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TITLE: Climate change considerations are fundamental to management of deep-sea resource extraction

AUTHOR: ['Lisa A. Levin', 'Chih-Lin Wei', 'Daniel C. Dunn', 'Diva J. Amon', 'Oliver S. Ashford', 'William W. L. Cheung', 'Ana Colaço', 'Carlos Domínguez-Carrió', 'Elva Escobar', 'Harriet Harden-Davies', 'Jeffrey C. Drazen', 'Khaira Ismail', 'Daniel O.B. Jones', 'David E. Johnson', 'Jennifer Le', 'Franck Lejzerowicz', 'Satoshi Mitarai', 'Telmo Morato', 'Sandor Mulsow', 'Paul V. R. Snelgrove', 'Andrew K. Sweetman', 'Moriaki Yasuhara']

ABSTRACT:

Abstract Climate change manifestation in the ocean, through warming, oxygen loss, increasing acidification, and changing particulate organic carbon flux (one metric of altered food supply), is projected to affect most deep-ocean ecosystems concomitantly with increasing direct human disturbance. Climate drivers will alter deep-sea biodiversity and associated ecosystem services, and may interact with disturbance from resource extraction activities or even climate geoengineering. We suggest that to ensure the effective management of increasing use of the deep ocean (e.g., for bottom fishing, oil and gas extraction, and deep-seabed mining), environmental management and developing regulations must consider climate change. Strategic planning, impact assessment and monitoring, spatial management, application of the precautionary approach, and full-cost accounting of extraction activities should embrace climate consciousness. Coupled climate and biological modeling approaches applied in the water and on the seafloor can help accomplish this goal. For example, Earth System Model projections of climate-change parameters at the seafloor reveal heterogeneity in projected climate hazard and time of emergence (beyond natural variability) in regions targeted for deep-seabed mining. Models that combine climate-induced changes in ocean circulation with particle tracking predict altered transport of early life stages (larvae) under climate change. Habitat suitability models can help assess the consequences of altered larval dispersal, predict climate refugia, and identify vulnerable regions for multiple species under climate change. Engaging the deep observing community can support the necessary data provisioning to mainstream climate into the development of environmental management plans. To illustrate this approach, we focus on deep-seabed mining and the International Seabed Authority, whose mandates include regulation of all mineral-related activities in international waters and protecting the marine environment from the harmful effects of mining. However, achieving deep-ocean sustainability under the UN Sustainable Development Goals will require integration of climate consideration across all policy sectors.

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