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Editorial: ICYMARE – early career researchers in marine science

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Editorial on the Research Topic
ICYMARE – early career researchers in marine science

This Research Topic is a collection of original research, review, and perspective articles produced in the frame of the ICYMARE initiative. ICYMARE – the 'International Conference for Young MArine REsearchers' – is an annual international conference and networking meeting for young marine scientists (www.icymare.com). As an event of the 'Bremen Society for Natural Sciences from 1864' (in German: 'Naturwissenschaftlicher Verein zu Bremen von 1864' NWV), it was established in 2019, and is organized and run on a voluntary basis by young marine scientists themselves, empowering the next generation of researchers from the bottom up. This includes the establishment of conference topics. Interested early career researchers apply to a 'Call for Sessions', in which Master's or doctoral students are invited to organize and moderate a conference session as session hosts during the upcoming conference. Thus, the sessions of the conference come from the participants' own ranks, and they in turn promote the conference topics in their fields of expertise. As the students are working towards their degree, their research often represents cutting-edge developments in the field.

Since ICYMARE started, the conference has welcomed more than 200 participants from over 80 institutions across 30 countries every year (even more joined the online-only editions during the COVID-19 restrictions). The conference provides a space for international career development, on-spot support, and a sense of community belonging for all participants. Financial capacities, institutional and personal, for young researchers are often limited. Sponsors and funders, as well as the voluntary work from the team members enable ICYMARE to keep cost on a very low level, and, therefore, support the participants in gaining conference experience and foster professional growth.

On an international level, the efforts of the ICYMARE conference series contribute towards the Sustainable Development Goals (SDGs) and is recognized as an endorsed activity of the Decade of Ocean Science for Sustainable Development of the United Nations.

Each edition of ICYMARE contributes to the SDGs no. 4 ('Quality Education'), 14 ('Life below water'), and 17 ('Partnerships to achieve the Goal') by providing early-career marine researchers with multi- and interdisciplinary ocean knowledge. ICYMARE aligns with all three of the UN Ocean Decade's objectives: (1) 'Identify critical ocean knowledge', (2) 'Build capacity and generate knowledge', and (3) 'Increase the use of ocean knowledge'. This triad facilitates interdisciplinary collaboration across different areas of marine science disciplines, as the establishment of new professional early-career networks can lead to new international partnerships and research collaborations amongst institutes. By focusing on the professional development of young marine scientists, ICYMARE supports capacity building at multiple levels, e.g., networking, presenting research talks, organizing topical conference sessions and scientific writing. Therefore, the ICYMARE initiative most strongly contributes to the Ocean Decade outcomes no. 4 ('A predicted ocean'), 6 ('An accessible ocean'), and 7 ('An inspiring and engaging ocean'). Since 2023, ICYMARE has also been an endorsed action of the "Mission Restore our Ocean and Waters" Charter of the European Union.

As part of the career development, session hosts were invited to contribute a scientific article for publication within this Research Topic. As a result, the Research Topic presented here showcases contemporary findings and perspectives across a range of marine research fields. While offering valuable insight into the work of marine early-career researchers, it is not intended to be exhaustive.

In the following, we present an overview of the articles included in this Research Topic, organized into five overarching areas of marine research:

- Biodiversity, Ecological Impacts, and Resilience.
- Fisheries and Aquaculture.
- Marine Environmental Management and Policy.
- Omics and Bioinformatics.
- Technological Advances and Data Science.

Figure 1 provides a visual summary of these five overarching research areas of this Research Topic with three key aspects each.

Biodiversity, ecological impacts, and resilience

Global marine biodiversity is increasingly under threat and halting its decline is pivotal to ensure that ecosystems are resilient to future changes (Lotze, 2021). This Research Topic highlights two often overlooked domains of marine biodiversity: the deep sea (Paulus) and marine invertebrates (Chen). Ultimately pointing to the challenges of effective management solutions, both articles review the related natural and anthropogenic stressors. The peak intensities of stressors (or "drivers") may occur simultaneously or sequentially which results in highly differing effects (Gunderson et al., 2016). This underlines the need for research on multiple rather than single drivers of change, as reviewed in Wernberg et al. (2012). Within this Research Topic, two studies investigate the effects of multiple drivers on corals. Using an experimental approach, Klinke et al. tested the effects of phosphate enrichment and ocean warming on the pulsating soft coral *Xenia umbellata*. Their results showed that only the combination of both drivers led to an increase in pulsation, which was interpreted as a potential enhanced resilience towards ocean warming and an advantage over hard corals in future reef systems. The study of Lishchenko et al. demonstrates that the situation in the field is more complex. In their study in central Vietnam, bleaching and partial mortality of the coral *Pocillopora verrucosa* showed a strong seasonal variability but with sequential timing, which prevents synergistic effects. Interestingly, the impact of one driver can, in turn, act as a catalyst for another driver. Water temperature and partial mortality were found to be drivers of bleaching, whereas wave action, temperature and bleaching itself were found to be impacting partial mortality. In some cases, as in Britayev et al., the forces behind a rather simple comparative study may unfold into more complex driver interactions. Here, the authors compared ectosymbiotic communities developing on natural and reared colonies of the coral *Pocillopora verrucosa*. During the analysis, the revealed differences were then attributed to differing microhabitat properties and age structure of the two types of colonies. Finally, the review of Kunze et al. showcases this complexity of drivers and effects for rocky intertidal systems. The authors conclude that the diversity of revealed effects of the reviewed multi-driver studies was giving the impression of "ecological surprises". They attributed this unpredictability to the broad spectrum of spatial and temporal scales at which the drivers act and call for a new, integrated approach to reliably inform decision-makers on potential management solutions.

Fisheries and aquaculture

Fish represent the most visibly exploited living resource of the ocean. Monitoring of single or multiple fish species, e.g., their population sizes and health status, is essential for the fisheries industry and ecosystem-based management (Trenkel et al., 2019). Marine protected areas (MPAs) are the most common area-based management tools (Devillers et al., 2019). Kriegl et al. review how MPA effectiveness is assessed and the critical role it plays in biodiversity conservation and fisheries management. The further five publications within this topical cluster focus on the foundational role of monitoring, i.e., the basis of fisheries management. Müller reviewed the uptake of microplastics in wild fish populations, which appears to be a crucial measurement of the health status of fish populations. The recommendations for microplastic *in-situ* studies in fish can, thus, be considered as a desired part of fish population monitoring. To differentiate the population of a fish species into distinct stocks, e.g., to monitor them separately, Lishchenko and Jones expound geometric morphometrics on otoliths to be a promising and cost-effective tool that complements traditional monitoring methods. These conventional monitoring methods, which often involve invasive practices like trawling or other invasive fishing methods, are becoming increasingly restricted in coastal zones, e.g., due to the

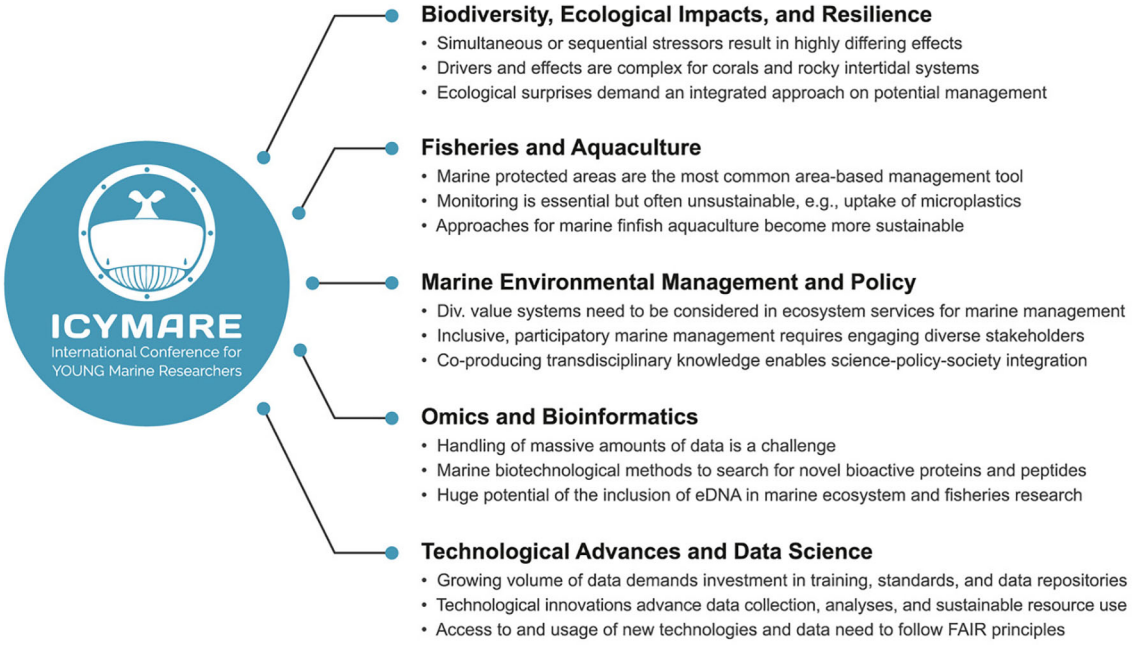

FIGURE 1
Overarching research areas and key aspects of articles within this Research Topic.

increasing number of MPAs and windfarms. Addressing these constraints, Hammerl et al. review non-invasive methods of monitoring fish populations, e.g., video, acoustic, and eDNA methods, and offer guidance on selecting the most appropriate methods for individual cases. Accurate monitoring is not only essential for ecological assessments but also underpins the establishment of fishing quotas. In their review on "blue growth" in fisheries, Sulanke and Rybicki advocate for Community Development Quota systems and the support of small-scale fisheries. They argue that such measures can help transition from subsistence fisheries into full-time livelihoods. Within the "blue growth" approach, aquaculture is another major sector, which has historically been linked to a whole array of environmental issues. However, various approaches have emerged to make aquaculture more sustainable. Carballeira Braña et al. provide an overview of such sustainable approaches for marine finfish aquaculture.

Marine environmental management and policy

Achieving sustainability in the marine and coastal realm requires inter- and transdisciplinary approaches that address complex challenges while generating actionable knowledge for effective and sustainable environmental governance (Franke et al., 2022). This is anchored in the United Nations Decade of Ocean Science for Sustainable Development, which calls for *the science we need for the ocean we want* by transcending traditional disciplinary approaches through societally relevant knowledge co-production (Claudet et al., 2019). Drawing from a survey of projects and initiatives employing inter- and transdisciplinary approaches, Rölfer et al. provide an overview of the challenges and good-practices in engaging with such complex approaches. They propose key considerations for designing integrated research approaches that support science-based decision-making, foster societal change, and drive transformative action through knowledge co-production across the science-policy-society interface. A good example for this integration is the application of the ecosystem services concept, which is gaining traction in policy and society. Carrasco De La Cruz reviews the current state of knowledge on coastal and marine ecosystem services and identifies six key lessons from literature to enhance an ecosystem services approach in coastal and marine management. These include the need to integrate the ecosystem service approach through a science-policy process, empower relevant stakeholders, and incorporate value pluralism that extends beyond monetary valuation. Drawing on a deeper understanding of relational values between people and nature, Sanborn and Jung review the different philosophies and value systems that have shaped traditional conservation efforts and explore the benefits of integrating social science into conservation through participatory methodologies and approaches. Similarly, Vigliano Relva and Jung highlight that divergent values, beliefs, and worldviews among societal actors require the integration of multiple ways of knowing in marine management. They suggest using a narrative lens to embrace multiple ways of knowing and demonstrate how storytelling can uncover, share, and reshape these underlying values and beliefs. However, participatory processes are not trivial both for the participating actors and researchers, as they require extensive resources, including time and funding. For example, Wilke analyzes the scope and depth of public participation in a Marine Spatial Planning process in Iceland. They show that only a limited group of people are engaged in the

initial phase of the process, the lack of local community members in the later phases of decision-making and highlight the urgent need for more inclusive approaches in decision-making processes. Finally, Rölfer et al. shed light on the particular obstacles that early-career researchers face, when engaging in knowledge co-production processes with non-academic actors. Based on these obstacles, they discuss actions at various organizational levels to leverage change towards a more inclusive environment for ECRs engaging in knowledge co-production.

Omics and bioinformatics

"Omics approaches" involve the analysis of various types of molecules as a whole. For instance, the analysis of DNA is considered "genomics", and the analysis of lipids is termed "lipidomics" (e.g., Yamada et al., 2021; Rey et al., 2022). In the marine realm, "omics" have led to a large and diverse novel field of analytical developments and methods to address diverse research questions (Kim, 2017). The diversity of omics approaches is reflected in the contributions to this Research Topic. The review by Wilms describes omics approaches for microbial communities and concludes that one of the main challenges is the handling of massive amounts of data generated, e.g., by high-throughput sequencing technologies. This challenge is certainly true for all omics approaches, particularly in screening approaches as reviewed in Cabral et al., who describe marine biotechnological methods for searching novel bioactive proteins and peptides as part of the exploration of the ocean. Examples of searching for novel bioactive compounds are the studies of Gonçalves et al. and Lawley et al. Gonçalves et al. conducted a screening for toxins and other bioactive proteins and peptides in the posterior salivary glands of *Sepia officinalis* (common cuttlefish) from the Portuguese West coast. In comparison with specimen from other areas, their findings uncovered inter-populational variation in venom composition, potentially adding to the diversity of bioactive compounds. In their study on pigments in rhizostome jellyfish, Lawley et al. discovered the new pigment family "rhizostomins". The authors describe the potential biochemical and biophysical roles of these pigments, and their potential for further biotechnological applications. Apart from the exploration aspect, omics approaches are now widely used to investigate biological interactions. For example, Stévenne et al. summarize the key concepts of studies on two well-known holobionts, corals and sponges, and review the underlying holobiont ecology and physiology. The review of Hewitt and Shaikh looks at a broader range of holobionts and specifically on the rhythmic regulatory activities of hosts and their symbionts, i.e., the field of holobiont chronobiomics. Omics approaches are also increasingly applied at the ecosystem level. The review of Page and Lawley, for instance, states that over 80% of transcriptomics studies from the past decade include some type of stressor, studied adaptation or ecological interactions. As an example, transcriptomic and genomic analysis helped in shedding light on the functional types of mixotrophic marine protists (i.e., mixoplankton) as shown in the work of Mansour and Anestis. At a broader scale, the inclusion of eDNA is expanding in marine ecosystem and fisheries research, as reviewed by Schadewell and Adams. The huge potential of eDNA approaches include, e.g., the tracking of migration patterns, population connectivity studies, and research on spatio-temporal patterns of biodiversity.

Technological advances and data science

Technological innovation and data-driven approaches are transforming marine research to an unprecedented extent, fundamentally reshaping the way ocean systems are observed, analyzed, and managed. At the core of modern marine research lies the ability to collect and integrate ocean observations across spatial and temporal scales. In their review, von Jackowski outlines the wide range of ocean observing platforms and activities contributing to global frameworks and collaborative networks developed by the ocean observing community. While these initiatives promote standardized data collection and adherence to FAIR data principles (Wilkinson et al., 2016), they also face challenges related to data synthesis and the effective involvement of all ocean actors. By enhancing transparency and inclusion across all structures, von Jackowski expects broader engagement and the removal of barriers, particularly for early career ocean professionals, playing a pivotal role in advancing the goals of the UN Ocean Decade. While the collection and availability of data is progressing, marine research increasingly depends on computational approaches to process and interpret big and complex datasets. In this context, Verwega et al., advocate for the establishment of "Marine Data Science" as an independent discipline that merges computational techniques with domain-specific marine expertise. Their perspective article highlights the need for structured training programs to equip researchers with the skills necessary to effectively analyze large, heterogeneous datasets and to apply machine learning and statistical methods to address marine science challenges. One example of such an application of machine learning is given by Oldenburg et al., who introduce "DeepLOKI", an AI-based system for identifying zooplankton taxa from high-resolution images. By employing Deep Transfer Learning with a Convolution Neural Network Backbone, DeepLOKI significantly improves classification accuracy of taxonomic groups as well as developmental stages. This deep-learning approach exemplifies how automation can enhance marine ecological assessments by reducing manual workloads and improving taxonomic precision. Similarly, digitization and standardization of biodiversity data are also central to the perspective article by Chernikhova and Basran. Using two case studies, the authors discuss the potential of biorepositories, or biobanking, in the Arctic, where, inter alia, rapid environmental change and limited resampling opportunities pose challenges for long-term biodiversity assessments. They understand biobanking as a cooperative research strategy in need of international investments to safeguard and manage the Arctic biodiversity heritage. In addition to monitoring and data science applications, technological advancements are also driving new approaches to

ocean-based renewable energy generation. In their technology and code article, Günzel et al. present the "Current Kite", a tethered undersea kite designed to harvest energy from low-velocity ocean currents. While full-scale testing was impeded during the COVID-19 pandemic, such prototypes and innovations underscore the potential of marine environments as a reliable and sustainable source of renewable energy. Altogether, the studies of this section illustrate how the intersection of technology and data science is opening new frontiers for facilitating marine research and conservation. However, realizing the full potential of these advancements will require sustained investment in infrastructure, the development of standardized methodologies, and interdisciplinary training. Equipping the next generation of marine scientists with the necessary tools and skills will be essential for navigating this rapidly evolving field.

Author contributions

SJ: Writing – original draft, Writing – review & editing. LR: Writing – review & editing, Writing – original draft. CM: Writing – review & editing, Writing – original draft. YS: Writing – original draft, Writing – review & editing. LH: Writing – review & editing, Writing – original draft. VL: Writing – review & editing, Writing – original draft.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

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References

Claudet, J., Bopp, L., Cheung, W. W. L., Devillers, R., Escobar-Briones., E., Haugan, P., et al. (2019). A roadmap for using the UN decade of ocean science for sustainable development in support of science, policy, and action. *One Earth* 2, 34–42. doi: 10.1016/j.oneear.2019.10.012

Devillers, R., Lemieux, C., Gray, P., and Claudet, J. (2019). Canada's uncharted conservation approach. *Science* 364, 1243. doi: 10.1126/science.aax9060

Franke, A., Peters, K., Hinkel, J., Hornidge, A.-K., Schlüter, A., Zielinski, O., et al. (2022). Making the UN Ocean Decade work? The potential for, and challenges of, transdisciplinary research and real-world laboratories for building towards ocean solutions. *People Nat.* 5, 21–33. doi: 10.1002/pan3.10412

Gunderson, A. R., Armstrong, E. J., and Stillman, J. H. (2016). Multiple stressors in a changing world: the need for an improved perspective on physiological responses to the dynamic marine environment. *Ann. Rev. Mar. Sci.* 8, 357–378. doi: 10.1146/annurev-marine-122414-033953

Kim, S.-K. (2017). *Marine OMICS: principles and applications* (Boca Raton: CRC Press), 744 p.

Lotze, H. K. (2021). Marine biodiversity conservation. *Curr. Biol.* 31, PR1190–PR1195. doi: 10.1016/j.cub.2021.06.084

Rey, F., Melo, T., Lopes, D., Couto, D., Marques, F., and Rosário Domingues, M. (2022). Applications of lipidomics in marine organisms: progress, challenges and future perspectives. *Mol. Omics* 18, 357–386. doi: 10.1039/D2MO00012A

Trenkel, V. M., Vaz, S., Alboury, C., Brind'Amour, A., Duhamel, E., Laffargue, P., et al. (2019). We can reduce the impact of scientific trawling on marine ecosystems. *Mar. Ecol. Prog. Ser.* 609, 277–282. doi: 10.3354/meps12834

Wernberg, T., Smale, D. A., and Thomsen, M. S. (2012). A decade of climate change experiments on marine organisms: procedures, patterns and problems. *Glob. Change Biol.* 18, 1491–1498. doi: 10.1111/j.1365-2486.2012.02656.x

Wilkinson, M. D., Dumontier, M., Aalbersberg, I. J., Appleton, G., Axton, M., Baak, A., et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Sci. Data* 3, 160018. doi: 10.1038/sdata.2016.18

Yamada, R., Okada, D., Wang, J., Basak, T., and Koyama, S. (2021). Interpretation of omics data analyses. *J. Hum. Genet.* 66, 93–102. doi: 10.1038/s10038-020-0763-5