just stopping] to understand and respond/react to significant impacts as they are identified?

LINKING IMPACTS TO POLICY THROUGH ECOSYSTEM SERVICES

Understanding the importance of evaluating significant impacts in the context of laws environmental decision-making, the breakout group explored the role of ecosystem services in understand impacts and linking them to issues relevant to policymakers. Questions addressed include:

- How do we get someone to care about what may happen if a significant environmental impact occurs?
- Based on impacts/ecosystem, what are the ecosystem service that will inform value judgment & policy choice?

- What are the ecosystem services are likely to be critically affected?

ADDRESSING CUMULATIVE IMPACTS

On the third day of the meeting, the participants considered cumulative impacts, with 3 breakout groups that focused on manganese nodules, seafloor massive sulfides, cobalt crusts, and phosphorite deposits. Each group addressed within sector and multi-sector impacts, answering the following questions:

- What are the cumulative impacts?
- What methods are available to understand them?
- How do we address cumulative impacts?

Next Steps

At the conclusion of the meeting, the participants discussed next steps, including the development of papers for publication that build from the breakout sessions and discussions. The participants agreed to work toward developing the following papers:

(1) Publication on defining significant impacts in deep seabed mining – across all mineral resources (Lead: Kathryn Mengerink plus most participants). Oct. 1 submission goal.
(2) Current and future ecosystem services affected by deep-sea mining (Lead: Claire Armstrong/Ashley Rowden)
(3) Monitoring and adaptation – (a) outreach piece on development of monitoring (Lead: Hannah Lily), (b) Mitigation and offsets related to deep seabed mining (Lead: Squires)
(4) Response to ISA needs: (a) input to ISA questionnaire (b) research agenda related to significant impact

Overarching Observations

Participants recognized the essential need for expertise from multiple disciplines and sectors to address significant impact. They recognized the extreme complexity of the issues and the enormous data gaps associated with assessing significant impact. Not only is it important to understanding how to understand significant impact in the context of environmental impact assessment, but there is a great need to assess impacts for monitoring and adaptation, compliance, and environmental management. It became clear that both states (nations) and international realm are underequipped to address these at this time, from the perspective of lack of knowledge and data and lack of regulatory frameworks.

Other issues to emerge include:

- Significant impact is a function of the inherent properties of the ecosystem and how the resource will be exploited (intensity and duration)

- Huge unknowns make the determination of significant impacts extremely difficult. Such unknowns include the questions related to species rarity and possible extinction; the ecological and social importance of extinction of a single deep sea species; numerical thresholds for significant impact; and ecosystem function, including, for example, which vent sites function as sources and which function as sinks, among many others.
- Understanding significance in the context of science and translating this into policy was a major challenge (significance in the policy and science realms may differ)

Appendix 1: Meeting participants

Appendix 2: Pre-meeting questionnaire

Appendix 3: Summary of questionnaire responses

EIA Workshop - 26-28 March 2014 Participant List

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Appendix 2: Pre-Meeting Questionnaire

(1) **How do you define significant environmental impact**? (*please include any working definitions that you or your organization use, or formal definitions that are contained in policies or legislation that you are familiar with or have to address. The definitions do not need to be directly related to deep-sea mining activities. Please include a reference for the definition(s), if available.*)

(2) What **key aspects of the environment** (e.g. biodiversity, commercial fish stocks, protected species, connectivity, etc) should be considered when determining significant environmental impact?

(3) What **types of environmental impacts** from seabed mining (e.g., destruction of substrate, mining plume, tailings, noise) are the most important to consider?

(4) What do we **need to know about species or the ecosystem** in order to determine whether the environmental impacts from deep sea mining are "significant"?

(5) How should **scientific uncertainty** affect determination of "significant environmental impact"?

(6) How should **worst case scenarios** inform the determination of "significant impact"?

(7) **How might significant environmental impacts**, including direct, indirect and cumulative impacts, **differ among ecosystems and resources** considered for mining? (SMS deposits, Mn nodules, polymetalic crusts, phosphorite nodules).

(8) How do we assess **cumulative environmental impacts**? What field studies have or can be conducted?

(9) What **distinctive aspects of the deep sea** might predispose a system to experience significant environmental impact from mining (that would not in shallow water)?

APPENDIX 3: ANSWER SUMMARIES

Summary of Answers to Question 1: Defining Significant Impacts

QUESTION 1: How do you define significant environmental impact? (*please include any working definitions that you or your organization use, or formal definitions that are contained in policies or legislation that you are familiar with or have to address. The definitions do not need to be directly related to deep-sea mining activities. Please include a reference for the definition(s), if available.*)

Several legal authorities were identified, including the national and international approaches. National approaches include the Pacific Islands/Cook Islands draft environmental impact regulations, the New Zealand framework for impact assessment, U.S. National Environmental Policy Act, the methodology for impact assessment for dredging marine phosphate in Namibia, and the approach used for environmental assessment of drilling in Canada. The Food and Agriculture Organization guidelines for deep-sea fisheries management was another source identified. Also, two examples of voluntary codes were presented along with other considerations for defining significance.

Among all of these approaches, some consistent themes emerged including consideration of:

- **Extent** of impact (e.g., geographical area)
- **Duration and frequency** of impact
- **Intensity or magnitude** of impact
- **Probability** of impact
- **Sensitivity/vulnerability** of ecosystem
- **Cumulative effects** of impacts
- **Scientific uncertainty** related to impact

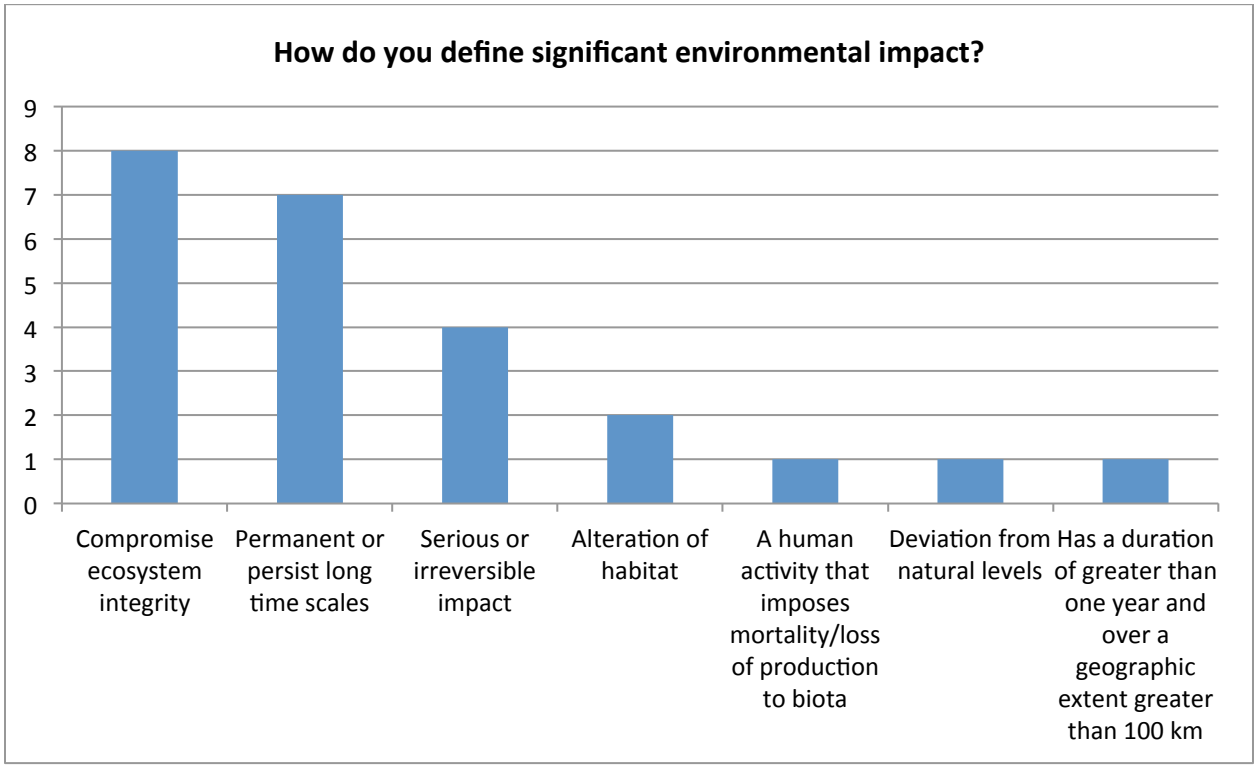
Several people pointed out the need to consider ecological, economic, and social factors when making a significance determination—approaches required by many legal frameworks.

A variety of answers identified specific biological considerations when determining significance, including the following:

- Unique characteristics of the environment
- Impact to natural functioning of the ecosystem, ecosystem integrity, population's ability to reproduce, productivity, species richness, heterogeneity, population connectivity
- Impact to protected species and their habitat
- Impact to fish and wildlife species
- Ecosystem recovery rate (linked to duration/frequency of impact)
- Impact above baseline levels or natural variability
- Causing avoidance behavior and sublethal impacts
- Impacts to ecosystem services

Legal and policy answers that may deserve additional attention include:

- The conversation between legislative and scientific understandings of "significant" needs to be carefully defined. One of the issues is that scientific interpretation of "significant," such as to determine a certain change in state in an environment, might not be consistent with the policy interpretation of what "significant" was intended to mean, capturing a wider range of considerations, such as economic, social and cultural impacts.
- An example of an unresolved issue in New Zealand EEZ policy is the question, "Are significant effects for a given habitat still significant at the scale of the entire EEZ? If not, what is the appropriate scale to determine significance for policy purposes?"
- Every action or project has its own unique qualities—sometimes the science is clear, oftentimes it is not, and many choices are made by those overseeing the preparation of EIAs about how to apply "best professional judgment" in light of legal, scientific or practical uncertainty or controversy. These choices are usually necessary—the key under EIA is that they be transparent.



Summary of Answers to Question 2: Key Environmental Considerations

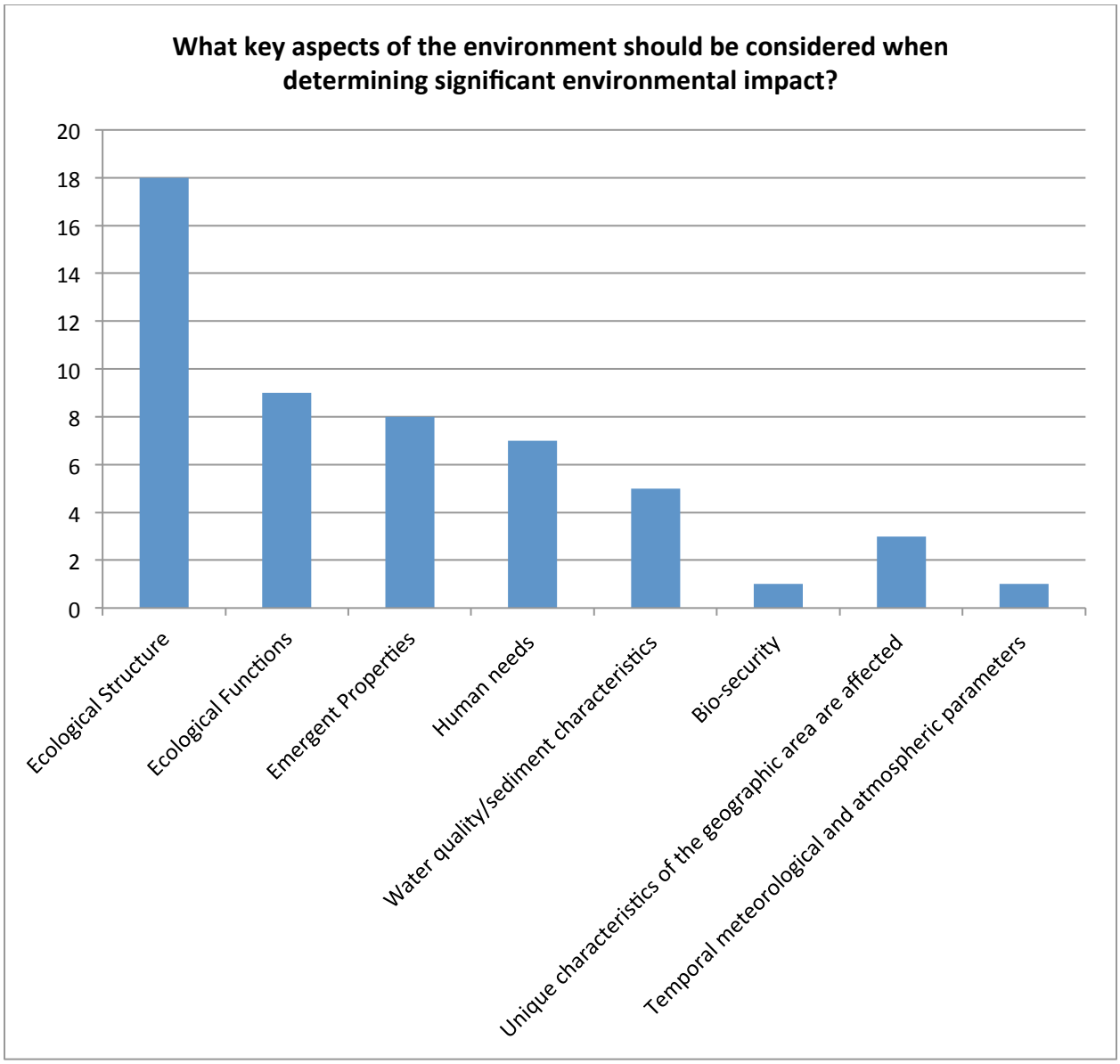
QUESTION 2: What key aspects of the environment (e.g. biodiversity, commercial fish stocks, protected species, connectivity, etc) should be considered when determining significant environmental impact?

Overarching comments and observations include:

- the recognition that ecological, economic, and social variables are important to address
- case-by-case determination of variables is required so approaches should focus on decision-making process rather than picking a suite of characteristics at the outset
- variables considered are a function of both the ecosystem itself as well as the human values placed on the ecosystem components.

Specific variables identified include the following:

- **Ecological structure**, including abundance, biomass, diversity (functional, species, genetic, metabolic), and size
- **Ecological functions**, including carbon sequestration, nutrient cycling, habitat (refugia, substrate), trophic support, food webs, and detoxification
- **Emergent properties**, including connectivity, stability, resilience, resistance, metacommunity structure, heterogeneity in space or time
- **Human uses and values**, including endangered/at risk/rare/protected species, fisheries (as well as habitat designations such as nursery grounds and spawning grounds), public health and safety, bio-security threats and other cultural and economic values
- **Water quality/sediment characteristics**
- Temporal **meteorological and atmospheric** parameters
- The degree to which the **unique characteristics** of the geographic area are affected


What key aspects of the environment should be considered when determining significant environmental impact?
20
18
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Ecological Structure
Ecological Functions
Emergent Properties
Human needs
Water quality/sediment characteristics
Bio-security
Unique characteristics of the geographic area are affected
Temporal meteorological and atmospheric parameters

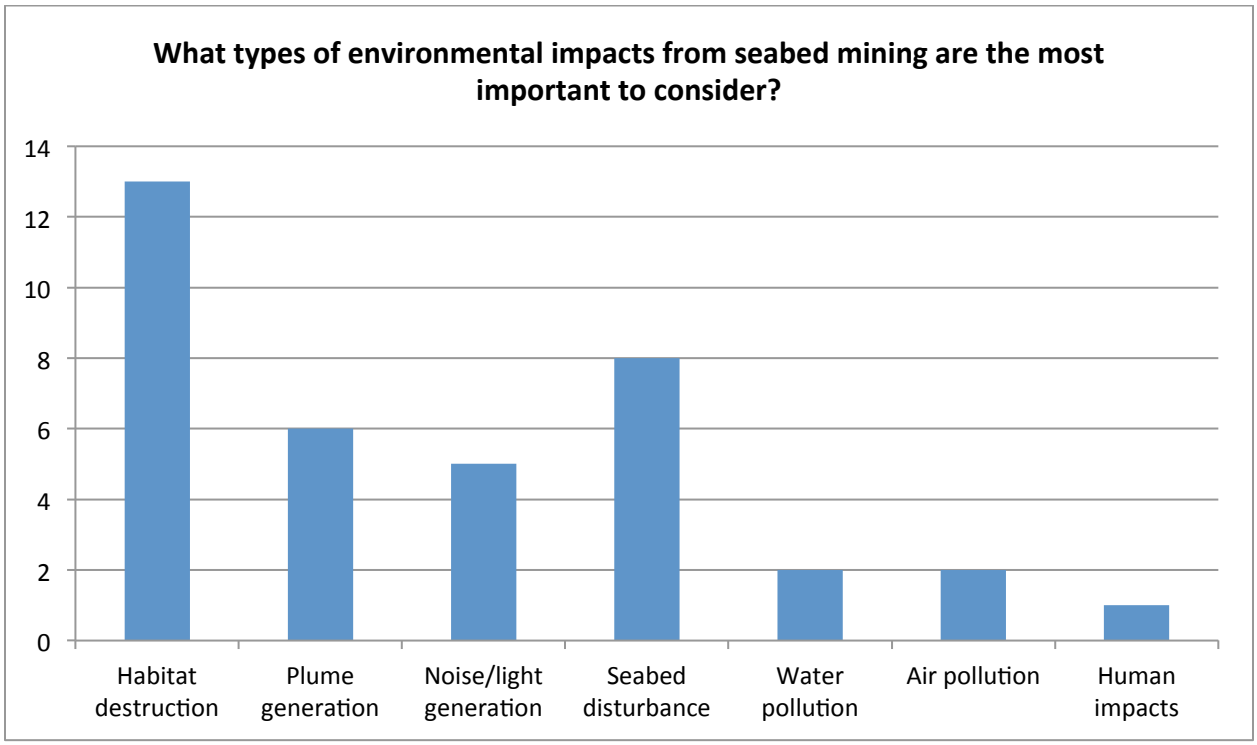
Summary of Answers to Question 3: Types of Environmental Impacts

QUESTION 3: What types of environmental impacts from seabed mining (e.g., destruction of substrate, mining plume, tailings, noise) are the most important to consider?

Many answers recognized that the impacts would vary based on activity and location and pointed out that different species/habitats/ecosystems would be more/less affected by different impacts. Several answers also recognized that impacts include direct, indirect and cumulative impacts.

Specific impacts identified include the following:

1) Direct seafoor habitat destruction/removal, disruption of systems, loss of living resources, loss of genetic resources, loss of genetic variation, disruption of food web (13)
2) Plume generation and dispersal (6)
3) Noise/light generation (5)
4) Seabed burial/sediment disturbance/destruction and suspended sediment (11)
5) Water Pollution from toxins or debris (8)
6) Air pollution (2)
7) Human impacts (social, economic, biosecurity, etc) (2)

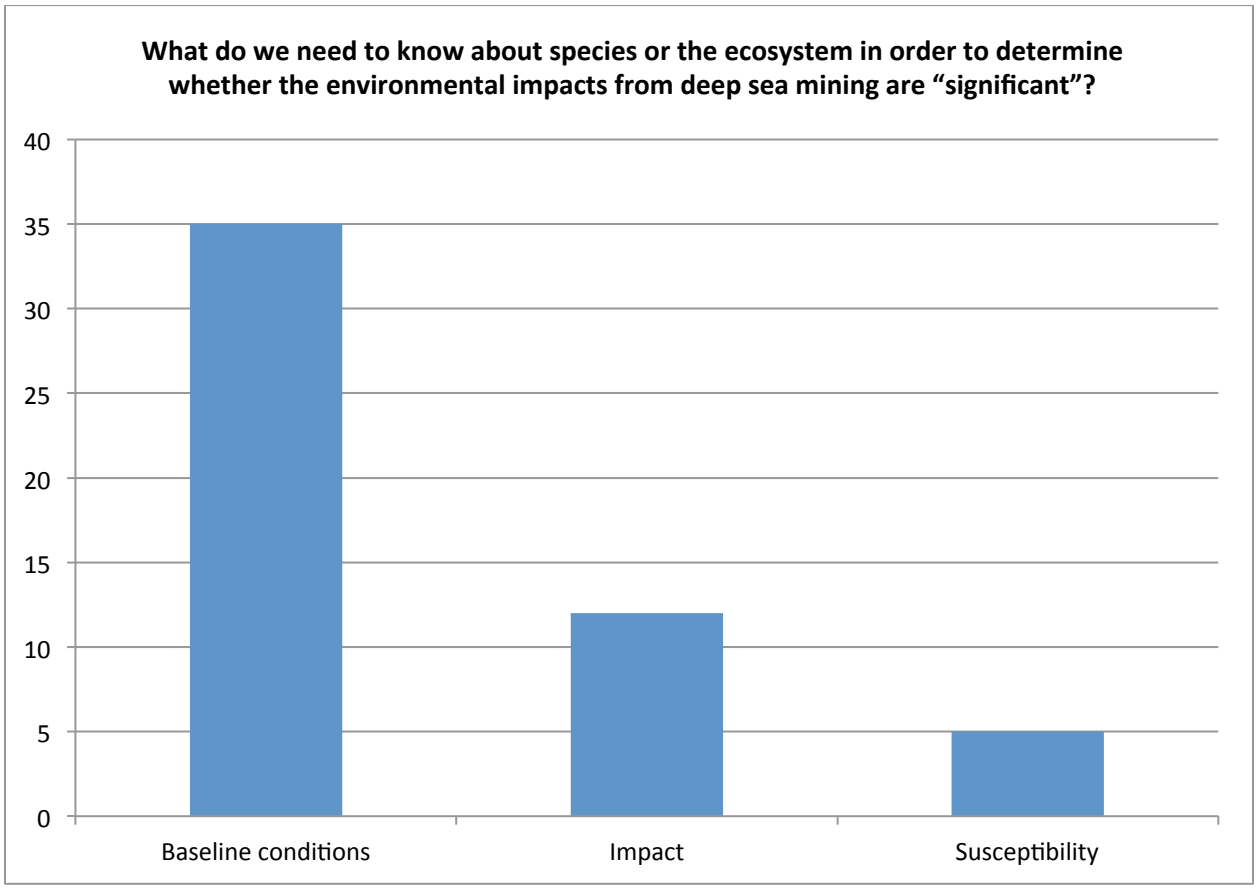


Summary of Answers to Question 4: Ecosystem Information to Determine "Significance" Finding

QUESTION 4: What do we need to know about species or the ecosystem in order to determine whether the environmental impacts from deep sea mining are "significant"?

Many people discussed the need to understand baseline conditions and species and ecosystem susceptibility to the various impacts as part of the determination of whether impacts are significant. Also, many answers referenced the answers to question 1, noting the need to understand impact scope and scale, duration, magnitude, etc. Some people advanced the idea of framing impacts in the context of ecosystem services, including supporting, provisioning, regulating, and cultural services. Others pointed out that the will be broad but that it is important to identify key metrics that can be used to evaluate impact.

- Ecosystem services (supporting, provisioning, regulating, and cultural) and the losses in relation to deep sea mining.
- Overall, ecosystem function and structure. Which is quite a lot. So, practically will need to concentrate on a few suitable metrics of function and structure (e.g., species diversity, productivity).



Summary of Answers to Question 5: Addressing Scientific Uncertainty

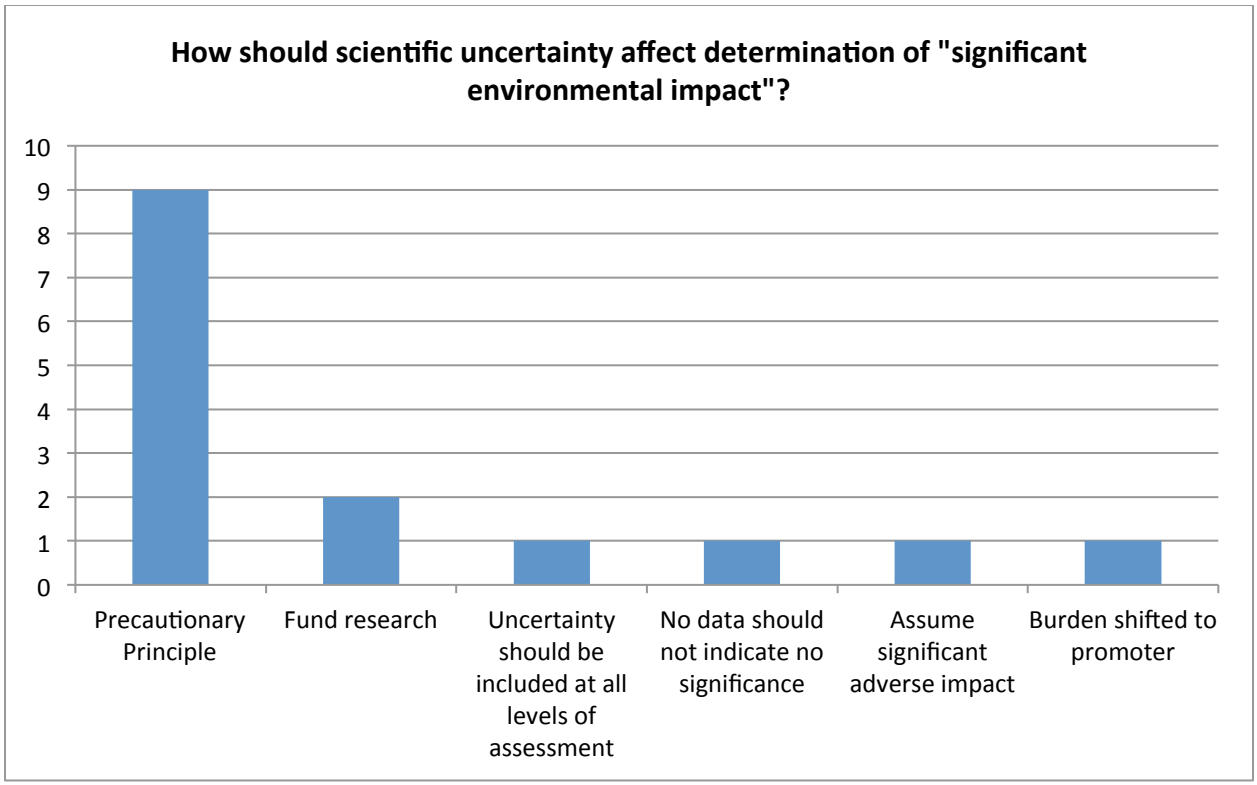
QUESTION 5: How should scientific uncertainty affect determination of "significant environmental impact"?

Most people identified the precautionary approach as a central requirement when acting in the face of uncertainty. Some answers point out that in addition to that uncertainty should be broadly considered, including ecological, economic, social and political uncertainty. Some point out that quantitative determination of uncertainty can be difficult to evaluate, and often expert opinion is used as a proxy.

One example identifies a 3-tier approach to uncertainty: (1) low level of confidence, (2) medium level of confidence, and (3) high level of confidence. Different ratings trigger different requirements—e.g., a rating of 1 requires additional research or monitoring.

In the U.S., information should be disclosed when it is lacking. Also, when incomplete information is essential for making a decision for deciding among alternatives *and* the cost to obtain information is not "exorbitant," then an agency should include the information. One person pointed out that under EIA practice in the United States, the greater the perceived threat to a valuable and/or sensitive resource, the greater the need to close the gap in scientific knowledge about potential environmental impacts.

Several people pointed out that uncertainty should lead to baseline assessments, research funding, and monitoring. Also, one person noted that adaptive management should be included in the process to address uncertainty.


How should scientific uncertainty affect determination of "significant environmental impact"?
10
9
8
7
6
5
4
3
2
1
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Precautionary Principle
Fund research
Uncertainty should be included at all levels of assessment
No data should not indicate no significance
Assume significant adverse impact
Burden shifted to promoter

Summary of Answers to Question 6: Addressing Worst Case Scenarios

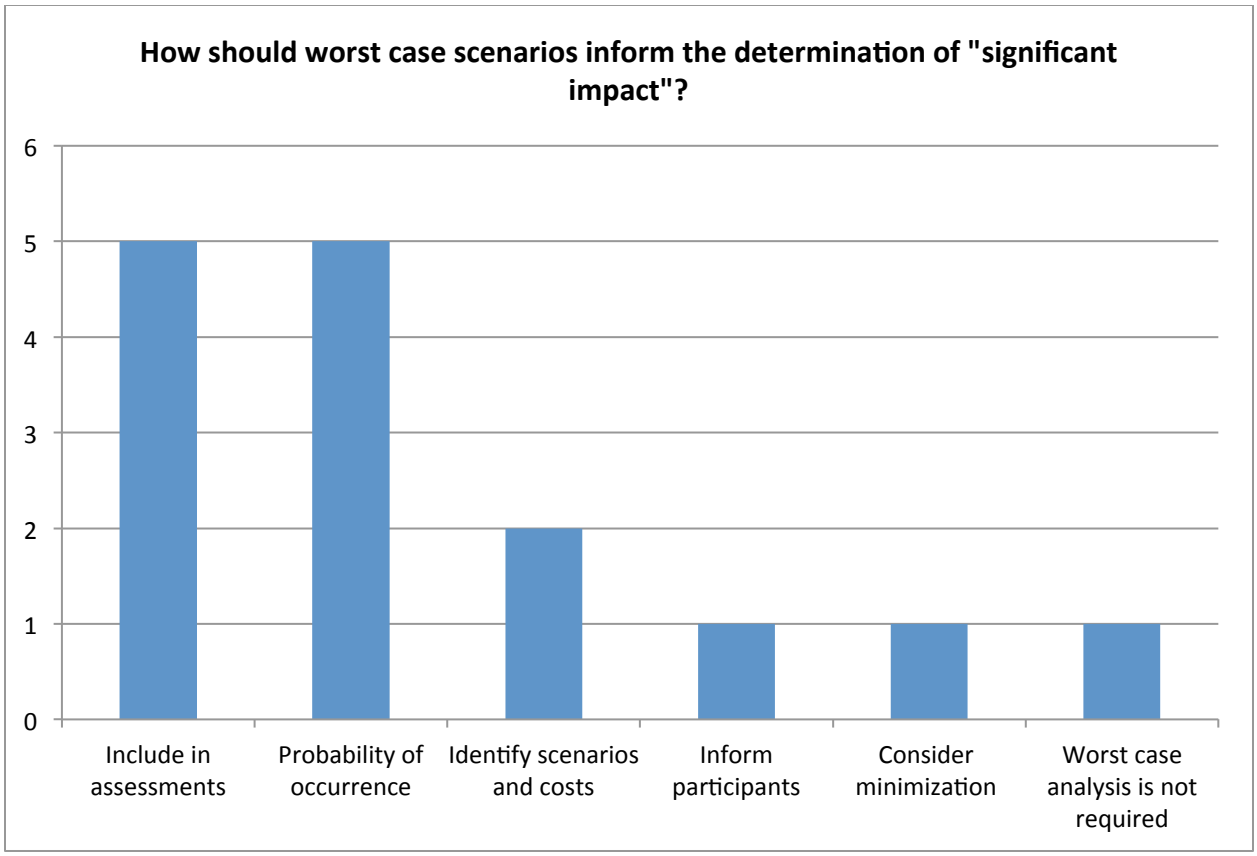
QUESTION 6: How should worst case scenarios inform the determination of "significant impact"?

A wide range of answers resulted from this question. In some circumstances, responders noted that worst case scenarios are not addressed. Others describe the issue of worst case scenarios being built into the evaluation of intensity, frequency, magnitude, duration etc, with the worst case scenario being at the far range of these factors. Some pointed out that worst case scenarios are both a function of the worst case impact itself and the likelihood of such an impact occurring. One person gives this example:

> MacDiarmid et al (2011) rates the consequence of a whale getting entangled in a subsea telecommunications cable as high, in that, if the event occurred, it could lead to the death of the animal and have a high consequence for that animal's population given the slow breeding rate of whales. However, the chance of this event is very low (such an event has not been reported since 1959[1]) and therefore it may not be prudent to conclude that laying subsea cables is an activity that carries "significant environmental effects".

In the U.S., "the regulations define "reasonably foreseeable" to include impacts "which have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason."" (citing Dan Farber (? Year) & 40 C.F.R. § 1502.22(b))

[1] Wood M.P.; Carter L.. (2008) Whale Entanglements With Submarine Telecommunication Cables. IEEE Journal of Oceanic Engineering (Volume 33, Issue 4)


How should worst case scenarios inform the determination of "significant impact"?
6
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1
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Include in assessments
Probability of occurrence
Identify scenarios and costs
Inform participants
Consider minimization
Worst case analysis is not required

Summary of Answers to Question 7: Differing Impacts Based on Ecosystem and Activity

QUESTION 7: How might significant environmental impacts, including direct, indirect and cumulative impacts, differ among ecosystems and resources considered for mining? (SMS deposits, Mn nodules, polymetalic crusts, phosphorite nodules).

Ecosystems, sealfloor structure, mineral types, and mining activities all vary based on mining type. Specific types identified include manganese nodule mining, cobalt crust mining, vent mining, and mining of sedimentary habitats (e.g. phosphate mining).

One person pointed out that plumes would be most significant in sedimentary habitats versus hard-substrate habitats. Nodules and crusts will take geological timescales to recover, while vents will recover in much shorter time periods (years to decades).

One person pointed out that impacts to the seafloor, in particular, will vary considerably; however impacts to the surface are unlikely to differ (as noted in a Comment from SPC-EU DSM Project Environment Advisor, Alison Swaddling). As one answer pointed out, issues will vary based on type of activity and ecosystem, including temporal dynamics that affect:

- natural levels of variability,
- magnitude of disturbance,
- rates of recovery
- potential for full functional recovery (in societal lifetime).

Also, ecosystem/activities will vary based on susceptibility to:

- loss of function and services (market and non market),
- potential for accidents (worst case secenario),
- ease of monitoring and enforcement,
- scale of mining required to be profitable
- cumulative effects from other stressors
- potential for mitigation or restoration

Summary of Answers to Question 8: Assessing Cumulative Impacts

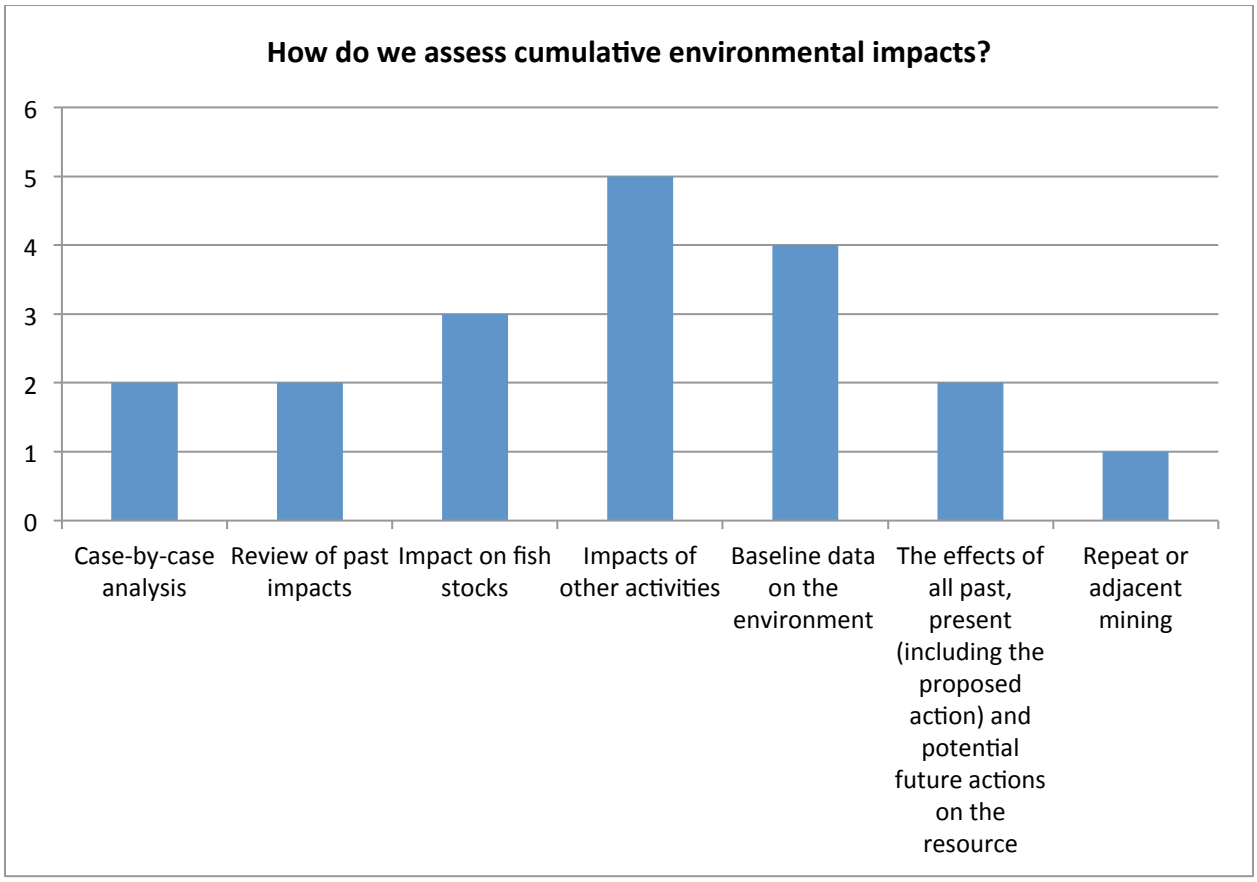
Question 8: How do we assess cumulative environmental impacts? What field studies have or can be conducted?

Two people described the need for a "strategic environmental assessment," which is a broader assessment than the project-level assessment. In the U.S., this would be similar to a programmatic environmental impact statement. Others mentioned the need for:

- marine spatial planning as a way to address cumulative impacts
- information and data sharing
- mapping
- baseline data and monitoring
- focus on the resources themselves and the relevant past, present and reasonably foreseeable future actions that may affect them.

One person identified cumulative effects as it relates to offshore drilling:

> Where drill centres are located within approximately 4 km of each other, 'mild' cumulative effects on sediment chemistry and, in some cases, benthic community structure have been noted.
>
> To apply these results to any other region, knowledge of bottom currents and sediment transport would be required. Mean monthly bottom current speeds for the areas beings discussed here are approximately 10 cm/sec, with monthly maxima of up to 50 cm/sec. Sediment transport occurs, but it is minor.


How do we assess cumulative environmental impacts?
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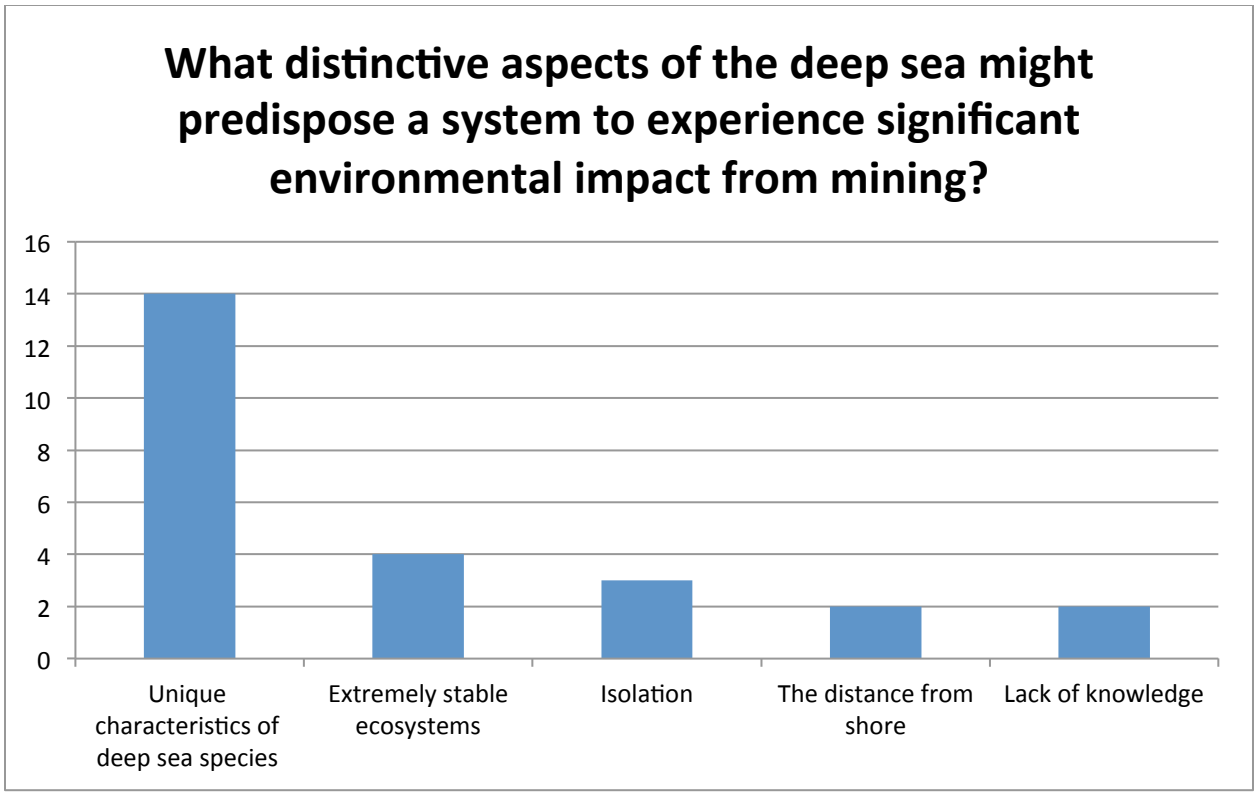
Case-by-case analysis
Review of past impacts
Impact on fish stocks
Impacts of other activities
Baseline data on the environment
The effects of all past, present (including the proposed action) and potential future actions on the resource
Repeat or adjacent mining

Summary of Answers to Question 9: Distinctive Aspects of the Deep Sea

(9) What distinctive aspects of the deep sea might predispose a system to experience significant environmental impact from mining (that would not in shallow water)?

1) Unique characteristics of deep sea species (14)
    a. Lower densities, longer lived species, low reproductive rates
    b. Slow maturation times and turnover of organisms
    c. Organisms operating at or near their physiological limits
2) Extremely stable ecosystems. A slight change in the environment in the deep sea will have more of an impact relative to the same change in the environment in shallow water (4)
3) Isolation (3)
    a. Isolated plant and animal life have not adapted to changing conditions that shallow-water plant and animal species have. Therefore they are less resilient/more susceptible to potentially significant adverse effects from development activities.
4) The distance from shore (2)
    a. Distance makes it more difficult to clean up after a spill
    b. More difficulty for both environmental and safety monitoring since regulatory agencies/authorities are further from the site
    c. Longer travel distances mean greater impacts from vessels traffic and greater chance for spills of any ores, fuels, or other chemicals
5) Extreme difficulty in understanding impacts and ways to mitigate them, lack of knowledge, pack of public awareness (2)


What distinctive aspects of the deep sea might predispose a system to experience significant environmental impact from mining?
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Unique characteristics of deep sea species
Extremely stable ecosystems
Isolation
The distance from shore
Lack of knowledge