

<https://doi.org/10.1038/s44183-025-00138-1>

Rethinking the Blue Economy: Integrating social science for sustainability and justice



Jerneja Penca¹✉, Irmak Ertör², Marta Ballesteros³, Michael Briguglio⁴, Maciej Kowalewski⁵, Birgit Paukstat⁶, Dražen Cepić⁷, Cristina Piñeiro-Corbeira⁸, Natasa Vaidianu^{9,10}, Sebastian Villasante¹¹ & José J. Pascual-Fernández¹²

To fulfill the Blue Economy's promise of sustainable and just ocean use, its scientific foundation must more fully integrate the social sciences. Drawing on insights from real-world scientific networking initiatives, we identify three key contributions of the social sciences and propose a strategy to redefine the Blue Economy. This strategy anchors knowledge in societal challenges and emphasizes co-creation, the science-policy interface, knowledge integration, and the values of accountability and care.

When the term Blue Economy was coined in 2011 by the Small Island Developing States (SIDS), it offered a new focus on the seas. It encouraged viewing the ocean as a space, as a living entity, and as a resource base capable of promoting the prosperity of people, especially those who live with and off it¹. This concept was a strong call for innovation to reduce inequalities and minimize the environmental impact of traditional (e.g. fisheries and aquaculture) and new economic activities (e.g. biotechnology, wind energy and deep-sea mining). With the seas and oceans becoming increasingly important in geopolitics and economics, it was essentially an appeal to “do things differently” at sea and to learn from what has been done on land.

Despite the remarkable agency of SIDS in shaping the discourse of the Blue Economy towards social equity, sustainable livelihoods, and ocean stewardship^{2–5}, that innovative, emancipatory, and ecosystem-based potential of the concept seems today unlikely to materialize. While the Blue Economy continues to be invoked as both a descriptive term (referring to the activities of industries related to ocean environments, along with the assets, goods, and services provided by marine ecosystems)⁶ and a signpost for action (aiming at sustainable, resilient, and equitable activities at sea)^{7–9}, attempts to implement the Blue Economy are resulting in unintended negative impacts on the environment and people. This is turning some of the early concerns about the concept into reality¹⁰ and transforming the inherently interdependent and reciprocal relationship between humans and oceans^{11,12} into an extractive and adversarial dynamic. For example, the

rapid expansion of the cruise industry, promoted as a promising sector in the early enthusiasm for the ocean-based economic development^{13–15}, is now widely recognized as adversely affecting water, air, and land ecosystems, including non-human species, as well as the health of passengers, crew, and residents in cruise ports¹⁶. Similarly, the growth of offshore wind farms, solar photovoltaics, and other renewable energy projects—driven by the global push for sustainable, cost-effective energy alternatives to both fossil and non-fossil fuels¹⁷—raises concerns about the displacement of other marine activities, such as fishing or aquaculture^{7,18}.

The Blue Economy, as it is implemented today, is contributing to a wide range of injustices and inequalities^{19,20}, as well as a disproportionate concentration of capital and resources in a few dominant actors^{21,22}. It also leads to the intensification of pollution and environmental pressures in the ocean²³, while it has not eliminated hazardous working conditions and breaches of human rights²⁴ for maritime workers and fishers^{25,26}, or reduced exclusion of indigenous peoples and women²⁷. Further, the expansion of the Blue Economy that demands more goods and services from the ocean could lead to an increase in conflicts^{2,28}. Paradoxically, a concept originally devised to empower the powerless appears to have been co-opted and leveraged mostly by the rich and powerful²⁹.

This uneven and disappointing implementation of the Blue Economy concept has translated into various responses on the scientific and policy levels, calling for more actionable^{30,31}, better-organized and coordinated^{32,33},

¹Science and Research Centre Koper, Mediterranean Institute for Environmental Studies, Koper, Slovenia. ²Bogazici University, The Ataturk Institute for Modern Turkish History, Istanbul, Turkey. ³Spanish Institute of Oceanography (IEO-CSIC), Vigo, Spain. ⁴University of Malta, Msida, Malta. ⁵University of Szczecin, Institute of Sociology, UNESCO Chair for Social Sustainability, Szczecin, Poland. ⁶Nordland Research Institute, Bodø, Norway. ⁷Institute for Social Research in Zagreb, Zagreb, Croatia. ⁸Universidad de A Coruña, BioCost Research Group, Centro Interdisciplinar de Química e Bioloxía (CICA), Facultad de Ciencias, A Coruña, Spain. ⁹Ovidius University of Constanta, Faculty of Natural Sciences and Agricultural Sciences, Constanța, Romania. ¹⁰University of Bucharest, CICADIT Center, Bucharest, Romania. ¹¹University of Santiago de Compostela, EqualSea Lab-CRETUS, A Coruña, Spain. ¹²Universidad de La Laguna, Instituto Universitario de Investigación Social y Turismo, Tenerife, Spain. ✉e-mail: jerneja.penca@zrs-kp.si

and more diverse and equitable science^{34,35}. Such calls are often accompanied by abandoning the Blue Economy discourse in favour of alternative frameworks, such as Blue Justice, Ocean Health, or Ocean Sustainability that bring much-needed attention to equity, ecological integrity, and long-term stewardship. While these alternative framings address critical issues, they can inadvertently widen the gap between science and policy. The pursuit of conceptual precision and accuracy through new concepts, however, can create a disconnect between critical academic debates and the continuing policy implementation of the Blue Economy. Parallel discourses can make consensus on Blue Economy more difficult and narrow the scope of the scientific community's influence on policymaking, leaving policymakers ill-equipped to draw on (a full spectrum of) scientific findings to inform and improve decision-making, including in ongoing interfaces that seek to integrate scientific knowledge into sustainable ocean governance, such as the creation of Blue Economy fora³⁶, the UN Decade of Ocean Science for Sustainable Development³⁷, the High-Level Panel for a Sustainable Ocean Economy³⁸, or the initiative to establish an International Panel for Ocean Sustainability³⁹. This fragmentation of policy-relevant knowledge weakens the societal ability to withstand the intensifying geopolitical and exploitative pressures⁴⁰ on the ocean, by moving away from further economic growth and exploitation towards sustainable and equitable pathways. It also diminishes the relevance of social science to the emerging and forthcoming uses of the marine space, as well as its ability to shape scientific and public debates, actions, and outcomes^{41,42}.

The Blue Economy concept has demonstrated an appeal for policy discourse and the private sector. It is easily understandable, partly because of its versatile and ambiguous meaning, which shapes funding partnerships^{43,44} and policy initiatives⁴⁵. While the Blue Economy concept is contested for its depoliticizing effect and hegemonic status⁴⁶, it has an unequivocal integrative potential. In this paper, we argue for the need for a critical revision of the Blue Economy discourse rather than its abandonment. We work with those who have used this concept effectively to facilitate the bridging of the often-challenging science-policy divide^{47–49}. However, we argue that to promote better-informed decision-making and the implementation of the Blue Economy in a way that is more just and sustainable, improved production of knowledge about the Blue Economy is necessary. One crucial aspect of this is the need to more fully incorporate analytical perspectives from the social sciences.

We present a roadmap for the future that includes a better integration of the social sciences in the creation of marine and maritime knowledge and in its exchange with other societal domains. We integrate prior calls for using social knowledge for ocean sustainability^{50,51} with our own reflexive approach to constructing research findings⁵² and sharing them⁵³. In subsequent section, we explain *why* it is necessary to fully incorporate the social sciences into the Blue Economy. Then, we present *how* this can be done by the scientific community, by outlining the rationale and functioning of actual effort.

Rethinking the Blue Economy with the role of the social sciences

The social sciences are instrumental in building a more just and sustainable Blue Economy through three broad contributions: (a) *understanding, holistically and critically, the impacts of the Blue Economy* in specific contexts and identifying power asymmetries and injustices; (b) *designing alternative visions of the future and pathways* that enable more just and sustainable decision-making; and (c) *supporting the science-policy interface to enact justice and sustainability*. All of these bring direct benefits to decision-makers.

Firstly, it is only through in-depth social science research that we can fully comprehend the socio-ecological dimensions in which the Blue Economy operates. The social sciences enable us to appreciate complexities of time and space, identify injustices and inequities in the outcomes of Blue Economy initiatives, assess their varied impacts on different societal groups, and uncover the cultural, technological, political, and economic dynamics and systemic forces that shape them. One example would be the Small-Scale

Fisheries (SSF). The social sciences have been vital in pointing out the immense contribution of SSF to supplying nutritious and healthy food and livelihoods worldwide^{54,55}, identifying a wide range of injustices and inequities to which SSF are subjected, and explaining the reasons for and impacts of these^{56,57}. Decision-makers can benefit directly from the identification of specific barriers that SSF face in accessing seafood markets^{58,59}, obtaining fishing rights⁶⁰, or accessing fishing grounds⁶¹. As such, they can replace the dysfunctional systemic prioritization of more powerful actors.

Secondly, social science frameworks are essential for designing alternative visions of the future and pathways that promote greater sustainability and justice. The social sciences' commitment to highlighting diverse perspectives and worldviews not only supports informed and legitimate decision-making but also plays a critical role in challenging dominant paradigms and proposing transformative alternatives⁶². This is particularly important when visioning involves epistemologically marginalized or historically disadvantaged groups, such as indigenous peoples and local communities⁶³. One example of the importance of discovering alternative visions is Maritime Spatial Planning (MSP). MSP promises to coordinate an increasing number of activities in shared spaces in order to avoid conflicts^{64,65}. However, this process or tool is not inherently impartial and rational, and it is not unusual to see it conducted in a way that ignores traditional activities at sea^{66,67}. Social science research has developed practices in MSP that challenge dominant policy goals and approaches and offer more open-minded and inclusive ways of shaping the future use of maritime space^{68,69}. While not disregarding the political considerations and power dynamics of the MSP⁷⁰ or any other process^{71,72}, the social sciences can open the eyes of decision-makers towards alternative goals and approaches in creating a more equitable management, governance, and cohabitation of the seas.

Thirdly, the social sciences can actively support the science-society-policy interface to enact sustainability and justice. Social scientists can design conceptual 'boundary objects' that generate shared understandings and facilitate interactions between different actors, perspectives, and types of knowledge^{73,74}. They can organize participatory processes for inclusive and collaborative engagement with and for communities, and propose holistic and operational decision-making tools^{75–77}. A case in point is the creation of Marine Protected Areas, where social scientists have helped with the conception of the sites, facilitated communication and discussion among stakeholders in drafting the management plan and supported its monitoring^{78,79}. Decision-makers do well to include social scientists when conducting any participatory campaigns in order to avoid ineffective policies or having them challenged in the courts, and to create more robust and lasting policies.

The strategy for rethinking the Blue Economy

With a stronger emphasis on social science, Rethinking the Blue Economy calls for the re-organization of the scientific community both internally and in how it engages with broader societal and political realms. Reflexivity – at both the individual and group levels – is a necessary condition for any meaningful reform. To illustrate how such a shift can take shape, we draw on several real-world networking initiatives that work to link scientific knowledge with governance processes. The most recent one is the COST Action Rethinking the Blue Economy: Socio-ecological impacts and opportunities (RethinkBlue), which builds on a range of previous collaborations and interacts with other parallel initiatives, e.g. COST Action Ocean Governance for Sustainability – challenges, options and the role of science (OceanGov), biannual MARE People & the Sea conferences, the Programme on Ecosystem Change and Society (PECS) conferences, One Ocean Hub, and others. From these, we distil five organizing principles that offer concrete guidance for reimagining the Blue Economy. We intentionally prioritize lived experiences over theoretical frameworks in order to move beyond an abstract critique of the scientific community and towards a grounded, adaptive strategy for practicing it, also highlighting that change is already being tested, iterated, and advanced.

Rethinking the relations with the object of the study: societal anchoring

The Blue Economy should be re-oriented from economic sectors as traditionally articulated (fisheries, transport, energy, etc.) towards themes that are anchored in human and societal challenges, concerns and aspirations. For example, inquiries (or working groups) can be dedicated to maritime occupations, food security and sustainable consumption, port cities and coastal communities, fisheries governance and emergent activities, or climate change and natural hazards. Such human-centric approach is more likely to acknowledge the complex causal interrelations among sectors⁸⁰ and inherently trigger non-siloed insights and collaboration beyond the traditional communities (e.g. when examining the impact of climate change on fisheries and the consumption of seafood).

Rethinking the relations with sea users: co-creation

The production of knowledge on issues such as climate impacts, new technologies or shifts in value chains should move from being intra-academic to being co-produced and co-created in transdisciplinary research with stakeholders beyond academia. Knowledge co-production involves stakeholders both in decisions and in identifying shared goals⁸¹. A pilot initiative demonstrates the value of this in practice: fishing organizations, public institutions, and civil society groups collaborated in supplying local fish to school canteens as alternatives to markets in enhancing sustainability and promoting local consumption⁸². While such locally co-created knowledge is context-specific, it can also be combined with experience from other regions and countries – either to highlight diversity or shared societal effects⁵⁸. In a network, transnational studies, policy briefs, and position statements with more conceptual and transnational findings can feed into strategies or shared policy frameworks.

Rethinking the relations with decision-makers: science-policy interface

Rethinking the Blue Economy should involve active engagement in the science-policy interface, i.e. the processes and activities that connect different knowledge domains and organizations, facilitating the exchange of information and ideas between them to ensure that scientific evidence effectively informs decision-making processes⁸³. Scholars should not shy away from engaging in it, targeting in particular the policy level that is most relevant, e.g. the EU-level, or the global fisheries industry. Formats, such as policy briefs that summarize research publications in accessible formats, trainings, webinars and presentations at policy-relevant events, are some of the possible tools to this end.

Rethinking the relations among researchers: knowledge integration

The building of a knowledge base should move from maintaining established disciplines, themes, and stable communities to integrating knowledge and improving the interaction among participating scientists. Active maintenance of inclusive networks is a primary tool for that, with a focus on new collaborations, working group meetings, training courses, mentorship programmes, research visits, conferences, and the regular communication of news and opportunities. In practising inclusiveness, attention should be paid to overcoming existing fragmentations and marginalizations. These can be related to researchers' skills, career stage, access to research funding and infrastructure, or the status of innovators from non-academic institutions or countries with lower levels of research intensity. Addressing these fragmentations also means involving, in the research, profiles that are particularly marginalized in the Blue Economy — such as historians, landscape architects, and user interface designers — for example, by actively integrating them as speakers in seminar series. Further, constant attention should be paid to ensuring that topic framings emerging from certain cultures or countries do not become hegemonic in the research discourse.

Rethinking the relations in the research community: accountability and care

Commitment to ensuring pleasant relations and ethical operation of structures is a key. Clear governance structures and practices should operate by consensual decision-making and transparent reporting to the members and stakeholders. These structures should be accompanied by a value-set centring on accountability, dialogue, mutual respect, care, and kindness that impact on developing specific actions. Rethinking the Blue Economy provides a direct opportunity to put into action a different way of running our lives and work by making kind and caring relationships central⁸⁴. Insofar as relational emphasis counters time efficiency, teamwork (e.g. in leading activities) becomes an important aspect of such collaboration, understood as the division of work and the provision of opportunities for discussion, feedback, and an incremental development of leadership skills for less experienced collaborators.

Rethinking the Blue Economy – Collectively

Rethinking the Blue Economy as a framework that prioritizes sustainability and justice does not require the disengagement of social scientists, but rather a more vocal integration of their questions and methodologies into transdisciplinary efforts, alongside the promotion of more relational principles. Rethinking the Blue Economy is not a task for the scientific community alone: it also calls for decision-makers to adopt revised metrics and assessment tools to reshape governance priorities toward broader societal goals of well-being, equity, and sustainability, alongside new governance models, built on collaboration and the inclusion of diverse stakeholders' perspectives and knowledge.

Across various contexts, opportunities and initiatives are emerging that are rooted in sustainability, justice and systemic reimagining, often of non-linear, interconnected character. Rethinking the Blue Economy is necessary for all who recognize the urgency of change and the power of collective action to make it possible.

Data availability

Data sharing is not applicable to this article as no datasets were generated or analysed during the current study.

Received: 13 March 2025; Accepted: 20 June 2025;

Published online: 12 July 2025

References

- Summary of the Second Session of the Preparatory Committee for the UN Conference on Sustainable Development. *Earth Negotiations Bulletin* **27**, 03, Accessible at: <https://www.un.org/en/desa/second-preparatory-meeting-united-nations-conference-sustainable-development-side> (2011).
- Betzold, C. Adapting to climate change in small island developing states. *Climatic Change*. **133**, 481–489 (2015).
- Moncada, S. et al. (Eds.) *Small island developing states: Vulnerability and resilience under climate change* (9) (1–10). Springer International Publishing.
- Pouponneau, A. Blue Economy: the perspectives of small island developing states. *Small State Territories* **6**, 69–82 (2023).
- Voyer, M., Quirk, G., McIlgorm, A. & Azmi, K. Shades of blue: what do competing interpretations of the Blue Economy mean for oceans governance?. *J. Environ. Policy Plan.* **20**, 595–616 (2018).
- Viridin, J. et al. The Ocean 100: Transnational corporations in the ocean economy. *Sci. Adv.* **7**, eabc8041 (2021).
- UN, Sustainable Blue Economy. Accessible at: <https://www.unep.org/topics/ocean-seas-and-coasts/ecosystem-based-approaches/sustainable-blue-economy>; EC (2024).
- EU, New approach for a sustainable blue economy in the EU Transforming the EU's Blue Economy for a Sustainable Future, COM (2021)240 (2021). Accessible at: <https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:52021DC0240>.

9. AU-IBAR. Africa Blue Economy Strategy Implementation Plan, 2021–2025 Accessible at: <https://www.au-ibar.org/news/latest-news/launch-africa-blue-economy-strategy> (2020).
10. Limits to Blue Growth. Joint NGO Position Paper Accessible at: <https://mio-ecsde.org/wp-content/uploads/2012/10/En-Joint-Position-Paper-on-the-Limits-to-Blue-Growth.pdf> (2012).
11. Berkes, F. & Folke, C. (1998) Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience. Cambridge University Press, Cambridge.
12. Alvarez, R. et al. Reciprocal contributions: Indigenous perspectives and voices on marine-coastal experiences in the channels of northern Patagonia, Chile. *People Nat.* **7**, 1086–1098 (2025).
13. Silver, J. J., Gray, N. J., Campbell, L. M., Fairbanks, L. W. & Gruby, R. L. Blue Economy and Competing Discourses in International Oceans Governance. *J. Environ. Dev.* **24**, 135–160 (2015).
14. Penca, J. Blue Economy in the Euro-Mediterranean: Implications of the Policy Paradigm. *Int. J. Eur. Mediterr. Stud.* **12**, 69–92 (2019).
15. Communication EU, Blue Growth opportunities for marine and maritime sustainable growth, 2012. Accessible at: <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2012:0494:FIN:EN:PDF>.
16. Lloret, J., Carreño, A., Carić, H., San, J. & Fleming, L. E. Environmental and human health impacts of cruise tourism: A review. *Mar. Pollut. Bull.* **173**, 112979 (2021).
17. Renewables 2023: Analysis and forecast to 2028. International Energy Agency Accessible at: https://iea.blob.core.windows.net/assets/96d66a8b-d502-476b-ba94-54fda84cf72/Renewables_2023.pdf (2023).
18. Knol-Kauffman, M., Nielsen, K. N., Sander, G. & Arbo, P. Sustainability conflicts in the blue economy: planning for offshore aquaculture and offshore wind energy development in Norway. *Marit. Stud.* **22**, 47 (2023).
19. Bennett, N., Bennett, J., Blythe, J., White, C. S. & Campero, C. Blue growth and blue justice: Ten risks and solutions for the ocean economy. *Mar. Policy* **125**, 104387 (2021).
20. Ertör, I. & Hadjimichael, M. Editorial: Blue degrowth and the politics of the sea: rethinking the blue economy. *Sustain Sci.* **15**, 1–10 (2020).
21. Jouffray, J.-B. et al. Blue Acceleration: an ocean of risks and opportunities. Ocean Risk and Resilience Action Alliance (ORRAA) Report (2021) Accessible at: <https://oceanrisk.earth/wp-content/uploads/2022/12/ORRAA-Blue-acceleration.pdf>.
22. Cisneros-Montemayor, A. M. et al. Social equity and benefits as the nexus of a transformative Blue Economy: A sectoral review of implications. *Mar. Policy* **109**, 103702 (2019).
23. Enevoldsen, H., Isensee, K. & Yoon, I. State of the Ocean Report, pilot edition. (eds. Enevoldsen, H., Isensee, K., Yoon, I.) IOC-UNESCO. (IOC Technical Series, 173, 2022). Accessible at: <https://unesdoc.unesco.org/ark:/48223/pf0000381921>.
24. Tickler, D. et al. Modern slavery and the race to fish. *Nat. Commun.* **9**, 4643 (2018).
25. Jepsen, J. R., Zhao, Z., Pekcan, C., Barnett, M. & van Leeuwen, W. M. A. Risk Factors for Fatigue in Shipping, the Consequences for Seafarers' Health and Options for Preventive Intervention. In: MacLachlan, M. (eds) Maritime Psychology. Springer, Cham. https://doi.org/10.1007/978-3-319-45430-6_6 (2017).
26. Sampson, H. & Ellis, N. 2021 Sampson, H. & Ellis, N. Stepping up: the need for Proactive Employer Investment in Safeguarding Seafarers' Mental Health and Wellbeing. *Marit. Policy Manag* **48**, 1069–1081 (2021).
27. Scheidel, A. et al. Global impacts of extractive and industrial development projects on Indigenous Peoples' lifeways, lands, and rights. *Sci. Adv.* **9**, eade9557 (2023).
28. Sardá, R. et al. Business for ocean sustainability: Early responses of ocean governance in the private sector. *Ambio* **52**, 253–270 (2023).
29. Fusco, L. M., Knott, C., Cisneros-Montemayor, A. M., Singh, G. G. & Spalding, A. K. Blueing business as usual in the ocean: Blue economies, oil, and climate justice. *Polit. Geogr.* **98**, 102670 (2022).
30. Gaill, F. et al. An evolution towards scientific consensus for a sustainable ocean future. *npj Ocean Sustain* **1**, <https://doi.org/10.1038/s44183-022-00007-1> (2022).
31. Penca, J. et al. Building competences for researchers working towards ocean sustainability. *Mar. Policy* **163**, 106132 (2024).
32. Shellock, R. J. et al. Building leaders for the UN Ocean Science Decade: A guide to supporting early career women researchers within academic marine research institutions. *ICES J. Mar. Sci.* **80**, 56–75 (2023).
33. Bavinck, M. & Verrips, J. Manifesto for the marine social sciences. *Marit. Stud.* **19**, 121–123 (2020).
34. Kelly, R. et al. Ten tips for developing interdisciplinary socio-ecological researchers. *Socioecol. Pr. Res.* **1**, 149–161 (2019).
35. Blythe, J. & Cvitanovic, C. Five organizational features that enable successful interdisciplinary marine research. *Front. Mar. Sci.* **7**, 539111 (2020).
36. The European Blue Forum (2025). Accessible at: <https://maritime-spatial-planning.ec.europa.eu/european-blue-forum>.
37. United Nations General Assembly. Resolution A/RES/72/73, Part XI of the Resolution for Oceans and the law of the sea (2017). Accessible at: <https://undocs.org/en/a/res/72/73>.
38. The High Level Panel for a Sustainable Ocean Economy (The Ocean Panel) Accessible at: <https://oceanpanel.org/>.
39. Towards IPOS: Shaping Ocean-Knowledge-Policy interfaces (2024). Accessible at: <https://ipos.earth/>. See also the scientific assessment: World Ocean Assessment WOA I (2015) & WOA II (2021) Accessible at: <https://www.un.org/regularprocess/woa2launch>.
40. Campling, L. et al. A geopolitical-economy of distant water fisheries access arrangements. *npj Ocean Sustain* **3**, 26 (2024).
41. Sumaila, U. R. et al. Financing a sustainable ocean economy. *Nat. Commun.* **12**, 3259 (2021).
42. Schadeberg, A., Kraan, M. L., Groeneveld, R. A., Trilling, D. & Bush, S. R. Science governs the future of the mesopelagic zone. *npj Ocean Sustain* **2**, <https://doi.org/10.1038/s44183-023-00008-8> (2023).
43. The Sustainable Blue Economy Partnership, Accessible at: <https://bluepartnership.eu/>.
44. Blue Futures Pathways (BFP), Accessible at: <https://soifoundation.org/>.
45. EC Oceans and fisheries, Blue Economy https://oceans-and-fisheries.ec.europa.eu/ocean/blue-economy_en.
46. Schutter, M. S., Hicks, C. C., Phelps, J. & Waterton, C. The blue economy as a boundary object for hegemony across scales. *Mar. Policy* **132**, 104673 (2021).
47. Croft, F. et al. Rethinking blue economy governance – A blue economy equity model as an approach to operationalise equity. *Environ. Sci. Policy* **155**, 103710 (2024).
48. Cisneros-Montemayor, A. M. et al. Enabling conditions for an equitable and sustainable blue economy. *Nature* **591**, 396–401 (2021).
49. Stephenson, R. L. & Hobday, A. J. Blueprint for Blue Economy implementation. *Mar. Policy* **163**, 106129 (2024).
50. Partelow, S. et al. Five social science intervention areas for ocean sustainability initiatives. *npj Ocean Sustain* **2**, 24 (2023).
51. Bennett, N. J. et al. Ocean equity: from assessment to action to improve social equity in ocean governance. *Front. Mar. Sci.* **12**, 1473382 (2025).
52. Mortari, L. Reflectivity in Research Practice: An Overview of Different Perspectives. *Int. J. Qual. Methods* **14**, 5 (2015).
53. Van Leeuwen, J., van Tatenhove, J., Schutter, M. & Voyer, M. Reflexivity and transformative change: empirical and theoretical insights from a special issue on reflexive marine governance. *J. Environ. Pol. Plan* **27**, 1–7 (2025).

54. Viridin, J. et al. Small-scale fisheries contributions to economic value and livelihoods. In: FAO, Duke University & WorldFish. Illuminating Hidden Harvests: the contributions of small-scale fisheries to sustainable development. Rome, FAO; Durham, USA, Duke University; Penang, Malaysia, WorldFish (2023).
55. Golden, C. D. et al. Aquatic foods to nourish nations. *Nature* **598**, 315–320 (2021).
56. Ertör, I. We are the oceans, we are the people! Fisher people's struggles for blue justice. *J. Peasant Stud.* **50**, 1157–1186 (2023).
57. Jentoft, S., Chuenpagdee, R., Bugeja Said, A. & Isaacs, M. (eds.) *Blue Justice: Small-Scale Fisheries in a Sustainable Ocean Economy*. MARE Publication Series, 26. Springer: Cham (2022) <https://link.springer.com/book/10.1007/978-3-030-89624-9>.
58. Penca, J. et al. Sustainable small-scale fisheries markets in the Mediterranean: weaknesses and opportunities. *Marit. Stud.* **20**, 141–155 (2021).
59. Pascual-Fernández, J. J., Pita, C., Josupeit, H., Said, A. & Garcia Rodrigues, J. Markets, Distribution, and Value Chains in Small-Scale Fisheries: A Special Focus on Europe. In R. Chuenpagdee & S. Jentoft (Eds.), *Transdisciplinarity for Small-Scale Fisheries Governance. Analysis and Practice*, 141–162 <https://doi.org/10.1016/j.marpol.2020.104009> (2019).
60. Said, A. et al. Small-scale fisheries access to fishing opportunities in the European Union: Is the Common Fisheries Policy the right step to SDG14b. *Mar. Policy* **118**, 104009 (2020).
61. Bennett, N. J. et al. Access rights, capacities and benefits in small-scale fisheries: Insights from the Pacific Coast of Canada. *Mar. Policy* **130**, 104581 (2021).
62. Villasante, S. et al., Visions of a sustainable world – for nature and people, in Thematic Assessment Report on the Underlying Causes of Biodiversity Loss and the Determinants of Transformative Change and Options for Achieving the 2050 Vision for Biodiversity of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, (K. O'Brien, L. Garibaldi, A. Agrawal, Eds.), Chapter 2, IPBES Secretariat (2024).
63. Santha, S. D. Climate change, small-scale fisheries, and blue justice: fishscapes and alternative worldviews. Routledge, Taylor & Francis Group (2023).
64. Ehler, C. & Douvère, F. Marine spatial planning: a step-by-step approach. Paris, France, Unesco (IOC Manuals and Guides 53), ICAM Dossier 6. <https://doi.org/10.25607/OBP-43> (2009).
65. Flannery, W. & McAteer, B. Assessing marine spatial planning governmentality. *Marit. Stud.* **19**, 269–284 (2020).
66. Trouillet, B. Aligning with dominant interests: The role played by geo-technologies in the place given to fisheries in marine spatial planning. *Geoforum* **107**, 54–65 (2019).
67. Jentoft, S. & Chuenpagdee, R. Blue Justice in Three Governance Orders. In S. Jentoft, R. Chuenpagdee, A. Bugeja Said & M. Isaacs (Eds.), *Blue Justice: Small-Scale Fisheries in a Sustainable Ocean Economy*. Springer International Publishing https://doi.org/10.1007/978-3-030-89624-9_2 (2022).
68. Josse, T., Hadiwinata, M., Pratama, H., Brent, Z. W. & Barbesgaard, M. Marine Spatial Planning: Resolving or entrenching conflicts over and in ocean space? https://www.tni.org/files/publication-downloads/msp_en_web.pdf (2019).
69. Tafon, R. et al. Multispecies blue justice and energy transition conflict: examining challenges and possibilities for synergy between low-carbon energy and justice for humans and nonhuman nature. *Marit. Stud.* **22**, 45 (2023).
70. Tafon, R. Taking power to sea: Towards a post-structuralist discourse theoretical critique of marine spatial planning. *Environ. Plan. C: Politics Space* **36**, 258–273 (2018).
71. Lukes (2021). *Power: A Radical View*. 3rd ed. Bloomsbury: London.
72. National Research Council (NRC) (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington DC: The National Academies Press.
73. Leclerc, N. & Halfar, J. Review of Arctic sea-ice records over the last millennium from modern, historical, and proxy data sources. *Arct. Antarct. Alp. Res.* **56**, 1 (2024).
74. Parviainen, T., Kuikka, S. & Haapasaari, P. Enhancing science-policy interface in marine environmental governance: Oil spill response models as boundary objects in the Gulf of Finland, Baltic Sea. *Mar. Policy* **135**, 104863 (2022).
75. Piñeiro-Corbeira, C. et al. Can Local Knowledge of Small-Scale Fishers Be Used to Monitor and Assess Changes in Marine Ecosystems in a European Context? In: Misiune, I., Depellegrin, D., Egarter Vigl, L. (eds) *Human-Nature Interactions*. Springer, Cham. https://doi.org/10.1007/978-3-031-01980-7_24.
76. Mascia, M. B. et al. A novel framework for analyzing conservation impacts: evaluation, theory, and marine protected areas. *Ann. NY. Acad. Sci.* **1399**, 93–115 (2017).
77. Hamelin, K. M., Charles, A. T., & Bailey, M. Community knowledge as a cornerstone for fisheries management. *Ecol. Society*, 29 <https://doi.org/10.5751/ES-14552-290126> (2024).
78. Chuenpagdee, R. et al. Marine protected areas: Re-thinking their inception. *Mar. Policy* **39**, 234–240 (2013).
79. Pascual-Fernández, J. J., De la Cruz Modino, R., Chuenpagdee, R. & Jentoft, S. Synergy as strategy: learning from La Restinga, Canary Islands. *Marit. Stud.* **17**, 85–99 (2018).
80. Reyers, B., Moore, M. L., Haider, L. J. & Schlüter, M. The contributions of resilience to reshaping sustainable development. *Nat. Sustain.* **5**, 657–664 (2022).
81. Holm, P., Hadjimichael, M., Linke, S., & Mackinson, S. (Eds.). (2020). *Collaborative Research in Fisheries: Co-creating Knowledge for Fisheries Governance in Europe* (1st ed.). Springer Nature.
82. Pascual-Fernández, J. J., Ramón Bruquetas, J. & de la Cruz Modino, R. A School of Local Fish on the School Lunch Menu. *Front. Young-Minds* **11**, 1047844 (2023).
83. Stoker, G. & Evans, M. (Eds.). *Evidence-based policy making in the social sciences*. Policy Press: Bristol <https://doi.org/10.2307/j.ctt1t89d4k> (2016).
84. Bauhardt, C. & Harcourt, W. *Feminist Political Ecology and the Economics of Care: In Search of Economic Alternatives*, Routledge (2019).

Acknowledgements

This article is based upon work from COST Action CA22122 “Rethinking the Blue Economy: Socio-Ecological Impacts and Opportunities” (RethinkBlue), supported by COST (European Cooperation in Science and Technology). All authors acknowledge the role of the RethinkBlue COST Action in inspiring the writing of the manuscript, and thank the members of the RethinkBlue COST Action for engaging in the collective research effort. J.P. acknowledges Slovenian Research Agency (P5-0453) to support the writing of the manuscript. S.V. acknowledges the financial support from EQUALSEA (Transformative adaptation towards ocean equity) project, under the European Horizon 2020 Program, ERC Consolidator (Grant Agreement # 101002784) funded by the European Research Council, also the support of the Earth Commission and Future Earth. J.J.P.-F. acknowledges the financial support from THINKINAZUL program and the support by the Spanish Ministry of Science and Innovation, with funding from the European Union Next Generation EU (PRTR-C17.11) and the Government of the Canary Islands. C.P.-C. received financial support from Xunta de Galicia “Axudas de apoio á etapa de formación posdoutoral” (grant ED481B-2021/095) and Xunta de Galicia “Axudas para completar á etapa de formación posdoutoral” (grant ED481D-2024/021). D.C. acknowledges the support of Croatian Science Foundation (HRZZ-UIP-2020-02-2238).

Author contributions

J.P., I.E., M. Ballesteros, M. Briguglio, M.K., B.P., D.C., J.J.P.-F. conceived the study and wrote the first draft and multiple subsequent versions, S.V., N.V., C.P.-C. revised the draft. All authors read and approved the submitted version.

Competing interests

The authors declare no competing interests.

Additional information

Correspondence and requests for materials should be addressed to Jerneja Penca.

Reprints and permissions information is available at <http://www.nature.com/reprints>

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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 licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence 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 licence, visit <http://creativecommons.org/licenses/by/4.0/>.

© The Author(s) 2025