

Co-designing marine science for the ocean we want

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The United Nations Decade of Ocean Science for Sustainable Development requires that all of the Actions it endorses have concrete plans to involve stakeholders in the co-creation of ocean science. As a result, we have a unique opportunity to test different approaches to stakeholder engagement to see what works and what does not. Here, we feature short essays in the “Food for Thought” series in which leaders from Decade-endorsed Actions describe how they plan to incorporate stakeholders in the co-design, co-production, and co-delivery of ocean science and how they will measure whether these approaches were successful. We also invited submissions to the journal’s “Stories from the Front Lines” series, in which authors were asked to share unvarnished accounts of the lessons learned from previous efforts to co-design ocean science. We hope that these initial articles will be the beginning of an ongoing series in which new Decade Actions will also document their plans to implement, monitor, and measure the success or failure of these approaches.

Keywords: co-design, sustainability, UN ocean decade.

Introduction—why co-design science for sustainable development

The United Nations General Assembly proclaimed the United Nations Decade of Ocean Science for Sustainable Development (the Ocean Decade) with the recognition that the current outputs of research on the ocean do not always meet the needs of those charged with plotting a sustainable course for the ocean, the coasts, and all of the people that depend upon and impact these resources (Pendleton *et al.*, 2019). To remedy this problem, the Ocean Decade’s Executive Planning Group, in close collaboration with the Intergovernmental Oceanographic Commission of UNESCO (the UN agency charged with the implementation of the Ocean Decade) and with the participation of thousands of stakeholders around the world, laid the groundwork for a vision that would transform how ocean science is conducted. In that vision, decision-makers and stakeholders are involved in the co-creation of ocean science for sustainable development (Pendleton *et al.*, 2020). The idea of co-creation was pushed even further by a group of scholars who urged the Ocean Decade to go beyond co-creation and to promote a type of science that includes stakeholders and decision-makers in every aspect of the design of the scientific endeavour, including exploring what problems are at hand, what decisions need to be made, what information and evidence are needed to make these decisions, how the science is to be conducted and the data collected, and how decisions are to be made with this new information (Singh *et al.*, 2021). This now has given rise to three phases of the *co-creation* of science: *co-design*, in which stakeholders and

scientists work together to define the research question and approach; *co-production*, in which stakeholders are directly involved in data collection and analysis; and *co-delivery*, in which stakeholders work with scientists to disseminate and apply the results of the science (Mauser *et al.*, 2013). This vision for ocean research is often conceptualized as transdisciplinarity (TD; Hirsch Hadorn *et al.*, 2006) and applied in the context of sustainability research (Strand *et al.*, 2022).

The Ocean Decade offers a unique opportunity to explore and test different ways of co-designing science and to use scientific methods to understand what works and what does not in the process of co-design. It is also an opportunity for the global sharing of experiences and best practices. As the Ocean Decade progresses, scientists, researchers, stakeholders, decision-makers, and facilitators have begun to propose concrete Ocean Decade Actions (hereinafter Actions) to co-design ocean science for sustainable development. Many of these Actions come in the form of large-scale, often global, programmes of work to support the vision and mission of the Ocean Decade (these are known as the Ocean Decade-endorsed Programmes) and specifically the ten Ocean Decade Challenges that are the cornerstone of the Ocean Decade Action Framework (UNESCO-IOC, 2021).

In this series of articles, we invited the first round of Ocean Decade-endorsed Programmes to write short essays describing the approaches that they have taken or plan to take in order to successfully co-design ocean science with stakeholders and how they intend to measure the success or failure of these approaches. In some cases, a single Ocean Decade Programme

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(e.g. the Deep Ocean Observing Systems Programme) intends to employ more than one approach with different types of stakeholders. Programmes that plan to undertake more than one approach to co-design were encouraged to propose separate manuscripts.

We hope that these initial articles will be the beginning of an ongoing series in which new Ocean Decade Programmes will take on the challenge of making concrete how they plan to implement and monitor their co-design programmes. We also hope that those programmes that publish their visions in this series will return later to tell us about the outputs of their efforts and the lessons that they have learned.

The remit of Ocean Decade-endorsed programmes

From its genesis, the Ocean Decade has worked to ensure the centrality of co-design, co-production, and co-delivery of the ocean science that it supports and promotes. Arguably, the solutions-oriented and sustainable development focus of the Ocean Decade can only be achieved if (i) the definition of ocean science that it adopts is extremely broad and considers a wide range of scientific disciplines and knowledge systems, and (ii) transdisciplinarity and, more specifically, co-design and co-delivery are required elements of all Ocean Decade Actions.

A recent analysis (IOC-UNESCO, 2021) carried out by the Ocean Decade Coordination Unit identified the following benefits of co-designed and co-delivered science in Ocean Decade Actions: (i) strengthened ability of ocean science to offer solutions of direct relevance to sustainable development that are most appropriate in specific local, national, or global contexts (Ommer and Perry, 2022); (ii) enhanced uptake of ocean science across the science-policy interface by establishing partnerships—founded in mutual trust—between generators and users of knowledge; (iii) increased visibility and support (including financial support) for ocean science; and (iv) promotion of wider stakeholder engagement in the design, generation, and use of ocean science, including the engagement of individuals, institutions, and groups that are often underrepresented.

The Ocean Decade Action Framework that guides the process for the identification of Ocean Decade Actions describes a series of criteria that are used to decide whether proposed programmes and projects are formally endorsed as Actions. To fulfil these criteria, proponents of proposed Actions are required to demonstrate the transdisciplinary nature of their initiatives, as well as the co-design and co-delivery processes that have and will be implemented throughout their work.

While the benefits of co-design are clearly recognized and central to the achievement of the vision and mission of the Ocean Decade, and while the Ocean Decade Action Framework is constructed to render co-design and co-delivery an obligatory part of the implementation of Actions, challenges and barriers to effective co-design and co-delivery persist. Such challenges include a lack of awareness of the tangible benefits and need for co-design and co-delivery, as well as previous experience with such approaches. As a result, some proponents pay only superficial attention to these concepts. Where willingness and awareness of tangible benefits do exist, capacity to carry out co-design is often lacking, as are the needed resources (time and/or financing) or partnerships with diverse stakeholder groups. Finally, the cultural, social,

and economic contexts in which co-design approaches work best differ around the globe due to the variety of challenges faced and the different social, cultural, economic, scientific, and technical contexts of each situation. This heterogeneity may impede an easy transfer of lessons from one region to another. In fact, experiences about the co-design and co-delivery of ocean science for sustainable development have rarely been documented, so there are few successful case studies or templates to guide the Actions and Programmes.

To address these challenges, the Ocean Decade and its partners have launched a suite of activities to build capacity and share knowledge about co-designing ocean science for sustainable development. Ocean Decade events and publications routinely stress the benefits of co-design to wide audiences. A training course on co-design has been developed and was piloted in 2022 with African partners as a prelude to a global rollout, as well as partnerships that are being developed with philanthropy and governments (for example, via the Meer-Wissen Initiative, supported by the German government) to identify new sources of support for carrying out co-design and co-delivery of Ocean Decade Actions.

With its highly participatory approach to stakeholder engagement, the Ocean Decade, through its online Ocean Decade Forum, hosts communities of practice that serve as online knowledge-sharing sites where national and regional stakeholder groups can share experiences and initiate new partnerships between diverse actors working on similar themes and/or in the same regions. The Ocean Decade also works in collaboration with other initiatives, such as the Ocean Knowledge Action Network, to use other channels to share knowledge about the scholarship of co-design and co-delivery of ocean science, including this article series. While it will take time for the impact of these initiatives to be felt, they are a clear indication of the importance that the Ocean Decade applies to issues of co-design and co-delivery.

Measuring the effectiveness of co-design in Ocean Decade programmes

The process of co-designing science represents a transformation in the way that ocean research and data collection are carried out. To assess whether this transformation works and leads to better decisions, it is critical to test different approaches and collect evidence to determine whether co-designed and co-delivered science leads to better outcomes—including whether such science is more useful for decision-making and leads to better decisions than more traditional approaches. Fortunately, there is a growing body of literature about the monitoring and evaluation of transdisciplinary scientific approaches (van Drooge and Spaapen, 2022) that can be applied directly to the co-design of ocean science for sustainable development.

TD approaches are widely used (Zscheischler *et al.*, 2018), and the process of carrying out TD research is well conceptualized (Lang *et al.*, 2012). While it is tempting to measure the success of TD research in terms of scientific output (e.g. measuring the number of papers produced), the societal impact of TD and, thus, co-design, is often more difficult to evaluate or quantify (Roux *et al.*, 2010). Mitchell *et al.* (2015) describe the potential outcomes of transdisciplinary research as a three-outcome space between situational outcomes, knowledge outcomes, and learning outcomes. This outcome space will be different across projects, but also across project participants

within and outside academia. The approaches needed to monitor and evaluate the success of the co-design carried out by the Ocean Decade Programmes will likely include both quantitative and qualitative measures of processes and outcomes—all of which can be tested against research and decision outcomes.

The Ocean Decade also gives us an opportunity to trial new ways of collecting data to monitor and evaluate the effectiveness of co-design and co-delivery of ocean science and creates a natural experiment to understand which approaches to co-design and co-production work and which do not, and under what conditions. In collaboration with the monitoring and evaluation framework that is being progressively developed and deployed for the Ocean Decade, we encourage funders and researchers to act now to create a sound analytical framework and data collection strategy that will allow us to use rigorous social science methods to analyse the enabling and disabling factors that influence the success of co-design and thus will allow us to maximize the lessons learned from these real-world experiments to improve the usefulness of ocean science for sustainable development. We cannot let this Ocean Decade pass without using this global initiative as a learning experience to improve the usefulness of ocean science.

Sharing knowledge about the co-design of ocean science

While the co-design of science is now standard in TD research, it is not familiar to many of those working in ocean science. In the ocean community, the skills needed to carry out co-design are unevenly distributed across generations, stakeholder types, and geographies. Ocean science researchers need to be aware of both the variety of approaches to the co-design of ocean science currently being undertaken and also the perspectives of those who have attempted to undertake co-designed science—including non-scientists. Neither objective is easily addressed in standard research articles. Fortunately, the ICES Journal of Marine Science has article types that provide opportunities to meet these objectives: (1) *Food for Thought* articles and (2) the *Stories from the Front Lines* series.

Food for Thought articles focus on innovative, even provocative topics and are intended to stimulate dialogue, ideas, and research. Articles in the *Front Lines* series provide a forum for authors to share the lessons learned from successes and failures in co-designed science. The articles in the *Front Lines* series are narrative-style accounts of challenges, wins, and losses on any aspect of ocean and coastal sustainability that draw at least partly on the authors' experiences with the intention of helping readers avoid pitfalls. Contributions to this series provide unvarnished perspectives about the challenges and promises of the co-design of ocean science in practice.

To showcase the innovative, yet still untested, approaches to co-design being taken by many Ocean Decade Programmes, we invited Programme participants to submit short *Food for Thought* articles describing their Programme's approach to co-design and how they intend to measure its effectiveness. The Deep Ocean Observing Systems Programme (DOOS) shared two articles describing different co-designing strategies. One article focuses on a human-centred approach to co-design data streams for deep-sea indicators off the California coast, for which the authors present a four-phase project roadmap (LaScala-Gruenewald *et al.*, 2022). A second article

describes how in the Azores region, DOOS and the Okeanos—University of Azores, together with other partners in the wider ocean observing community, have set out to build a “deep ocean demonstration project” that will integrate community mapping with continuous observations and numerical models while serving local stakeholder needs (Pachiadaki *et al.*, 2022).

By developing a novel, bottom-up network structure with topic-based links between regions, Marine Life 2030 aims to address local problems associated with changing marine life while engaging all parties of the ocean community (Muller-Karger *et al.*, 2022). Similarly, FishSCORE 2030 (Fisheries Strategies for Changing Oceans and Resilient Ecosystems by 2030) plans to co-produce knowledge and provide tools via a global network to contribute solutions to climate-resilient fisheries, while implementing those tools through local and regional partnerships (Mills *et al.*, 2022). The Ocean Acidification Research for Sustainability Programme (OARS) presents another approach to including local contexts within a global initiative (Dobson *et al.*, 2022). OARS plans to utilise the regional-hub structure set up by the Global Ocean Acidification Observing Network's (GOA-ON) to develop ocean acidification science, build capacity, and tackle seven Ocean Decade Outcomes.

In contrast to the Programmes mentioned above, the Observing Air–Sea Interactions Strategy (OASIS) focuses on the physical environment at the air–sea interface (Cronin *et al.*, 2022). OASIS activities are organized into five transdisciplinary “Theme Teams”, to which stakeholders are actively recruited to participate (Cronin *et al.*, 2022); the intent is to transform how ocean observations contribute to a healthy and resilient ocean.

Cazé *et al.* (2022) reflect on how co-designing processes can be improved in future projects and highlight the prominent role that politics play in transdisciplinary research projects, considering power asymmetries and recognizing the rights and cultural practices of indigenous peoples and local communities.

The *Stories from the Front Lines* series reveals a variety of experiences in the actual implementation of the co-design of ocean science for sustainable development. In this series, Köpsel (2022) provides insight into the co-development process between researchers and artisanal fishers in the Bay of Biscay, France. Drawing upon her own experience and that of her colleagues, the author reflects on how codependency, trust, and the understanding that experiential knowledge is crucial to the co-designing process can lead to successful cooperation (Köpsel, 2022). Collaboration in transdisciplinary teams becomes particularly complex when strong power imbalances come into play. Mahajan *et al.* (2022) offer a first-hand account of “the good, the bad, and the ugly” in co-designed research projects across the Global North and the Global South. The authors detail the challenges they encountered related to funding and power dynamics, differences in culture and training, diverse needs and interests, and authorship norms—and how to overcome them (Mahajan *et al.*, 2022). Lastly, authors from the Lenfest Ocean Program provide a grantmaker's perspective on co-design. Their paper emphasizes the importance of outreach plans and communication with stakeholders and managers throughout the process and presents narrative storytelling as an approach to evaluating research impact and increasing transparency around grant-making methods (Hudson *et al.*, 2022).

As the Decade of Ocean Science for Sustainable Development continues, we expect to gain new insights and knowledge about the co-design of ocean science. The authors in this series are encouraged to follow-up with new submissions, including research articles, as they implement co-design and associated monitoring and evaluation assessments. We also encourage new Ocean Decade Programmes to contribute to the series as they receive endorsement and undertake their own new and innovative approaches to co-designing ocean science.

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Conflict of interest

LP served on the Executive Planning Group and Interim Decade Advisory Board of the United Nations Decade of Ocean Science for Sustainable Development. AC is an employee of the Intergovernmental Oceanographic Commission's Decade Coordinating Unit. JOS is Chair of the science committee of the International Council for the Exploration of the Sea and coordinator of the SmartNet Decade Programme. The authors declare no conflicts of interest.

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Data availability

Not relevant.

Disclaimer

The opinions and positions taken in this article are those of the authors and do not necessarily reflect those of their employers.

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