DEEP-OCEAN STEWARDSHIP INITIATIVE

DOSI

POLICY BRIEF

JULY 2019

Diving deep into diversity: The importance of biodiversity assessment and monitoring for deep-seabed mining impacts

With commercial mining of the deep seabed projected to begin in the near future, robust environmental assessments and monitoring programs are necessary to assess impacts. Biodiversity is an important ecosystem component that can be measured using several methods, which have associated economic costs and scientific tradeoffs. One or more methods of biodiversity assessment may be needed to meet scientific goals and objectives set by the International Seabed Authority.

Biodiversity in the Mining Code As industry gears up to begin the exploitation phase of deep-seabed mining, the International Seabed Authority is working diligently with scientists and other stakeholders to develop appropriate rules, regulations, and procedures. One essential component to consider during this development is Article 145 of the United Nations Convention on the Law of the Sea: "necessary measures shall be taken [...] with respect to activities in the Area to ensure effective protection for the marine environment from harmful effects which may arise from such activities" in order to "[prevent] damage to the flora and fauna of the marine environment"[1]. This article highlights the importance of two tasks: (1) establishing a baseline of deep-sea biodiversity, and (2) monitoring deep-sea biodiversity for changes against that baseline resulting from mining activity.

Why is Biodiversity important? Biodiversity can be measured in a variety of ways: number of species in a given area, species absolute and relative abundances, number of functional roles in a system and species interactions, genetic variation between and among populations, representation of phylogenetic lineages, and number of habitats and ecosystems[2]. In addition to important ecological functions, deep-sea biodiversity supports products like fish catch and genetic resources that can be used for industrial and pharmaceutical purposes. Organisms in the deep sea can also play an important role in element and nutrient cycling, such as carbon, which is increasingly important as climate change impacts begin to manifest. Current recommendations and draft regulations for deep-seabed mining reflect the importance of several measures of biodiversity (Box 1).

Fig 1 *Pilargid Worm. Image by Greg Rouse*

[1] United Nations General Assembly, Convention on the Law of the Sea, Article 145, 10 December 1982, available at: http://www.refworld.org/docid/3dd8fd1b4.html

[2] Convention on Biological Diversity, 29 December 1993, available at: https://www.cbd.int/doc/legal/cbd-en.pdf

Biodiversity Questions

BOX 1

1. What is the composition of the biological community? Which species are dominant and most abundant?
2. Which functions are essential to ecosystem health and integrity? What is the trophic structure?
3. How are systems connected genetically and ecologically? How dynamically resilient are these systems?
4. How do these systems vary with space and time?

Approaches to measuring biodiversity

Currently, biodiversity assessments are based on taxonomic identification of individual organisms, which necessitates visual examination of morphological details by an expert. Because many deep-sea taxa are small, rare, and often new to science these visual methods can be difficult and costly, especially at large spatial scales. Recent advances in sequencing technology have allowed for taxonomic identification using "barcodes" (specific segments of DNA), which can be more time-efficient and cost-effective especially as DNA technology continues to advance and sequencing costs decrease[3]. In contrast, visual methods can be expensive due to the time taken to count and identify individual organisms (on the order of weeks to months). This can be inconvenient if management requires rapid results. However, morphology-based identification is needed to assess important ecosystem characteristics such as absolute abundance, biomass, and other ecological roles and functions of organisms. Additional tradeoffs exist between these taxonomic methods (Table 1). These methods represent a small subset of scientific tools that can help answer the above questions and meet environmental requirements.

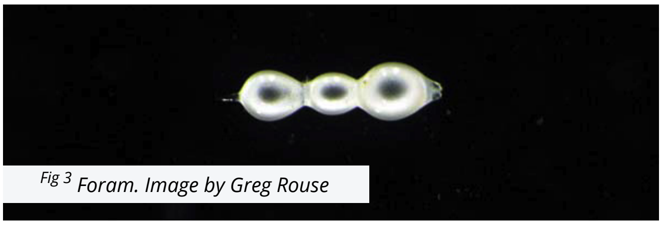

Fig 3 Foram. Image by Greg Rouse

[3] National Human Genome Research Institute. 2016. The Cost of Sequencing a Human Genome. Accessed 10 June 2019. https://www.genome.gov/about-genomics/fact-sheets/Sequencing-Human-Genome-cost

Thinking ahead

Much remains unknown about the structure and function of ecosystems targeted for deep-seabed mining, highlighting the need for establishing baseline datasets and robust monitoring programs. A systematic approach to do so may benefit the seabed mining community as a whole, allowing for data comparison through time and space, and distinguishing mining impacts from climate and other impacts. One example of such an approach may incorporate both molecular- and morphology-based techniques, using the former to rapidly screen large areas in order to identify representative sites for the latter. The decision to use one, another, or a combination will depend on the desired outcomes (e.g. basic characterization of the biological community, ecological function, demographic information). Additional techniques that may be helpful include genomics, transcriptomics, proteomics, metabolomics, and image analysis.

As the International Seabed Authority continues to develop environmental regulations and recommendations for mining, there is a novel opportunity to incorporate cutting edge science. A range of scientific tools can be used to balance economic development and environmental concerns in the deep sea. Sequencing technology, which represents an arsenal of methods, is decreasing in cost while increasing in ease of use and utility of output. Early adoption of such scientific tools now, in workflows complementary to current methods, may help fulfill future needs such as mining impact assessments, monitoring programs, and marine spatial planning.

This policy brief was prepared by:

Jennifer Le, Franck Lejzerowicz, Lisa Levin, Elizabeth Lyons, Jan Pawlowski, Katharine Ricke, Greg Rouse

The Deep-Ocean Stewardship Initiative seeks to integrate science, technology, policy, law and economics to advise on ecosystem-based management of resource use in the deep ocean and strategies to maintain the integrity of deep-ocean ecosystems within and beyond national jurisdiction.

For further information please contact:
dosi@soton.ac.uk
dosi-project.org

Advantages and disadvantages associated with either type of methodology.

TABLE 1

	Advantages	Disadvantages
Morphology-based taxonomy	Can provide absolute abundances as well as demographic information (size, age, sex, etc.)	More time to yield results Unable to resolve cryptic taxa
Molecular methods	Can identify microbes and cryptic taxa Easier to identify small and/or rare taxa	Lack of reliable quantitative data for many organisms