Brief to the Global Ocean Commission

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## *on behalf of the Deep-Ocean Stewardship Initiative[[1]](#footnote-1)*

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The deep ocean below 200 meters is the largest habitat for life on Earth and the most difficult to access. We remain largely ignorant of how deep-ocean ecosystems change in space and time in response to specific human activities and the consequences of these changes.

It is only since the mid-1960s that human-occupied vehicles began to take scientists to the deep seabed. Each decade since has led to increased access to the deep ocean through use of technologically advanced robotics for exploration and scientific research. Large uncertainties exist in predictions of the magnitude of consequences of human activity in the deep ocean. Put simply, we do not yet know what we do not know.

Existing extractive industries in the deep ocean with the potential to cause harm to the marine environment include fisheries and oil and gas exploitation, and there is accelerating interest and action in other sectors of deep-ocean industrialization, such as deep-sea mineral extraction. Because of this ocean industrialization, it is essential that coherent and coordinated actions are taken now to ensure protection and preservation of the deep-ocean environment and conservation of its ecosystems, while enabling use of its living and non-living resources.

In this document, we highlight some of the special features of the deep ocean that justify actions (Box 1) toward effective stewardship of deep-ocean resources. We recommend ways in which these actions may be advanced. While some actions are already underway, much more needs to be done.

Special Features of the Deep Ocean

Box 1. ACTIONS TOWARD EFFECTIVE DEEP-OCEAN STEWARDSHIP

1. Develop and implement a strategic vision for ecosystem-based management in the deep ocean.
2. Establish consistent and effective governance.
3. Advance a precautionary approach.
4. Promote exploration, marine scientific research and best practices for exploitation.
5. Evaluate resource allocation and equity.
6. Build capacity internationally.
7. Undertake comprehensive benefit-cost analyses and advance benefit-sharing obligations.

To understand what is special about the deep ocean is to gain the opportunity to use it wisely, preserving its functions and services for future generations. The deep ocean challenges us to advance stewardship strategies that take into account its special features and that draw from best practices used in terrestrial and shallow-water ecosystems. Some of the special features of the deep ocean that should inform laws, policies, and management are described here.

## Limited Access to the Deep Ocean

The deep ocean is a remote wilderness and access to it requires advanced technologies and costly at-sea operations. The vastness and great depth of the deep sea, which covers two-thirds of the planet and has a maximum depth that reaches greater than six miles (more than the height of Mount Everest) is a domain routinely accessed only by researchers funded by a subset of wealthy nations.

## Complex Deep-Ocean Governance

The deep ocean spans national and international waters and seabeds, so no single governance regime applies. Multiple jurisdictional regimes operate independently from one another, including national jurisdictions (further subdivided into territorial seas, exclusive economic zones, and continental shelves that may be extended beyond EEZ boundaries), as well as areas beyond national jurisdictions with different high seas and seabed (the Area) frameworks.[[2]](#footnote-2)

The Law of the Sea Convention provides the overall framework for order in the oceans and for protection and preservation of the marine environment. In addition, international, multilateral, and bilateral treaties and soft-law agreements abound that address deep-ocean issues in a piecemeal way. National governance frameworks are also fragmented, sector-based, and often fail to address user conflicts and cumulative impacts.

Sector-based management approaches for activities such as shipping, fishing, and mining can lead to illogical results. For example, one legal framework may close areas to bottom-fisheries to preserve cold-water corals and sponge gardens while another legal framework would allow extraction of metal-rich crusts or phosphates that destroys these same corals and sponges.

Gaps abound in deep-ocean governance: Many legal frameworks (national and international) lack essential mechanisms to manage and protect ocean resources. For instance, there is no global legal framework to protect marine biodiversity beyond national jurisdiction and there are critical gaps in governance related to stewardship of genetic resources.

## Rich Deep-Ocean Biodiversity

Deep-ocean biodiversity is extraordinarily rich: the number of species to be found rivals that of tropical rainforests. Most deep-ocean species remain unsampled and unknown; many species that have been sampled have not been described morphologically or genetically; and every sampling effort on the seafloor yields dozens of species new to science.

This rich deep-ocean biodiversity supports key ecosystem functions and services including nutrient regeneration and carbon sequestration and represents a storehouse—a *living library*—of genetic resources that ultimately may be applied to societal needs. This genetic diversity is also the raw material that will allow life in the ocean to evolve and adapt to changing climate conditions, a key reason for sustaining ocean biodiversity.

While much about the deep ocean is poorly understood, what is known gives rise to concerns about potential long-term impacts of human activities.

## Exceptionally Long-Lived Animals

Many deep-ocean fish and invertebrate species are long-lived; they grow slowly, recruit episodically, and mature at a late age. These living resources are susceptible to and will not quickly (if ever) recover from over-exploitation, which often occurs through intentional serial depletion within a region or as bycatch of a different targeted fishery.

## Deep-Ocean Heterogeneity

The deep ocean is not homogeneous; there is no one-size-fits-all approach to environmental stewardship. Temporal dynamics vary in the deep ocean. On the one hand, deep cold-water corals, fishes, and other animals live long and grow slowly; on the other hand, animals living at submarine hot springs are among the fastest-growing animals known on Earth. The seafloor is as also as varied as any continental landscape, arguably more so. Deep-ocean animals are distributed in as complex a manner as trees and shrubs are on land, with global, regional, and local patterns in what lives where and in what numbers. Some features of the deep ocean include:

* **Volcanic mountain ranges that girdle the globe**—more extensive than any mountain range on land—that host hot springs and luxuriant communities of worms and microbes exquisitely adapted to chemicals in the warm fluids rising from the ocean crust and from which scientists are learning much about the potential for life on other planets and the origin of life on Earth. As the fluids exit the crust and encounter cold ocean water, they deposit massive sulfide ore that can host valuable quantities of copper, zinc, and, in some settings, silver and gold.
* **Submarine canyons** that channel swift currents from the continental slope to the deep sea, carrying with them bulk deliveries of dead organisms, sediment from land, and pollutants from cities and agriculture.
* **Abyssal plains** thick with sediment settled from the water column and rich in minute animal species, each busy in its own way, parsing the muds into microzones of life and chemistry. It is here at great depths that metal-rich nodules may form, ever so slowly, accumulating manganese, cobalt, copper, nickel and even rare earth elements, which are increasingly needed for modern technology.
* **Deep trenches and subduction zones**, where seafloor moves beneath continents, are the deepest reaches of the biosphere. Organisms that live in trenches are adapted to the greatest extremes of hydrostatic pressure and have much to yield in terms of genetic resources.
* **Mud-covered continental margins (slopes)** extend outward from the shelf, hosting deep-water coral and sponge reefs that are critical nursery grounds for deep-water fishes and shellfish. The slopes accumulate organic matter that, over geological time, transform into fossil energy reserves (oil, gas and frozen methane). In regions where surface primary production is high, phosphate deposits accumulate in sediments, offering an untapped repository of fertilizer used in agriculture.
* **Tens of thousands of seamounts** in the deep ocean, the greatest of which stretch several kilometers upward from the deep ocean to the sunlit zone, creating submarine *Shangri La*s for ancient corals, for sponges of centennial growth and height, and for fish with lives longer than those of humans. Despite knowledge about these incredible habitats, centenarian fish are still harvested and venerable (and vulnerable) corals and sponges decimated in the process. It is also on seamounts that, over the course of millennia, bacteria facilitate formation of pavements of cobalt crusts rich in metals and rare earth elements—a potential target for deep-ocean miners.
* **The water column** is the largest biovolume on Earth and, while it may seem to be a homogenous ecosystem, this is far from the case. Geographical and vertical zonation in the deep ocean combined with distinctive water masses create local and regional conditions not dissimilar in effect on biodiversity to those of polar, boreal, temperate, sub-tropical, and tropical climate regimes on land.
* **Deep-ocean currents** transport materials (chemicals, organisms, pollutants) and physical properties (temperature, density) from one region to another, just as rivers do.

## Linkages among Deep-Ocean Systems, the Ocean Surface and Atmosphere, and the Coasts

The deep ocean is a complex, 3-dimensional biosphere with physical, chemical, biological, and energetic linkages between water-column ecosystems and the seabed. At the ocean surface, sunlight supplies energy to marine phytoplankton. This energy sinks to the deep ocean as particles of organic material, often with lag times of days to months. Bottom-dwelling fishes, invertebrates, and microorganisms break down some of this material and release inorganic nutrients back into the water column, fertilizing the growth of the phytoplankton. But most of the particulate carbon settling to the seabed from surface waters is ultimately buried and sequestered in seafloor sediments; deep-ocean sediments are the largest sink for carbon in the global carbon cycle.

As the transfer of energy and matter from the atmosphere and surface to the seabed demonstrates, what is produced in one place is received in another. Actions at the surface of the sea have consequences in the deep ocean:

* Ocean acidification—the result of increasing carbon dioxide in the atmosphere and its diffusion into seawater—moves as insidious ‘smog’ from the surface of the sea through the water column to the seabed, changing the nature of the very medium in which contemporary ocean life is bathed and to which it has been adapted.
* Climate–induced intensification of upwelling brings deep water (low in oxygen and pH) up to the coastal zone, impacting shellfish culture, altering habitat suitability for fishery species, and shifting animal distributions.
* Surface pollution—plastics, organic and pharmaceutical contaminants, disaster debris, and other materials and chemicals—ultimately make their way from land and coastal waters into deep water. The deep-ocean has become an unintentional dumping ground. Equally troublesome is the notion that terrestrial waste (e.g., mine tailings, garbage, munitions, radioactive material) is better deposited into deep water than on land or in the coastal zone. The deep ocean should not be Earth’s waste bin; accumulations and consequences are removed from human perception at our peril.

**Recommended Actions for Effective Deep-Ocean Stewardship**

For each action listed below, we highlight areas where specific advances would substantively promote effective deep-ocean stewardship.

### 1. Develop and Implement a Strategic Vision for Ecosystem-Based Management in the Deep Ocean

* There is a compelling need for a unified and strategic vision for ecosystem-based management in the deep ocean. The International Seabed Authority, as the global body responsible for management of mineral resource-related activities in the deep seabed Area on behalf of humankind, is the appropriate body to develop such a vision. An interdisciplinary community of practice has emerged that is willing to assist in identifying the basic elements for such an approach[[3]](#footnote-3). It is time to engage in a multidisciplinary, international, cooperative, and cross-sectoral effort, with particular attention to environmental and cumulative impact assessments and including monitoring, compliance, and enforcement needs. This vision should, among other things, highlight the need to
  + Identify spatial and temporal conflicts, consider tradeoffs among different resource uses, and account for future needs for ecosystem service needs.
  + Recognize differences among ecosystems and ensure that variable natural histories of deep-ocean species and uncertainties are taken into account.
  + Facilitate cooperation among deep-sea mineral exploration companies, the scientific research community, and civil society to maximize scientific knowledge gained from exploration and commercial activities that take place in the deep sea.
  + Enhance tools and strategies that preserve biodiversity and ecosystem structure and function, mitigate harm, and may facilitate recovery from deep-sea disturbances, including use of systematically planned deep-water marine protected areas (i.e., ISA´s Environmental Management Plan for the Clarion Clipperton Zone).
  + Recognize our inability to survey the diversity of the entire deep sea and develop means to preserve undiscovered ecosystems, species, and genetic diversity prior to their loss from present and future resource extraction.
  + Ensure accountability, transparency, and wide stakeholder participation (including civil society) in ecosystem-based management of the deep ocean.

### 2. Establish Consistent and Effective Governance

* The global community and individual nations should establish coherent and consistent governance regimes for deep-ocean ecosystems and resources, so that what is protected under one sector-specific regime is not at risk under another regime.
* A cross-sector, intergovernmental body should be charged with coordinating and enhancing stewardship of the deep ocean across regimes and jurisdictions.
* Sector-specific and regional organizations should be authorized and required to implement ecosystem-based and precautionary approaches as described below.

### 3. Advance a Precautionary Approach

* The global community must implement the mandatory requirement in general international law that prior environmental and cumulative impact assessments be carried out whenever there is a risk that an industrial activity creates a significant adverse impact on the marine environment.
* Where there is substantial scientific uncertainty or a lack of data about the impacts of a deep-ocean activity, it should be assumed that significant adverse impacts will occur and further evaluation is required to resolve uncertainty before authorizing the activity to proceed.
* Extractive activities in the deep ocean should not be permitted unless appropriate mitigation measures are adopted, including avoiding and minimizing harmful impacts and restoration or offset actions are undertaken.

### 4. Promote Exploration, Marine Scientific Research and Best Practices for Exploitation

* There is need for promotion of private and public funding of deep-ocean research and science in support of best practices for ecosystem-based management (including research and development of technologies that minimize environmental impacts); this funding should be in addition to and independent of regulatory and contracting parties.
* International collaborative research programs, databases, sample archives and sample sharing should be promoted by the scientific community to advance contributions and cooperation in building our knowledge of deep-ocean ecosystems, dynamics, processes, and resource distribution (living and non-living, including marine genetic resources).
* Best practices of resource extraction methods and technologies, ecosystem-based management, and deep-sea data collection and database development should be developed through academic-industry partnerships and other mechanisms.

### 5. Evaluate Resource Allocation and Equity

* Rational resource allocation strategies for the deep ocean should include spatial *and* temporal strategies of allocation to ensure renewable living resources beyond national jurisdiction are sustained, and that non-living, non-renewable resources are apportioned in a manner consistent with their status as the common heritage of mankind and with regard for protection and preservation of associated living resources.

### 6. Build Capacity Internationally

* Developing nations with exploitable deep-sea resources should be provided with the expertise, technology, and financial support to manage their resources, including policy, environmental, and economic perspectives.
* Public awareness (ocean literacy) and political will are key elements that underlie stewardship of the deep ocean. All countries should promote this awareness, especially those countries with rapidly expanding pressures for resource extraction.
* The International Seabed Authority endowment fund in support of early career scientists in collaborative marine scientific research should be expanded to keep pace with the increasing demand for expertise in deep-ocean scientific research.

### 7. Undertake Comprehensive Benefit-Cost Analyses and Advance Benefit Sharing Obligations

* Benefit-cost analysis should be undertaken to ensure that un-priced (external) costs, such as seafloor damage and ecosystem degradation, are considered when calculating the net benefits of resource use.[[4]](#footnote-4)

1. 1The Deep-Ocean Stewardship Initiative (DOSI) comprises an international and interdisciplinary group of natural scientists, social scientists, and representatives of civil society and industry. The inaugural activity of DOSI took place 15-17 April 2013 at the Universidad Nacional Autónoma de México (UNAM) in Mexico City with support from INDEEP, the Kaplan Foundation, and UNAM; this Brief represents one action item recommended by DOSI workshop participants (A Ascencio, J Ardron, M Baker, B Currie, J Dean, E Escobar, A Figueroa, K Gjerde, P Holthus, T Koslow, A Lara-Lopez, L Levin, M Lodge, K Mengerink, L Menot, C Neumann, L Pendleton, F Pfirter, E Ramirez-Llodra, D Squires, A Sweetman, A Tawake, P Tyler, V Sierra, T Sutton, C Van Dover, H Yamamoto, U Witte). [↑](#footnote-ref-1)
2. Under international law, the seabed beyond national jurisdiction is referred to as ‘the Area’ with a capital ‘A’. [↑](#footnote-ref-2)
3. As evidenced, for example, through the work of participants at recent workshops on guidelines for networks of chemosynthetic ecosystem reserves (Dinard France 2010), on the potential of deep-sea restoration (Sete France 2012), and the DOSI workshop (Mexico City 2013). [↑](#footnote-ref-3)
4. Benefit-cost analysis considers whether the proposed resource use creates positive net benefits for humanity as a whole, in addition to benefits to private entities conducting the activity. Some activities may be beneficial for private entities but not for humanity (and vice versa). Benefit-cost analysis also accounts for subsidies, transfer prices, and over- or under-valued exchange rates that may misprice resources at various locations over the value chain, and for otherwise unrecognized employment benefits. It can further account for differences in broad-based total economic value for raw ore over processed minerals (allowing for transfer prices and exchange rates calculated over the supply chain). Analysis of the amount and sharing of risk, and of the net private financial and broader social benefits should be taken into account in any financial and economic benefit sharing or administrative and regulatory burden-sharing rules for seabed mining. [↑](#footnote-ref-4)