ENVIRONMENTAL STUDIES

High stakes on the high seas

Today, "the high seas" are generally understood to refer to the vast expanses of open oceans that are not under the formal jurisdiction of any nation. Legally, the high seas are defined as the 60% expanse of the oceans that lie beyond national exclusive economic zones, which are within 200 nautical miles (370 km) of coastlines. Despite legal definitions, however, the expanses of the high seas are neither well-defined nor well-understood from ecological or geological perspectives. The surface area of these waters is one-and-a-half times the total land area on the planet and the dynamics in their depths play critical roles in regulating climate and biogeochemical cycles, supporting incalculable biodiversity and providing rare habitat to some of the most charismatic species on Earth. Like the continent of Antarctica and the canopy of the Amazon, the high seas are places that few will experience but remain sources of wonder and imagination for people of all nations and cultures.

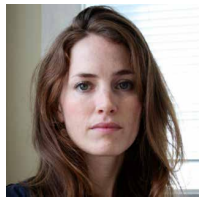
Today, the sustainable health of the high seas is at risk. Industrial activities are already draining the oceans of their natural capital including valuable minerals, new genetic resources, and wild animals. This set of research articles on the science of the high seas has been compiled to underscore some of the major challenges and risks that nations face as ocean exploitation accelerates. Each study explores a particular facet of human influence on the high seas and highlights economic interests in bioprospecting, mining, and fishing. We hope that these can serve to inform researchers and policy makers concerned with sustainable management and international governance of the high seas.

A major concern regarding sustainable use of ocean resources includes how to equitably share benefits derived from marine genetic resources. Blasiak *et al.* (2018) set the stage by looking at the institutional actors that have been acquiring patents on marine genetic resources over the last 30 years, finding that only 30 institutions hold a full 84% of all patents related to marine species, and a single transnational corporation holds almost half of all patent sequences. A little more than 10% of patent sequences are derived from 91 species associated with deep-sea and hydrothermal vents, many of which are found on the high seas—although there is rarely disclosure about where the species were collected.

Another concern about the sustainable use of ocean resources is the increased mining of mineral deposits on mid-ocean ridges, all of which fall beyond any national jurisdiction. Dunn *et al.* (2018) propose a series of metrics that could be used when planning for mining, including a discussion of the value of no-mining areas. They apply their criteria to a case study of the northern and equatorial Mid-Atlantic Ridge, where contractors are already exploring for sulfides. They underscore the need to set aside large areas to protect deep-sea populations, to create conservation corridors for genetic exchange, and to close areas around all active hydrothermal vents to protect the very rare and precious life forms there.

While high seas mining is early in expansion, intensive fishing operations are already well-established on the high seas, in part due to the overfishing in nearshore waters. Tickler *et al.* (2018) use reconstructed catch data to present a historical view of the expansion of fishing offshore starting in 1950. They found that China, Taiwan, Japan, South Korea, and Spain are the most active fishing nations on the high seas. Using newly available satellite data, McCauley *et al.* (2018) found that boats flagged to the same five countries represent the greatest fishing effort on the high seas and these five countries are also among the top countries fishing in the nearshore waters of other countries. Although these new data do not represent all boats on the high seas, they do provide the best view of global, spatial view of fishing activities around the planet.

Three additional studies use satellite data to suss out other views of the impacts of fishing on the high seas. Sala *et al.* (2018), for example, used several large-scale data sets to build a global economic model of high seas fishing costs and revenues and found that without government subsidies more than half of high seas fisheries would be unprofitable. Work on the economics of high seas fisheries is relevant not only to sustainability researchers but also to policy makers at international institutions including the United Nations and the World Trade Organization, where there is talk of decreasing or banning fishing subsidies. Crespo *et al.* (2018) used satellite data to develop a model to detect patterns and potential locations of longline fishing. They showed that this model can be used to predict fishing effort and potential bycatch, as well as indicate where to place additional monitoring and enforcement resources. Boerder *et al.* (2018) also used satellite data to monitor transshipment-at-sea, which is when fishing boats offload their catch, restock, and resume fishing without returning to port. At present, transshipment is a common practice that allows fishing boats to evade monitoring and enforcement and facilitates both illegal fishing and related human rights abuses. In response, many Regional Fisheries Management Organizations (RFMOs) have taken steps to regulate transshipment, and one RFMO, the South East Atlantic Fisheries Organization (SEAFO), has banned transshipment altogether. Despite these efforts, Boerder and her colleagues found more than 100 probable transshipments between 2012 and 2017 in the SEAFO area, demonstrating that satellite data will be essential for detecting violations.



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This collection also includes work by Schiller *et al.* (2018), who used catch and trade data to examine the contribution of high seas fisheries to global food security. They found that total catch from the high seas accounts for only 4% of annual marine capture fisheries by volume and consists of species primarily destined for luxury markets in Japan, the European Union, and the United States. There is only one species, Antarctic toothfish, caught exclusively on the high seas while the remaining 38 fish and invertebrate species, which represent almost the entire high seas catch, are captured in both national and high seas waters. Policy makers may find these data useful in debating the merits of creating no-fishing areas on the high seas and the possible implications of such action on global food security.

These studies, along with many others, provide concrete evidence that, at present, institutions and governments do not have adequate tools to keep pace with those who work to overexploit the high seas. The data and analyses in this collection highlight the challenges in balancing the long-term imperatives of preserving the ocean's vast resources with shorter-term economic and political interests that seek to quickly and vigorously profit from the oceans. The high seas, like everything on Earth, are a limited resource. How we choose to protect and use its precious resources will test our humanity, our cooperation, and our collective vision for the future.

– Jennifer Jacquet and Jeremy B. C. Jackson

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