

What Does the Deep Ocean Do for You?

Key Messages

- Ecosystem services are benefits that people derive from nature.
- The deep ocean provides many critical ecosystem services, such as fish and shellfish for food; products from organisms that can be used for medicines; climate regulation; and historical, cultural, social, educational, and scientific value for people worldwide.
- Human activities can harm deep-ocean ecosystem services both directly and indirectly.
- States have committed to protecting ecosystem services through national laws and international commitments, but these often fail to consider the deep ocean.
- Improved understanding of deep-ocean ecosystem services provides a core foundation for effective ecosystem-based management of the deep ocean.
- We have an opportunity to protect deep-ocean ecosystem services through incorporation into policies and decision-making processes.

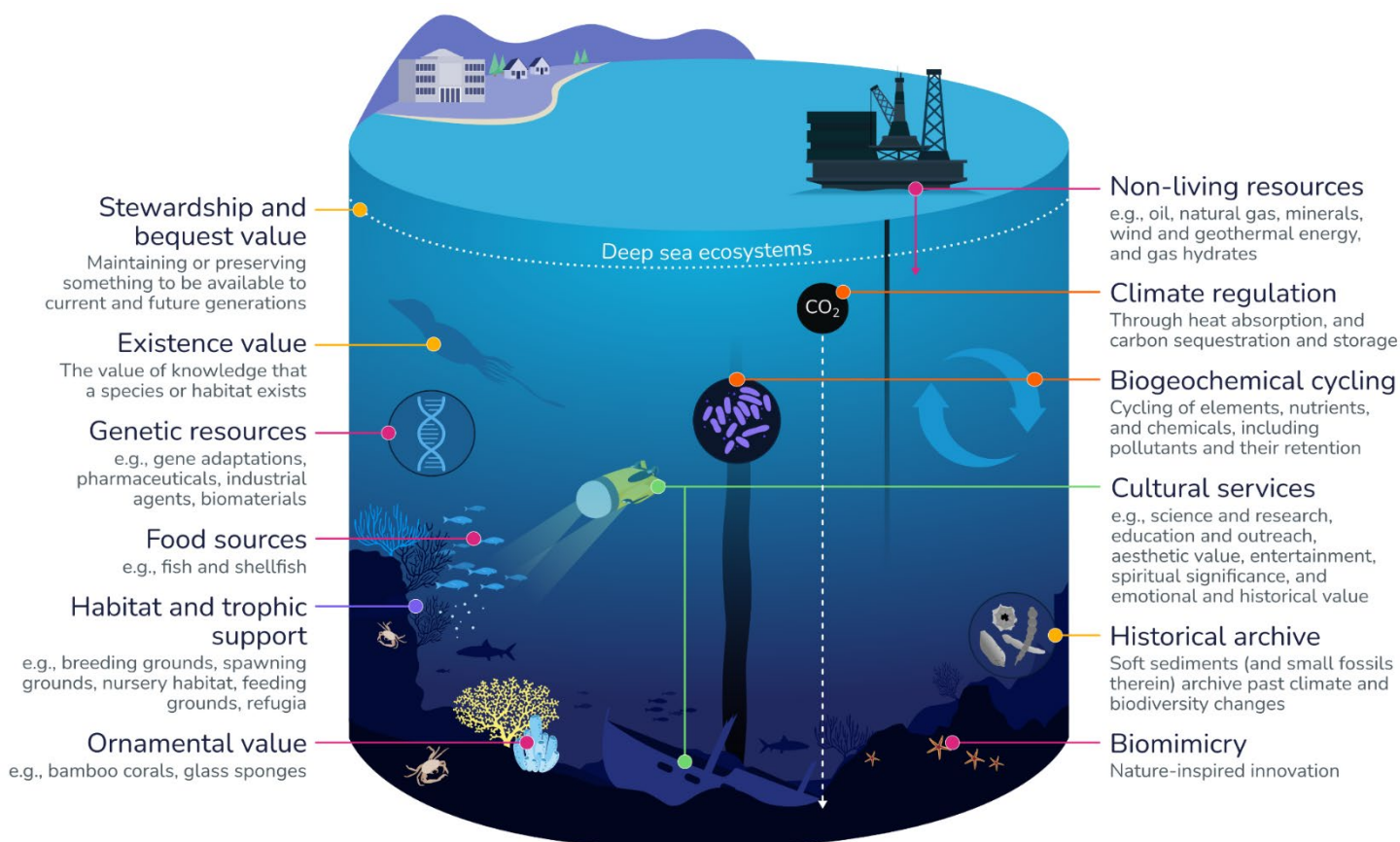
What are ecosystem services?

Ecosystem services are benefits that people receive from the natural environment. By identifying how natural processes support human well-being, we can begin to understand the often-unclear value that ecosystems provide to us. This direct link between natural systems and people is a critical consideration for policy development across a number of issues, from the just and equitable sharing of benefits to responsible environmental stewardship.

What ecosystem services are provided by the deep ocean?

Because most people do not interact with the deep ocean directly, it is not obvious how this realm provides ecosystem services. However, the deep ocean provides over 95 percent of Earth's living space (water column and seabed greater than 200 meters water depth) and hosts diverse habitats and organisms that support various ecosystem services essential to human and ocean health globally (Figure 1, Box 1).

Figure 1: Categories of ecosystem services and deep-ocean examples of each category. Illustrated by Stacey McCormack.



KEY

- Provisioning services: result in tangible goods and/or products
- Regulating services: contribute to the natural production and resilience of habitats and ecosystem processes
- Supporting services: underlying ecosystem functions that are essential to produce other services
- Cultural services: non-material benefits deriving from nature
- Biodiversity values: biodiversity has intrinsic value, but is also the source of most ecosystem services

Human Impacts on Deep-Ocean Ecosystem Services

Human activities and climate change are leaving their mark on the deep ocean, including on ecosystem services. Industries such as fishing, oil and gas extraction, shipping, and mining are all moving to deeper ocean areas, with increasing potential for direct and indirect impacts on deep-ocean habitats. For example, physical disturbance on the seafloor can affect fisheries services by removing critical habitat needed by commercially important species. Biogeochemical cycles that are important to water quality and detoxification can be disrupted by pollution and increased toxicity. Climate change also affects deep waters and their global-scale circulation. Warming, increased acidification, and oxygen loss threaten habitat integrity and traits of deep-sea organisms, underpinning critical functions and services, such as evolutionary novelty in hydrothermal vents and carbon cycling from food web interactions.

Given the challenges and costs of deep-ocean research, there are persistent gaps in knowledge that impact our ability to protect ecosystem services. Natural variation in deep-ocean ecosystems, and their associated services, remains mostly unknown and can occur over long timescales and large spatial scales. Some deep-ocean ecosystem services, such as stewardship value or the value of maintaining a habitat or organism for present and future generations, are also poorly known largely because they are difficult to measure. These knowledge gaps create uncertainty about impacts of human activities, including cumulative impacts, on deep-ocean ecosystems, their services, and their potential for recovery from disturbance. There is a need for robust baseline data collection that explicitly includes ecosystem services, as well as for the application of a precautionary approach to deep-ocean activities to ensure our continued benefits.

Help from Hydrothermal Vents

Box 1

Hydrothermal vents are unusual ecosystems in that they rely on chemical energy and not energy directly from the sun/photosynthesis. The unique and often endemic creatures that live there are known as 'extremophiles' due to their ability to survive, or thrive, in extreme environmental conditions, such as high temperature and toxic metal concentrations. These extremophiles are a source of great evolutionary novelty, which may help us solve contemporary challenges. Examples include:

- Insights into how life on Earth originated billions of years ago
- Polymerase enzymes from vent bacteria, which are an essential compound for DNA replication that fueled the molecular science revolution, including quickly testing for viruses like SARS (avian flu) and COVID-19
- A potential template for artificial human blood from giant vent tubeworm blood that has hemoglobin with exceptionally high oxygen affinity
- Vent bacteria that may help remove carbon dioxide from industrial sources
- Vent-endemic snails with iron scales that provide bioinspiration for stronger materials for airplanes, cars, and military equipment



Tubeworms around a hydrothermal vent. Image courtesy of Ocean Networks Canada/CSSF-ROPOS

Protection of ecosystem services

Ecosystem services directly contribute to human well-being; activities that degrade and damage them result in direct losses for humanity. Ecosystem structures and functions that deliver ecosystem services need to be protected for us to continue receiving nature's benefits. For example, fish populations require habitat for breeding, nursing, feeding, and shelter. For fish stocks to be sustained, not only does the stock itself need monitoring to document changes, but so do these essential habitats. There are no known substitutes or replacements for some ecosystem services, such as climate regulation that operates over large distances and long timescales. Human activities that risk disruption of irreplaceable ecosystem services warrant cautious measures to avoid their loss.

The need for sustainable management and protection of ocean ecosystems that promote increased resilience, health, and productivity is recognised in many intergovernmental and national policy agendas worldwide. These include the post-2020 Global Biodiversity Framework, the United Nations Sustainable Development Goal 14, and Article 145 of the United Nations Convention on the Law of the Sea, which calls on States to protect and preserve the marine environment. Although some of these agreements may be focused on ecosystems rather than services, protecting supporting structures and functions will also benefit associated services. However there remain many challenges to achieving sustainable management of deep ocean resources.

Policies that support the protection of deep-ocean ecosystem services, and precautionary approaches to avoid irreversible losses of those services, are critical. For example, strategic environmental assessments with robust baseline data at a regional-scale, followed by risk analysis and mitigation strategies of ecosystem services should be part of project-specific environmental impact assessments. Such requirements can be incorporated into all stages of management. For example, stakeholder consultations can help assign values to given ecosystem services. These values, in turn, can inform decision-making through cost-benefit analysis where the benefit of an action is compared against the cost of ecosystem service losses due to that action. As an absolute last resort, the value of ecosystem service losses can be used to calculate environmental damage compensation. However, avoidance and minimization are currently the only feasible options of mitigating damage to deep-sea ecosystem services.

Further research to uncover critical ecosystem services remains essential. As scientists learn more about the deep ocean, we can better understand linkages among ecosystem structures, functions, and services. These linkages can help identify what is essential to protect to ensure that humankind continues to benefit from this vast ocean realm. There may well be benefits we derive from deep-ocean ecosystem services that we have yet to even discover or understand. At the same time, it will be critical to share what we learn about those benefits with stakeholders and the public. Ecosystem services provide a framework for science, policy, and science communication that is fundamental for informed and holistic decision-making.

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About DOSI

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.

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Further Information

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