Scientific Community Input on Environmental Objectives for V3 and V4 Testing

Contributors

This document is a summary of the issues and considerations discussed by scientists in relation to the testing plans for Impossible Metals selective harvesting v3 and v4 AUVs, during a discussion held on October 25, 2022. The session was facilitated by Renee Grogan, Chief Sustainability Officer of Impossible Metals.

Scientists involved in these preliminary studies, as well as other scientists with expertise in the field of benthic ecology and abyssal ecosystems, are encouraged to contact Renee Grogan (renee.grogan@impossiblemetals.com) if they would like to be involved in further scoping and subsequent environmental studies related to the selective harvesting methodology proposed by Impossible Metals.

The scientists who contributed to the discussions summarized in this document are as follows:

- Sandra Brooke - Florida State University, USA
- Patrick Collins - Queen's University Belfast, UK
- Erik Cordes - Temple University, USA
- Tanja Stratmann - Royal Netherlands Institute for Sea Research - Netherlands
- Phil Weaver - Seascape Consultants, UK

Introduction

In May 2022, Impossible Metals held an initial roundtable discussion with approximately 12 marine scientists specializing in the deep ocean to gather initial feedback in relation to studying the impacts and management of Impossible Metals' selective nodule harvesting technology. The outcome was a preliminary summary of key scientific considerations for studying environmental impacts of selective nodule harvesting (Preliminary Scientific Consideration of Selective Harvesting Methodology Proposed by Impossible Mining)

With these preliminary scientific considerations in mind, Impossible Metals developed testing plans for versions 3 and 4 (v3 and v4) of the selective nodule harvesting robotics system. V3 testing is planned for December 2022 and v4 testing is planned for late 2023.

Purpose

The purpose of this discussion is for Impossible Mining to gather feedback from leading scientists in relation to considerations for studying environmental impacts during v3 and v4 testing.

V3 Testing Plan

Selective nodule harvesting robotics system v3 is planned to be tested in ~May 2023 in shallow freshwater (~50 metres) picking up nodule analogues (volcanic rocks with similar density to nodules). This test will demonstrate the integrated robotics system of the computer vision system and one robotic arm.The computer vision system will identify nodules but will not identify life at this stage. The integrated system will be untethered and autonomous, will avoid unintentional contact with the lake floor, and will return nodule analogues to the surface.

Feedback on Environmental Objectives for Testing V3

Scientists identified the following areas for consideration in relation to observations for v3 testing:

- Successful nodule identification - confirmation that the system is able to effectively identify and pick up nodules with a low failure rate.
- Qualitative plume observations - scientists indicated that the plumes were likely to be small with such a small test, and that the testing environment would not be a proxy for the deep ocean, and as such there is limited value in quantitative plume observations.

V4 Testing Plan

Selective nodule harvesting robotics system v4 is planned to be tested in late 2023 in deep sea water (~5000 metres) picking up actual nodules. This test will demonstrate the integrated robotics system of the computer vision system and 3-4 robotic arms. The computer vision system will identify nodules and megafauna, and we will track % success with avoidance of megafauna. The integrated system will be untethered and autonomous, will avoid unintentional contact with the seafloor, and will return nodules to the surface.

Feedback on Environmental Objectives for Testing V4

Scientists identified the following areas for consideration in relation to observations for v4 testing:

- Successful nodule identification - confirmation that the system correctly identifies and selects nodules, and avoids nodules with life forms attached, with a low failure rate.
- Successful identification and avoidance of megafauna - scientists were particularly interested in the system's ability to identify and avoid megafauna that may prevail over a larger area than a single nodule (e.g. long-tendrilled corals, stalked sponges, sea pens, Cerianthid anemones). It was recommended that IM seek to use the pre-harvest survey to identify these organisms, and demonstrate that this information can be used to enforce a larger exclusion zone, in order to avoid contact with this fauna.

- Quantitative or qualitative plume observations were recommended, including the potential for ‘cut and fill’ survey, to determine where sediment had been removed and/or redeposited.
- Successful programming of percentage of nodules left behind - given this will be a key management strategy associated with selective harvesting, scientists noted the need to demonstrate that the system can accurately leave behind a defined percentage of nodules within a given area. It was noted that high-resolution pre and post pickup survey would be required to quantify this outcome.
- Amount of sediment that adheres to the nodules - scientists noted that understanding whether sediment adheres to the nodules following selective harvesting, and whether this sediment is transported to the surface or “washed” during ascent will be important to understand whether uncontrolled release of sediment occurs throughout the water column during transportation.
- One scientist suggested using Sediment Profile Imaging (SPI) pre and post harvesting to show sediment structure and bioturbation after pickup, and to measure sediment resettling, however there were also logistical challenges to this process identified during the discussion.
- Nodule fauna biodiversity - using either the computer vision and AI system on the selective harvesting AUV, or interpreting video imagery after the trial.
- One scientist also indicated that use of fluorescence to identify the presence/absence of biota may be valuable, indicating that it is currently being used in offshore oil and gas survey work quite effectively.
- Anecdotal fauna observations in relation to avoidance - while the system will not be full scale so hydrophone data may not be relevant, scientists agreed that it would be interesting to note any anecdotal evidence of fauna avoiding the AUV due to noise or light emissions.

Further Work

Renee confirmed at the conclusion of the session that Impossible Mining will be progressing with the design and implementation of environmental studies as part of both shallow-water and deep-water prototype testing, in line with the recommendations made during this session.