



**QUEEN'S
UNIVERSITY
BELFAST**

Advancing interdisciplinary knowledge for ocean sustainability

Frazão Santos, C., Agardy, T., Aheto, D., Allison, E. H., Bennett, N. J., Blythe, J. L., Calado, H., Crowder, L. B., Day, J. C., de Vos, A., Flannery, W., Galparsoro, I., Gissi, E., Gjerde, K. M., Gobin, J. F., Green, S., Isaacs, M., Karuaihe, S. T., Lombard, A. T., ... Sumaila, U. R. (2023). Advancing interdisciplinary knowledge for ocean sustainability. *npj Ocean Sustainability*, 2, Article 18. <https://doi.org/10.1038/s44183-023-00026-6>

Published in:
npj Ocean Sustainability

Document Version:
Publisher's PDF, also known as Version of record

Queen's University Belfast - Research Portal:
[Link to publication record in Queen's University Belfast Research Portal](#)

Publisher rights

Copyright 2023 the authors.

This is an open access article published under a Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution and reproduction in any medium, provided the author and source are cited.

General rights

Copyright for the publications made accessible via the Queen's University Belfast Research Portal is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

The Research Portal is Queen's institutional repository that provides access to Queen's research output. Every effort has been made to ensure that content in the Research Portal does not infringe any person's rights, or applicable UK laws. If you discover content in the Research Portal that you believe breaches copyright or violates any law, please contact openaccess@qub.ac.uk.

Open Access

This research has been made openly available by Queen's academics and its Open Research team. We would love to hear how access to this research benefits you. – Share your feedback with us: <http://go.qub.ac.uk/oa-feedback>

EDITORIAL OPEN



Advancing interdisciplinary knowledge for ocean sustainability

npj Ocean Sustainability (2023)2:18; <https://doi.org/10.1038/s44183-023-00026-6>

THE FIRST YEAR OF NPJ OCEAN SUSTAINABILITY

In August 2022 we launched the inaugural issue of a new Nature journal focused on our blue planet: *npj Ocean Sustainability*¹. The opening issue highlighted the journal's intended role in sharing research, critically debating key challenges to achieving ocean sustainability, with its environmental and human dimensions, and advancing pathways to address them.

In just 1 year, the journal's interdisciplinarity and solution-oriented nature have shone through and made it stand out among prestigious journals. Covered topics were diverse (Fig. 1), ranging from the challenges of seabed mining to the new agreement on marine biodiversity beyond national jurisdiction, to fisheries management, climate change impacts, global science-policy interfaces, human connections with ocean spaces, and digital twins. Many papers address different ocean sectors simultaneously, integrating different disciplines and different dimensions of ocean sustainability challenges (e.g., biodiversity loss, pollution, over-exploitation of species).

In this promising first year, accepted publications included 12 original research *Articles*, two *Review articles*, two *Perspectives*, and seven *Comments* (with c. 30 additional manuscripts under revision). These publications resulted from the collaborative work of 180 authors representing 30 countries worldwide (Fig. 2). Authorship was geographically widespread; yet only 20 authors (11%), hailing from 12 countries (40%) outside of established research hubs were involved (Fig. 2b). This underscores the importance of fostering greater participation from under-represented parts of the world, which is part of our mission for the near future. As for gender equality, there was a balance between women (51%) and men (49%), and 70% of the lead authors were women (Fig. 2d). With a focus on representativeness and an inclusive spread of articles, the editorial team has also been revamped, with an expansion in both numbers and geographical representation (the earlier team was composed of 20 members, 85% of which were based in Europe, North America, and Australia). The journal now has two Editors-in-Chief, seven Associate Editors, 22 Board Members and two Managing Editors from 15 countries, with a third of the editors (33%) based in the Global South (in Brazil, China, Ghana, Malaysia, Nigeria, South Africa, Sri Lanka, and Trinidad and Tobago) (Fig. 2b), and a balanced gender distribution (58% women versus 42% men) (Fig. 2d). We will keep working further to improve representativeness from other regions in the editorial team (e.g., Southern Asia, Eastern Africa, Central America).

Over this time, we received an increasing number of submissions, particularly in the last six months (Fig. 2e). Attention to *npj Ocean Sustainability* is growing as the journal has published globally relevant science on pertinent topics that received significant media attention over the past year. *Deep seabed mining* (DSM) is one such topic and the two pieces on DSM published in the journal are both in the top 5% of all research outputs ever scored by Altmetric (which aims to quantify online engagement with published research) with scores of 224² and

396³ (Fig. 3b). The first, a provocative *Comment* by Jaeckel et al.², questioned whether DSM meets standards for social legitimacy. The authors used a legitimacy framework to discuss the social-equity dimensions of this emerging industry in the ocean commons and concluded that the impacts of DSM on people have not been sufficiently researched or understood. Next, in an original research *Article*, Amon et al.³ highlighted how climate change will likely drive increasing overlap between Pacific tuna fisheries and the emerging deep-sea mining industry in the Clarion-Clipperton Zone of the Pacific Ocean. While recognising that the interactions between mining, fish populations, and climate change are complex and unknown, the authors explained that projected increases in overlap indicate that the potential for conflict and resultant environmental and economic repercussions will be exacerbated in a climate-altered ocean. Constructively and thought-provokingly, the authors further suggested pathways for closing critical scientific and governance gaps in the region, for example, by including future climate scenarios into regional planning processes and developing and evolving rules and procedures of the International Seabed Authority's (ISA's) Mining Code. Both pieces had high media coverage, appearing in a total of 59 news outlets^{2,3}.

The *Biodiversity Beyond National Jurisdiction (BBNJ) Agreement*—the Agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction that was adopted in June 2023⁴—is another topic that attracted significant reflection over the past year, both in the journal and in social and mainstream media. An inspiring *Comment* by Gjerde et al.⁵ reflected on the need for getting beyond 'yes' and fast-tracking the Agreement's implementation (the piece was developed after the first part of the fifth session of the Conference of the Parties had taken place in August 2022⁴). The authors provided initial reflections on three priority areas to support rapid, effective, and equitable implementation of the Agreement: bringing the Agreement into force; establishing the institutional framework, including financial mechanisms; and developing capacity, science, and technology. They observed that the growing impacts of climate change and human activities on the global ocean require urgent action. The piece received significant online attention, being in the top 5% of all research outputs scored by Altmetric (Altmetric Attention Score of 127)⁵. A subsequent *Comment* by Deasy⁶ further examined what was known and what remained unclear about the Agreement—the piece was developed after the second part of the fifth session of the Conference had taken place in February–March 2023⁴. Deasy appropriately highlighted that, while the Agreement leaves a lot open to question, it establishes several historic benchmarks for protecting the High Seas, setting the stage for further scientific exploration and paving the way for more effective marine conservation. A third piece, a thought-provoking *Article* by Nocito and Brooks⁷, examined the influence of Antarctic marine conservation governance frameworks in Agreement negotiations. Aligned with Deasy's piece, the authors explored the precedent-setting and lessons learned from the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)⁸ regarding establishing High Seas marine protected areas, and how the latter have affected and may further affect the Agreement's architecture and implementation.



Fig. 1 Word cloud of titles of manuscripts (Articles, Reviews, Perspectives, and Comments) accepted for publication in *npj Ocean Sustainability* in 2022 and 2023. Data includes online and *in press* manuscripts by the end of August 2023.

The topic of *fisheries* received considerable attention in *npj Ocean Sustainability*, with authors adopting a systems perspective encompassing nutrition and public health and climate change adaptation and mitigation. The *Article* by Kjellevoid et al.⁹, investigated the contribution of small-scale fisheries to food and nutrition security using Norway as a case study. In a surprising analysis, the authors showed that small-scale fisheries could provide up to five million people with between 70 to 96% of the recommended intake of key nutrients. Quantifying catches and comparing them with recommended dietary intakes, the authors called for fish to be included in Norway's food-based dietary guidelines. A cautionary *Article* by Beckenstein et al.¹⁰ used a stylised bio-economic model of the global marine fishery to show that failing to limit regulation of access under future climate change is likely to lead to fishery maladaptation, unstable conditions for both the fishing industry and fish stocks, and significant economic losses. By incorporating ecological, industry, and management responses, the authors demonstrated the value of integrated approaches to study the impacts of climate change on fisheries. Finally, a well-developed *Article* by Prellezo et al.¹¹ highlighted the need to build climate resilience, target sustainability, and equity in global fisheries to achieve targets to limit global warming established by the Paris Agreement¹². In applying a market-based solutions (MBS) scheme, the authors found that if CO₂ trading prices reach the 2050 social cost of carbon, around 75% of the landings worldwide would be more valuable as carbon than as foodstuff in the market, echoing the findings reported in Rogers et al.¹³ with respect to the High Seas. Applying MBS would produce a socialisation of the climate costs of fishing and benefit the overall fisheries challenge of keeping global ocean biomass high enough to maintain a profitable fisheries sector, while at the same time increasing resilience that supports other values obtained from the ocean.

Climate change mitigation and adaptation was a topic of interest across areas and sectors, and was further addressed in pieces

centred on ocean energy and maritime shipping. A comprehensive *Review Article* by Galparsoro et al.¹⁴ assessed the ecological impacts of offshore wind energy production. The authors argued that the environmental effects of ocean energy production need to be comprehensively evaluated so they can be reduced as much as possible to ensure ocean sustainability and avoid unintended environmental losses. The latter was one of the earlier pieces published in *npj Ocean Sustainability* and yet another to receive significant online attention. It is in the top 5% of all research outputs scored by Altmetric (Altmetric Attention Score of 132) and has the highest number of online accesses among the journal's publications—29,000 (Fig. 3c)¹⁴. Focus on another important maritime sector was provided in an *Article* by Lu et al.¹⁵, who discussed how the global maritime container shipping industry, being responsible for a significant part of the burning of marine fossil fuels and shipping emissions, is under pressure to decarbonise. The authors presented an integrated framework of bottom-up estimation and upscaling pathway analysis to measure container shipping emissions and project possible pathways toward carbon neutrality. They further argued that the energy transition will be the largest contributor to emission reductions over the medium to long term. An *Article* by Müller et al.¹⁶ provided a fascinating examination of Arctic shipping trends and discusses the effectiveness of the International Code for Ships Operating in Polar Waters (Polar Code)¹⁷. The authors analysed shipping activity patterns in severe sea-spray icing conditions and showed that there has been a strong increase in winter sailing under extreme conditions over the past decade. They argued that the Polar Code needs refinement through the integration of maritime warning systems in order to avoid sea-ice-induced incidents¹⁶.

The *ocean science-policy interface* is another highly relevant thematic area to advance a sustainable ocean. Five pieces published this year addressed it, starting with an intriguing *Perspective* by Gail et al.¹⁸, who made the case that a global

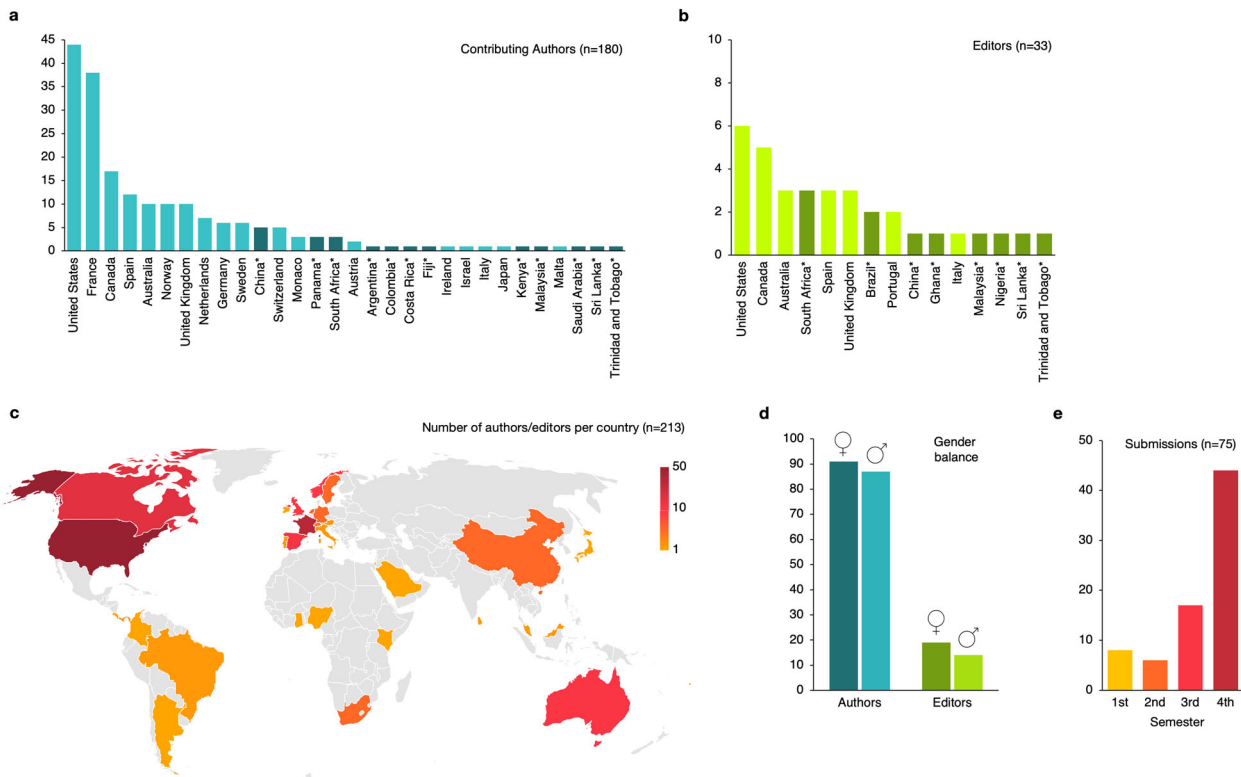


Fig. 2 Distribution of contributing authors and editors of *npj Ocean Sustainability* per country and gender. **a** Number of contributing authors of papers accepted for publication until the end of August 2023, per country of affiliation (countries from the Global South are highlighted with an asterisk and darker colour tone). **b** Number of journal editors per country of affiliation. **c** Total number of contributing authors and editors per country. **d** Gender distribution of contributing authors and editors. Data on gender was inferred from information available online; when information was not available (such as references to ‘she/her/he/his’) in credible pages data was not included. **e** Total number of submissions to *npj Ocean Sustainability* from September 2021 (when the journal started welcoming submissions) to the end of August 2023; this 24-month period was divided into semesters for visualisation purposes: 1st semester (September 2021–February 2022), 2nd (March 2022–August 2022), 3rd (September 2022–February 2023), 4th (March 2023–August 2023).

platform with a thematic focus on ocean sustainability—similar to the Intergovernmental Panel on Climate Change (IPCC)¹⁹ and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)²⁰—was needed to effectively support a shift towards a sustainable ocean. The authors introduced the International Panel for Ocean Sustainability—the IPOS—as a coordinating mechanism to integrate knowledge systems to bridge ocean science-policy divides cross-sectorally. The piece received ample attention online (in the top 5% of all research outputs scored by Altmetric with an Attention Score of 88¹⁸) and in the decision-making realm—the IPOS’s creation is supported by the European Union²¹ and a growing alliance of marine science institutions and nations. A subsequent *Article* by Schadeberg et al.²² focused on a largely overlooked biome and considered the influence of science on the current governance of the mesopelagic zone (i.e., 200–1000 m depth). Using an automated content analysis of scientific abstracts and tweets, the authors identified two emerging topics related to the mesopelagic zone—the exploitation of fish resources and the zone’s role as a carbon sink—that are shaping how the resources and ecosystem services are understood and valued. They further highlighted the need for transdisciplinary knowledge creation and stakeholder engagement to ensure the legitimacy of policymaking affecting the future of this understudied but vital realm. Another stimulating *Article* by Boemare et al.²³ pointed to the benefits of hybridising research and decision-making in ocean spaces. Using a French Mediterranean protected area as a marine social-ecological case study, the

authors combined codesigned visioning narratives with an ecosystem-based model. They argued that hybridising research and decision-making with iterative collaborative modelling frameworks could pave the way for previously unidentified transformative pathways, enhance adaptive management policies and support ocean sustainability. Next, an extensive *Article* by Potter and Pearson²⁴ assessed the state of the global ocean science community. The authors investigated international collaborations, underlying concerns, and the current state of research in five ocean basins (i.e., Arctic, Atlantic, Indian, Pacific, and Southern Ocean). They argued that in specific regions—e.g., South America and sub-Saharan Africa—growth in research outputs and collaborations could be catalysed by increased financial and social support for educational efforts and infrastructure development. Finally, and in line with the latter piece, a timely *Comment* by Spalding et al.²⁵ advocated for the need to engage low to middle-income countries in the tropics—the so-called ‘tropical majority’—to make ocean governance and science more equitable and effective. The authors proposed four actions for transformational change that are grounded in the perspectives, experiences, and existing knowledge of people in the tropics. They argued that such actions are critical to ensuring a leading role for the tropical majority in maintaining thriving ocean societies and ecosystems. The latter piece received significant online and media attention, being in the top 5% of all research outputs scored by Altmetric (Altmetric Attention Score of 166) and appearing in 15 news outlets²⁵.

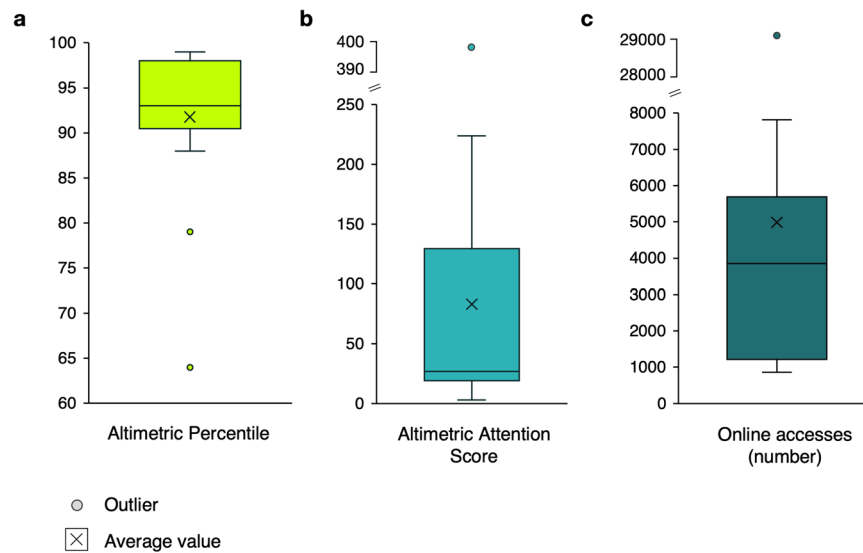


Fig. 3 Metrics of manuscripts (Articles, Reviews, Perspectives, and Comments) published at *npj Ocean Sustainability* in 2022 and 2023. **a** Altimetric percentile of published manuscripts. **b** Altimetric Attention Score of published manuscripts. **c** Number of online accesses of published manuscripts. Data were collected on September 15, 2023, from Altimetric (<https://nature.altimetric.com>). Manuscripts in press at the time (not yet online) were not accounted for here.

Six additional pieces delved into the multiple dimensions and diversity of *human connections with ocean spaces*. An interesting and innovative *Comment* by Kelly et al. (2023, *forthcoming*)²⁶ discusses the conceptualisation of the construct of an ocean identity. The authors argued that the latter is a valuable lens that can be used to unpack multiple conceptual dimensions of human connections with ocean spaces. They presented a revised definition of ocean identity, proposing a conceptual framework based on a robust analysis of literature aiming to contribute to the ongoing ocean literacy discourse. A fascinating *Comment* by Bennett et al.²⁷—one of the earlier pieces published in *npj Ocean Sustainability*—highlighted that local marine stewardship initiatives and ocean defenders are commonly at the forefront of ocean sustainability efforts yet often receive insufficient recognition and support. The authors provided five recommendations to bring greater attention and support to the topic in research, policy, practice, and funding. A subsequent and wide-ranging *Review Article* by Crosman et al.²⁸—another earlier article published in the journal—argued that social equity should be a key concern in ocean governance. The authors argued that calls to address social equity in ocean governance are expanding, and presented a framework to support consistent operationalization of equity and evaluate progress without oversimplification. Also exploring the connections of coastal communities and peoples with the ocean, a *Comment* by Manero²⁹ discussed the case for protecting the value of ‘surfing ecosystems.’ Manero argued that while surfing ecosystems (surf breaks and their surrounding environments) are valuable natural assets, their sustainability is compromised by mounting threats (e.g., coastal erosion, urban development, mass tourism). The author further discussed international examples of how conservation frameworks could support the protection of these ‘surfing ecosystems.’ Moving from coastal areas to the High Seas, a creative *Article* by Lübker et al.³⁰ explored imagined sustainable futures by combining the power of computation and narrative. The authors created four science fiction stories that aimed to capture the system’s complexity, embrace uncertainty, and question current unsustainable trajectories. Visions were analysed using the concept of imaginaries, and the authors argued that engaging with alternative futures could open

transformative spaces to rethink the relationships between humans and the High Seas, from which novel imaginaries could emerge. An intriguing *Article* by Reimer et al.³¹ presents a new index to assess progress in marine spatial planning (MSP). The authors developed and validated the ‘MSP Index’ to be employed by practitioners and to inform the evolution of MSP processes. Their goal was to create a user-friendly guidance tool that translated MSP principles into practice and allowed for the assessment of individual initiatives and their comparison across ocean regions and nations. The index was initially applied to the United States, Ireland, Kiribati, the Philippines, Israel, and South Africa³¹.

One final thought-provoking piece “closes” the first year of *npj Ocean Sustainability*, a *Perspective* by Tzachor et al.³² on *digital twins*, which are digital representations of a physical entity (e.g., object, person) or process, contextualised in a digital version of its environment. The authors discussed how digital twins, a nascent yet potent computer technology, can be a stepping stone to achieving ocean sustainability. The authors argued that while digital twins can substantially advance sustainable ocean management, the potential of such emerging technology is still under-explored. They reflected on the promise of digital twins across four thematic areas—reducing and preventing overfishing, predicting marine pollution, adapting to climate change, and promoting MSP—further emphasising implementation barriers such as data availability, quality, compatibility, and cost, and proposed corresponding solutions³².

The multiplicity of topics and approaches described above illustrates the diversity of ocean science and knowledge that our journal aims to support and highlight. Still, much work is needed to further include less represented research areas, such as Indigenous perspectives on human-ocean relationships, and explicitly transdisciplinary work co-produced by researchers of all disciplines and representatives of the people they are working with—maritime workers and ocean defenders, government officials, private sector actors, NGOs, and civil society organisations.

LOOKING TOWARDS THE FUTURE

While it is still early to properly assess *npj Ocean Sustainability*’s metrics and impact, early indications are that the journal is off

to a good start. Articles published in the journal have received significant online and media attention, including from social media (total of over 1500 tweets) and news outlets (total of 90 new outlets, including *The Guardian*, *Bloomberg*, *Reuters*, *EurekAlert*, *ScienMag*, *The Conversation*, and the World Resources Institute). Most publications (>82%) are over Altimetric's 90th percentile of all tracked articles of a similar age across all journals (Fig. 3a), with six publications over the 97th percentile and, therefore, in the top 3% of all research outputs scored by Altimetric. On average, each publication was accessed online c. 5000 times, with a maximum of 29,000 accesses for one of the earlier review articles¹⁴ (Fig. 3c) and a total of c. 85,000 accesses for all published articles. As for Altimetric's Attention Score, the average score for all *npj Ocean Sustainability* articles is 83, with five pieces standing out with values from 127 to 397 (Fig. 3b).

In the coming year, the editorial team will support key actions to keep the momentum and take the journal to the next level. The first pertains to the further development of topical Collections. During the first year of *npj Ocean Sustainability*, two thematic Collections were launched—both welcoming submissions until early 2024. One collection focused on *Moving towards Climate-smart Ocean Planning*³³. While the need to integrate climate knowledge into MSP has been globally acknowledged in recent years, few marine spatial plans consider climate change explicitly^{34,35}. To highlight current progress, advance research, and inspire action on the development of MSP initiatives that are resilient to climate impacts, the main topics to be addressed in this collection include:

- the integration of knowledge (ecological, social, economic) to unravel climate challenges, opportunities, and risks;
- pathways to support dynamic, flexible, and adaptive solutions to respond to (climate) change;
- MSP as a vehicle to support climate adaptation and mitigation solutions;
- MSP as an approach to integrated ocean management to consider climate-induced risks and opportunities at multiple spatial and temporal scales; and
- fresh perspectives on climate-smart MSP.

A second collection pertains to *Bridging Land and Seascape Restoration for Ecoscape Recovery*³⁶. Ecosystem restoration initiatives have been dominated by single-species or small-scale initiatives with high rates of failure, with few that evaluate cascading site-based ecological and social consequences. The aim of this collection is to establish a widely applicable foundation for scalable approaches that support integrated multi-habitat coastal ecosystem restoration. We aim to highlight innovative case studies that speak to active restoration and passive recovery across multiple interconnected habitats. To that end, key topics to be addressed pertain to:

- novel multi-habitat restoration case studies across any coastal biomes;
- approaches along a continuum of high-tech to community-based, utilising diverse sources of knowledge/ways of knowing and both top-down and bottom-up interventions;
- the integration of biocultural restoration and Indigenous knowledge in restoration planning;
- fresh perspectives on social and political challenges in ecological restoration approaches; and
- conceptual discussions highlighting different pathways to successful coastal ecoscape restoration worldwide.

In addition to these, the editorial team is planning three new themed Collections to be launched in *npj Ocean Sustainability*—

one dedicated to 'Blue Justice and Social Equity', another to 'Distant Water Fishing', and a third on the 'Politics of Marine Conservation'. The journal is also supporting two broader collections by the *Nature* group, which are currently welcoming submissions: *Progress Towards the Sustainable Development Goals*³⁷ (as SDG 14, *Life Below Water*, and its interconnectedness with other SDGs are of high interest to our journal), which encompasses studies that focus on at least one SDG, at the local, regional or global scale; and *Marine Heatwaves*³⁸, which aims to explore the causes, characteristics, and impacts of marine heatwaves.

Another priority action area for the future is inclusivity and geographical representativeness. The journal's editorial team looks forward to welcoming research from local to global levels, from all ocean basins and regions (in particular, from and about oceans in the so-called tropical majority: Asia, Central and South America, the Pacific, Africa, and the Middle East). Further, we are interested in contributions from large ocean states and Indigenous scholars. This emphasis by the editorial board is because most contributions received over the past year were from authors based in Europe and North America. We are committed to addressing this imbalance. We thus strongly encourage Indigenous authors and authors from under-represented regions or research areas to contact us at any time to discuss how we might better support the submission of their research to *npj Ocean Sustainability*.

One commonly identified limitation relates to publication costs. Being an open-access journal, *npj Ocean Sustainability* is subject to article processing charges (APC). Full APC waivers are provided directly by *Springer Nature* to corresponding authors based in countries with low-income economies, and 50% discounts are ensured to those based in countries with lower-middle-income economies. Recognising that the latter is often insufficient, the editorial team can assign additional full APC waivers directly where this is found to be needed to ensure that a great paper gets published. We therefore invite all interested authors who see APCs as a limitation to publishing in the journal to contact the editorial team.

For the future, *npj Ocean Sustainability* continues to be interested in research focused on the science-policy-practice interlinkages, systematic and systemic approaches to complex problems, transformative solutions, and innovation to support ocean sustainability at multiple levels and scales. We heartily welcome inspiring and thought-provoking pieces on all realms of *Ocean Sustainability*—anything relevant to its environmental, social, and economic dimensions—both theoretical and empirical, ranging from case study-based to meta-analyses, addressing a broad range of fields, their policy dimensions, and potential pathways and solutions to identified issues. We encourage that contributions are kept broad, including, but not limited to, fisheries management, marine conservation, ocean economy, coastal management, ocean planning, marine pollution, and climate change, among many more. In a nutshell, we encourage interdisciplinary, collaborative, co-creation of knowledge by diverse, equitable, and inclusive partnership-based groups of authors³⁹.

The editorial team is deeply committed to making *npj Ocean Sustainability* a valuable, unique, and inclusive forum for sharing research, critically debating issues and advancing solutions to support "a sustainable ocean for all"¹. We are optimistic about our first year and will continue to work hard to make the journal thrive in a sustainable and equitable manner!

Received: 11 October 2023; Accepted: 12 October 2023;
Published online: 02 November 2023

Catarina Frazão Santos^{1,2✉}, Tundi Agardy³, Denis Aheto⁴, Edward H. Allison⁵, Nathan J. Bennett^{6,7}, Jessica L. Blythe⁸, Helena Calado⁹, Larry B. Crowder¹⁰, Jon C. Day¹¹, Asha de Vos¹², Wesley Flannery¹³, Ibon Galparsoro¹⁴, Elena Gissi^{10,15,16}, Kristina M. Gjerde^{17,18}, Judith F. Gobin¹⁹, Stephanie Green²⁰, Moenieba Isaacs²¹, Selma T. Karuaithe²², Amanda T. Lombard²³, Priscila F. M. Lopes²⁴, Elena Ojea²⁵, Michael Orbach²⁶, Gretta Pecl^{27,28}, Andrea Reid²⁹, Marinez Scherer³⁰, Austin J. Shelton³¹, Temitope O. Sogbanmu³², Sebastián Villasante⁷, Lisa Wedding³³ and U. Rashid Sumaila^{34✉}

¹Department of Animal Biology, Marine and Environmental Sciences Center/Aquatic Research Network, Faculdade de Ciências, Universidade de Lisboa, Lisbon, Portugal. ²Environmental Economics Knowledge Center, NOVA-SBE, Carcavelos, Portugal. ³Sound Seas, Bethesda, MD, USA. ⁴Centre for Coastal Management, Africa Centre of Excellence in Coastal Resilience, University of Cape Coast, Cape Coast, Ghana. ⁵WorldFish, Bayan Lepas, Penang, Malaysia. ⁶Global Science, WWF, Washington, DC, USA. ⁷EqualSea Lab, University of Santiago de Compostela, Santiago de Compostela, Spain. ⁸Environmental Sustainability Research Centre, Brock University, St. Catharines, ON, Canada. ⁹Marine and Environmental Sciences Center, Faculdade de Ciências e Tecnologia, University of the Azores, Ponta Delgada, Portugal. ¹⁰Oceans Department, Hopkins Marine Station, Stanford University, Pacific Grove, CA, USA. ¹¹College of Science & Engineering, James Cook University, Townsville, QLD, Australia. ¹²Oceanswell, Colombo, Sri Lanka. ¹³Queen's University Belfast, Belfast, Northern Ireland, UK. ¹⁴AZTI, Marine Research Division, Basque Research and Technology Alliance (BRTA), Pasaia, Spain. ¹⁵National Research Council, Institute of Marine Sciences, Venice, Italy. ¹⁶National Biodiversity Future Center, 90133 Palermo, Italy. ¹⁷International Union for Conservation of Nature and World Commission on Protected Areas, Cambridge, MA, USA. ¹⁸Middlebury Institute of International Studies at Monterey, Monterey, MA, USA. ¹⁹The University of the West Indies, St. Augustine Campus, St. Augustine, Trinidad and Tobago. ²⁰Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada. ²¹Institute for Poverty, Land and Agrarian Studies, University of Western Cape, Bellville, South Africa. ²²Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, Hatfield, South Africa. ²³Institute for Coastal and Marine Research, Nelson Mandela University, Gqeberha, South Africa. ²⁴Department of Ecology, Universidade Federal do Rio Grande do Norte, Natal, RN, Brazil. ²⁵Future Oceans Lab, CIM-University of Vigo, Vigo, Spain. ²⁶Duke University Marine Laboratory, Duke University, Beaufort, NC, USA. ²⁷Centre for Marine Socioecology, University of Tasmania, Hobart, TAS, Australia. ²⁸Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, TAS, Australia. ²⁹Centre for Indigenous Fisheries, Institute for the Oceans and Fisheries, University of British Columbia, Vancouver, BC, Canada. ³⁰Federal University of Santa Catarina, Florianópolis, SC, Brazil. ³¹Center for Island Sustainability and Sea Grant, University of Guam, Mangilao, Guam, USA. ³²Ecotoxicology and Conservation Unit, Department of Zoology, Faculty of Science, University of Lagos, Lagos, Nigeria. ³³School of Geography and the Environment, University of Oxford, Oxford, UK. ³⁴Fisheries Economics Research Unit, Institute for the Oceans and Fisheries and the School of Public Policy and Global Affairs, Vancouver, BC, Canada.

✉email: cfsantos@ciencias.ulisboa.pt; r.sumaila@oceans.ubc.ca

REFERENCES

- Frazão Santos, C. et al. A sustainable ocean for all. *npj Ocean Sustain.* **1**, 2 (2022).
- Jaeckel, A. et al. Deep seabed mining lacks social legitimacy. *npj Ocean Sustain.* **2**, 1 (2023).
- Amon, D. J. et al. Climate change to drive increasing overlap between Pacific tuna fisheries and emerging deep-sea mining industry. *npj Ocean Sustain.* **2**, 9 (2023).
- The United Nations. *Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction.* www.un.org/bbnj (The United Nations, 2023).
- Gjerde, K. M. et al. Getting beyond yes: fast-tracking implementation of the United Nations agreement for marine biodiversity beyond national jurisdiction. *npj Ocean Sustain.* **1**, 6 (2022).
- Deasy, K. What we know about the new High Seas Treaty. *npj Ocean Sustain.* **2**, 7 (2023).
- Nocito, E. S. & Brooks, C. M. The influence of Antarctic governance on marine protected areas in the Biodiversity Beyond National Jurisdiction Agreement negotiations. *npj Ocean Sustain.* **2**, 13 (2023).
- CCAMLR. *Commission for the Conservation of Antarctic Marine Living Resources.* www.ccamlr.org (CCAMLR, 2023).
- Kjellefjord, M. et al. Small-scale fisheries contribution to food and nutrition security—a case study from Norway. *npj Ocean Sustain.* **1**, 5 (2022).
- Beckensteiner, J., Boschetti, F. & Thébaud, O. Adaptive fisheries responses may lead to climate maladaptation in the absence of access regulations. *npj Ocean Sustain.* **2**, 3 (2023).
- Prellezo, R., Da-Rocha, J. M., Palomares, M. L. D., Sumaila, U. R. & Villasante, S. Building climate resilience, social sustainability and equity in global fisheries. *npj Ocean Sustain.* **2**, 10 (2023).
- Sumaila, U. R. et al. Benefits of the Paris Agreement to ocean life, economies, and people. *Sci. Adv.* **5**, eaau3855 (2019).
- Rogers, A. D., Sumaila, U. R., Hussain, S. S. & Baulcomb, C. *The High Seas and Us: Understanding the Value of High-Sea Ecosystems.* (Global Ocean Commission, 2014).
- Galparsoro, I. et al. Reviewing the ecological impacts of offshore wind farms. *npj Ocean Sustain.* **1**, 1 (2022).
- Lu, B., Ming, X., Lu, H., Chen, D. & Duan, H. Challenges of decarbonizing global maritime container shipping toward net-zero emissions. *npj Ocean Sustain.* **2**, 11 (2023).
- Müller, M., Knol-Kauffman, M., Jeuring, J. & Palerme, C. Arctic shipping trends during hazardous weather and sea-ice conditions and the Polar Code's effectiveness. *npj Ocean Sustain.* **2**, 12 (2023).
- International Maritime Organization. *International Code for Ships Operating in Polar Waters (Polar Code).* www.imo.org (International Maritime Organization, 2023).
- Gaill, F. et al. An evolution towards scientific consensus for a sustainable ocean future. *npj Ocean Sustain.* **1**, 7 (2022).
- IPCC. *The Intergovernmental Panel on Climate Change.* www.ipcc.ch (IPCC, 2023).
- IPBES. *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* www.ipbes.net (IPBES, 2023).
- The European Commission. *Directorate General for Maritime Affairs and Fisheries. Seascape Assessment: Feasibility Study for the Establishment of an Intergovernmental Panel for Ocean Sustainability (IPOS)* (Press Office, 2023).
- Schadeberg, A., Kraan, M., Groeneveld, R., Trilling, D. & Bush, S. Science governs the future of the mesopelagic zone. *npj Ocean Sustain.* **2**, 2 (2023).
- Boemare, C. et al. Hybridizing research and decision-making as a path toward sustainability in marine spaces. *npj Ocean Sustain.* **2**, 5 (2023).
- Potter, R. W. K. & Pearson, B. C. Assessing the global ocean science community: understanding international collaboration, concerns and the current state of ocean basin research. *npj Ocean Sustain.* **2**, 14 (2023).
- Spalding, A. K. et al. Engaging the tropical majority to make ocean governance and science more equitable and effective. *npj Ocean Sustain.* **2**, 8 (2023).
- Kelly, M. Conceptualizing the construct of ocean identity. *npj Ocean Sustainability* (2023, forthcoming).
- Bennett, N. J., Le Billon, P., Belhabib, D. & Satizábal, P. Local marine stewardship and ocean defenders. *npj Ocean Sustain.* **1**, 3 (2022).
- Crosman, K. M. et al. Social equity is key to sustainable ocean governance. *npj Ocean Sustain.* **1**, 4 (2022).
- Manero, A. A case for protecting the value of 'surfing ecosystems'. *npj Ocean Sustain.* **2**, 6 (2023).
- Lübker, H. M. et al. Imagining sustainable futures for the high seas by combining the power of computation and narrative. *npj Ocean Sustain.* **2**, 4 (2023).
- Reimer, J. et al. The Marine Spatial Planning Index: a tool to guide and assess marine spatial planning. *npj Ocean Sustain.* **2**, 15 (2023).
- Tzachor, A., Hendel, O. & Richards, C. E. Digital twins: a stepping stone to achieve ocean sustainability? *npj Ocean Sustain.* **2**, 16 (2023).
- Frazão Santos, C. & Gissi, E. *Collection: Moving Towards Climate-smart Ocean Planning.* www.nature.com/npj oceansustain/collections (2023).
- UNESCO & European Commission. *Updated Joint Roadmap to accelerate Marine/ Maritime Spatial Planning Processes Worldwide-MSProadmap (2022–2027)* (2022).

35. Frazão Santos, C. et al. Integrating climate change in ocean planning. *Nat Sustain.* **3**, 505–516 (2020).
36. Wedding, L., Agardy, T., Green, S. & Crowder, L. B. *Collection: Bridging Land and Seascape Restoration for Ecoscape Recovery*. www.nature.com/npjocceansustain/collections (2023).
37. Skipper, M. et al. *Collection: Progress towards the Sustainable Development Goals*. www.nature.com/collections/bhfffjiadc (2023).
38. Rodrigues, R. et al. *Collection: Marine Heatwaves*. www.nature.com/collections/cgfacdihaa (2023).
39. Sumaila, U. R., Armitage, D., Bailey, M. & Cheung, W. W. L. *Sea Change: Charting a Sustainable Future for Oceans in Canada* (UBC Press, 2024, forthcoming).



Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.

© The Author(s) 2023