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Global priorities for ocean sustainability from Early Career Ocean Professionals

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Abstract

Intergenerational diversity is central to achieving long-term ocean sustainability. As such, one of the main goals and challenges in the UN Decade of Ocean Science for Sustainable Development (2021–2030) is fostering engagement and leadership across career stages and from diverse sectors. To understand the knowledge and professional development needs of the next generation, we surveyed the perspectives of 1344 Early Career Ocean Professionals (ECOPs) across 108 countries and territories. We assess the survey results, reflect on what has been done to address these needs halfway through the Ocean Decade, and suggest areas to further progress. We found that climate change and its social and ecological impacts are the unifying topical priority for ECOPs globally. ECOPs called for support and access to professional development. Despite progress in many initiatives, enhanced opportunities for collaboration across disciplines and sectors, mentorship and professional development, knowledge and resource-sharing across regions, inclusion in decision-making and policy processes, and support for socially impactful and applied research require further attention. In addition, the survey responses indicated that access to funding, infrastructure, and ocean science tools was not equitably distributed globally, with the need to prioritize the ECOPs in the Global South and island nations and states. The results from this global survey serve as a foundational step to reflect upon and continue to co-design and deliver a collective vision for ocean sustainability involving the next generation of ocean leaders throughout the second half of the UN Decade of Ocean Science for Sustainable Development and beyond.

Keywords: ocean sustainability; intergenerational diversity; early career ocean professionals; ocean decade; SDG 14; professional development; knowledge exchange

Addressing global ocean sustainability requires international and intergenerational cooperation

Globalization has enhanced the interconnected nature of many challenges facing humanity. Issues stemming from rapid industrialization and the establishment of complex global supply chains, such as climate change, environmental degradation, public health crises, and economic disparities derived from resource access and benefit sharing, often transcend national borders. This is especially true for the distant ocean, which lies outside national jurisdictions, but is under increasing anthropogenic pressure from resource exploitation and climate change (Jouffray et al. 2020, Virdin et al. 2021). Therefore, it is essential for countries and in-

ternational organizations to work together in a coordinated and sustained manner to address ocean challenges effectively (Polejack 2021). One platform for international coordination is the United Nations (UN), which serves as a forum for member states to discuss and collaborate on various global issues and to foster more sustainable development worldwide. The UN Decade of Ocean Science for Sustainable Development 2021–2030 (hereafter the Ocean Decade) is a global effort to generate the necessary knowledge to reverse the cycle of decline in ocean health and to build toward a more sustainable and equitable relationship between the ocean and society (Ryabinin et al. 2019). In producing the knowledge to understand and respond to sustainability challenges that contribute to solving these long-standing societal prob-

lems, this initiative seeks to honor regional contexts and engage a diversity of perspectives, including multiple disciplines, types of knowledge, geographies, generations, and career stages.

Intergenerational engagement and knowledge sharing are essential to the success of any initiative working toward ocean sustainability (Kaplan *et al.* 2017). This requires actively including those early in their career, herein referred to as Early Career Ocean Professionals (ECOPs). ECOPs are individuals working toward sustainability in ocean and marine-related sectors, among other objectives, who identify as being early in their career (Satterthwaite *et al.* 2022) and, more specifically, within 10 years of completing their last professional degree (ECOP Programme). Ocean professionals include a diversity of career paths such as researchers, engineers, resource managers, practitioners, program managers, mariners and marine industry representatives, artists, educators, students, and volunteers.

Engaging ECOPs in international sustainability initiatives, such as the Ocean Decade, is important for several reasons. First, it takes time to learn how multilateral processes work and to build meaningful interpersonal professional relationships. ECOP engagement is especially important in bridging generational gaps and when developing connections across disciplines, sectors, and cultures, all of which are important to developing effective and sustainable solutions across regions. Furthermore, the sustainability of organizations relies on retaining institutional knowledge over time, which requires sharing knowledge between people at different career stages, as younger professionals benefit from being at the forefront of new knowledge and methodologies. Involving early career professionals from the beginning of processes and projects allows for shared development and ownership over time. Finally, holders of diverse perspectives may be able to think more creatively and be less constrained by traditional norms and paradigms, some of which hold us back from transformative change. This characteristic provides valuable sources of innovation and helps to both renew and regenerate organizations (Brasier *et al.* 2020, Kent *et al.* 2022, Satterthwaite *et al.* 2022, Mitrano *et al.* 2023). This visionary thinking, coupled with the experience and insight from those in later career stages, can help us to move from the status quo to the transformations needed to achieve long-term sustainability. Thus, integrating early career professionals into strategic sustainability initiatives serves as a valuable approach to addressing intergenerational differences in perspectives, skills, and insights.

Understanding the priorities and needs of ECOPs globally

The increasing connectedness of the world has led to an increase in collaborative science and sustainability programs (Bettencourt and Kaur 2011). Increasingly, those in the early stages of their careers are faced with a dynamically evolving global landscape marked by novel challenges, methodologies, and cultural dynamics (Bandichhor *et al.* 2023). Global coordination that acts towards a shared vision for ocean sustainability is needed. This vision must be inclusive of the next generation of ocean leaders by providing platforms for knowledge sharing and the involvement of ECOPs in decision-making processes (Satterthwaite *et al.* 2022).

Involving ECOPs in integrated, international processes introduces diverse regional perspectives while enabling them to

learn, build trust, establish connections, and foster deeper collaborations that can benefit their careers over the long term. For example, during the first Global Planning Meeting of the Ocean Decade in May of 2019, it became clear that to ensure the success and continuity of the Ocean Decade, ECOPs would need to be engaged from the start. The establishment of the IOC Informal Working Group of ECOPs for the preparation for the Ocean Decade marked the initial phase of the efforts to engage ECOPs in the Ocean Decade and enhance intergenerational diversity and knowledge sharing, which eventually evolved into the Early Career Ocean Professionals Network Programme (ECOP Programme; Kostianai *et al.* 2022) and numerous and growing efforts to engage early career professionals in the Ocean Decade.

Although there have been numerous assessments of the challenges faced by and perspectives of early career researchers working within marine and sustainability disciplines (Mofokeng *et al.* 2023; Brasier *et al.* 2020, Duke *et al.* 2023, Mitrano *et al.* 2023), there has been little work that captures the full spectrum of ECOP voices across disciplines, sectors, and nations relevant to ocean sustainability. Additionally, there has not been a documented reflection on how identified priorities and needs have been addressed throughout the first half of the Ocean Decade.

Here, we provide a summary of the results from a survey assessing the perspectives of ECOPs globally (Ortuño Crespo *et al.* 2024). Our paper expands on Ortuño Crespo *et al.* (2024) report to highlight key findings and offer additional context for current efforts and future priorities. The survey results identify key priorities for (1) scientific knowledge, action, and solutions in ocean science and sustainability and (2) professional development, with a specific emphasis on early career professionals, to promote comprehensive and sustainable ocean management. Additionally, we reflect upon these results to assess progress throughout the first half of the Ocean Decade and explore priority needs moving forward. We hope that this study serves as a foundational step for co-designing a collective vision for international ocean sustainability that focuses on capacity building and sharing, with a path forward through and beyond the Ocean Decade.

A diverse pool of respondents revealed key priorities and needs

The IOC Informal Working Group of ECOPs conducted a global survey from 2019 to 2020, across marine regions and seas, to assess the priorities and needs of ECOPs worldwide. A detailed description of the survey, including methods and results, has been published as an ECOP report (Ortuño Crespo *et al.* 2024). The survey garnered responses from a substantial and diverse pool of participants (Ortuño Crespo *et al.* 2024). In total, 1344 individuals with an average age of 32 from 108 countries and territories across all inhabited continents responded to the survey, demonstrating a widespread and international reach even prior to the official start of the Ocean Decade. The survey achieved a fairly equal gender distribution (41% identifying as male, 57% as female, and the remaining 2% choosing not to disclose) and encompassed individuals working across all ocean basins and within various disciplines and sectors within the ocean science and sustainability fields (Ortuño Crespo *et al.* 2024). For example, the top disciplines represented included biology, earth sciences, engi-

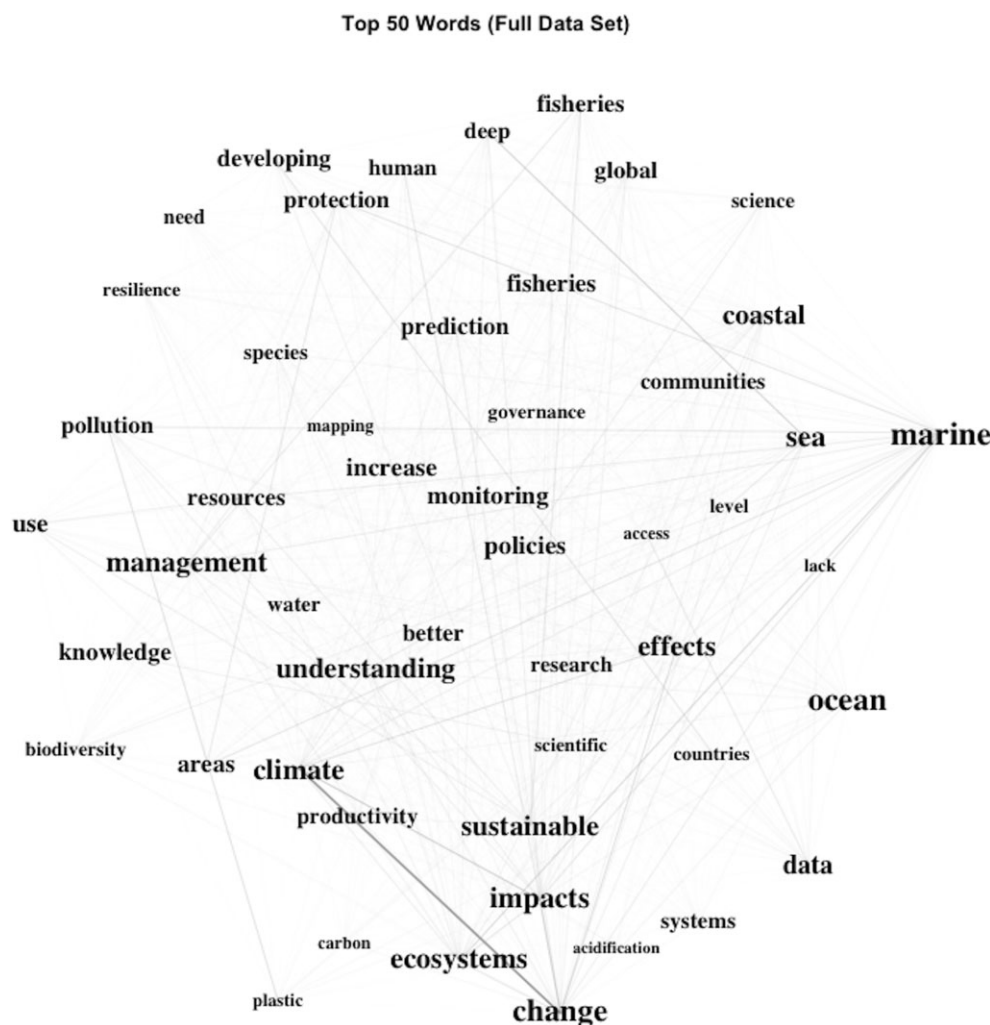


Figure 1. The top 50 most commonly used unigrams globally in response to the question on scientific knowledge gaps. Words co-occurring within a 3-word window in the written responses are connected with a line. Line thickness corresponds to the frequency of co-occurrence. The highest scientific priority was a deeper understanding of the impacts of climate change on marine ecosystems, including impacts on coastal communities. For complete semantic network analysis methods, see Ortuño Crespo et al. (2024).

neering, data, technology, social science, policy, governance, geography, and communications.

(1) Global consensus among ECOPs on urgent research priorities for climate change impacts on marine ecosystems and coastal communities

The survey revealed that climate change was a global priority for ECOPs, suggesting a shared focus on advancing our understanding of and addressing the impacts of climate change on marine ecosystems and coastal communities (Fig. 1). This emphasis encompasses diverse aspects, such as the role of the ocean in climate change, the effects of climate change on weather patterns, extreme events, ocean hazards, circulation, and the health and distribution of biodiversity. These topics align with and extend existing research priorities and substantiate the urgency and significance attributed to these research areas (Malhi et al. 2020, Raymond et al. 2020, Timmermans and Marshall 2020). The multidisciplinary nature of these research fields calls for facilitated interdisciplinary and transdisciplinary collaboration (Friedman et al. 2021).

Specific aspects emphasized by respondents were the repercussions of climate change on fisheries and aquaculture, as

well as the broader implications for the sustainable blue economy. Furthermore, the impacts of climate change on the deep sea and polar regions could have severe consequences for marine biodiversity, which already faces significant pressures and stressors (Brito-Morales et al. 2020). Notably, these outcomes align with the findings of Raatikainen et al. (2021), emphasizing the importance of a shared and multidimensional understanding of the diversity and prioritization of conservation objectives to counteract climate change and biodiversity loss.

While these priorities were shared across regions, regional differences emerged in other high-priority sustainability and research themes. These region-specific priorities include human impacts on biodiversity and deep-sea ecosystems, the development and implementation of marine protected areas, marine pollution, fisheries management, ecosystem-based approaches, marine ecosystem services, equity considerations, governance structures, coral habitat resilience, or the impact of melting ice caps and sea level rise. The geographic scale of action for many of these themes varied.

(2) Supporting professional opportunities to exchange and share knowledge is a priority

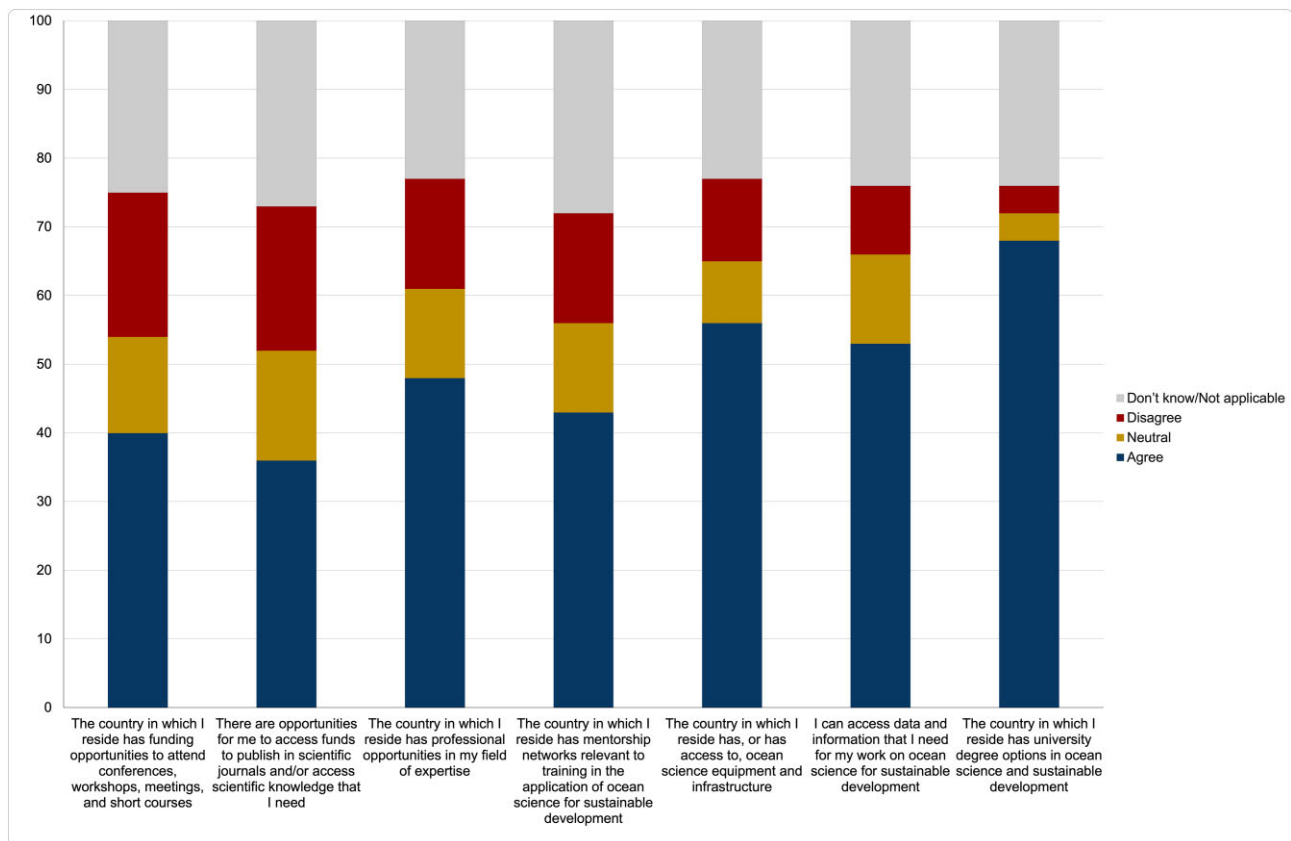


Figure 2. Stacked bar plot of responses ($n = 1344$) for capacity development questions indicating agreement, neutral, disagreement, or no answer/do not know to each statement. The statements are ordered from left to right according to the highest percentage of respondents who disagreed with the given statements.

Access to higher education degrees in ocean science and sustainable development was of the least concern (Fig. 2). This suggests that ocean education is relatively well integrated globally. Conversely, the subsequent support of professional opportunities to exchange and share knowledge was identified as the capacity development action with the strongest need for ECOPs globally. Specifically, this included support to attend conferences, workshops, meetings, and short courses; funding for publishing and accessing knowledge; and access to mentorship networks (Fig. 2).

Sharing knowledge through informal and formal networks, mentorship and support from peers and colleagues, and interdisciplinary training and opportunities are important enablers in fostering intergenerational diversity and knowledge sharing (Satterthwaite *et al.* 2022; Shellock *et al.* 2023). Establishing a support network, having a good supervisor/supervisory team, and finding inspirational professional role models are important for cross-disciplinary work (Mitrano *et al.* 2023; Shellock *et al.* 2023). To this end, needs for the ECOP community include bringing together early career professionals in order to enable mutual/peer-to-peer learning; finding mentors with experience in inter and transdisciplinarity and knowledge co-production; and connecting professionals across sectors through fora such as international meetings, conferences, workshops, and professional societies (Jaeger-Erben *et al.* 2018).

Additionally, supporting training and acquisition of practical experience related to knowledge co-design and participatory research with societal stakeholders (Jaeger-Erben *et al.* 2018, Satterthwaite *et al.* 2022); methodological training in social science, inter and transdisciplinarity (Jaeger-Erben *et al.* 2018, Schrot *et al.* 2020); national and multinational policies and agreements (Wang *et al.* 2022); soft skills (e.g. moderation, science communication, and conflict-resolution) (Jaeger-Erben *et al.* 2018), learning about research philosophy positionality and reflexivity (Shellock *et al.* 2023), and learning from best-practice cases (Jaeger-Erben *et al.* 2018) have been highlighted as key for early career professionals in sustainability science.

Opportunities to engage across the science-to-society interface, including connecting science with both policy and local communities are essential to ECOP career development (Giron-Nava and Harriet-Davies 2022, Satterthwaite *et al.* 2022). Cross-boundary engagement mechanisms could include offering opportunities for ECOPs to become involved in multilateral negotiations via joining national delegations or observer groups (Wang *et al.* 2022) and holding leadership roles or seats on governance bodies within domestic or international organizations and initiatives. Additionally, ECOPs could contribute through calls for evidence, experts, submissions, and peer review for international organizations, programs, conventions, and international agreements (Wang *et al.* 2022). Finally, pursuing an ocean-related degree also has the

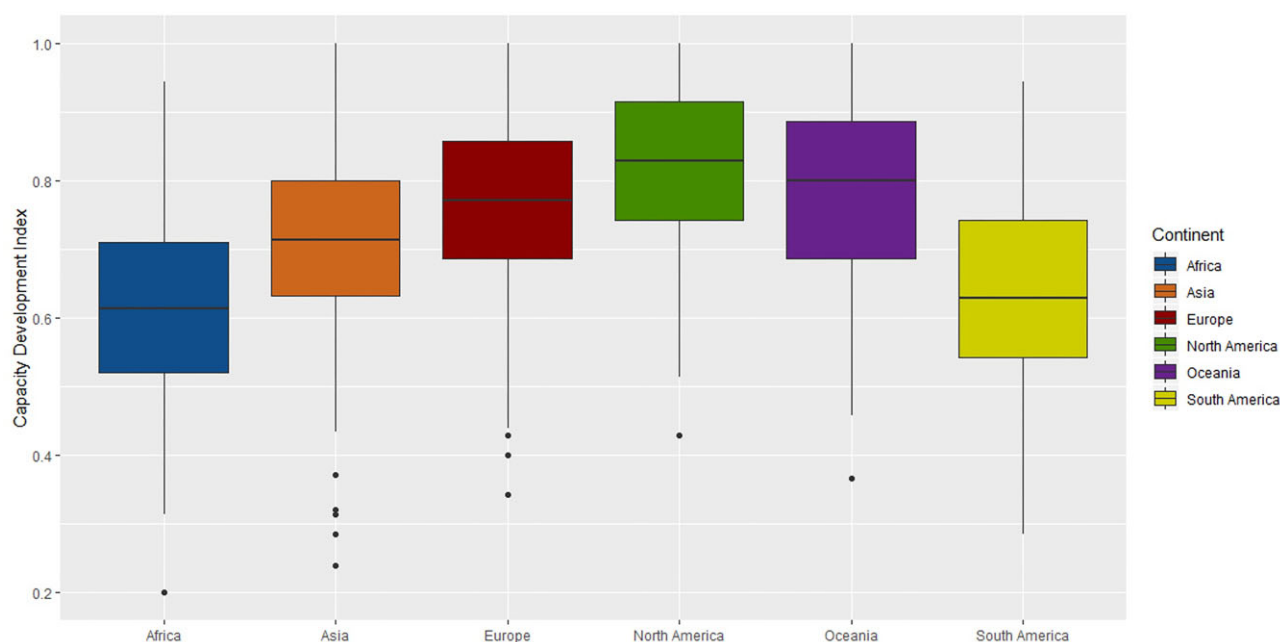


Figure 3. Box and whisker plot displaying the mean, variance, and outliers of the capacity development index (CDI) per continent. A lower CDI suggests that respondents indicated the need for more professional development opportunities. For complete CDI methods, see Ortuño Crespo et al. (2024).

potential to expand professional opportunities by equipping graduates with versatile and relevant skills that span across sectors.

(3) Urgent need for knowledge and capacity sharing across countries, especially for the Global South and island nations and states

Respondents from North America and Oceania had the highest average capacity development index (CDI) scores across all seven capacity development challenges, while Africa and South America scored the lowest (Fig. 3). Respondents from regions with higher CDIs indicated that they have adequate infrastructure, courses, and resources for their science, whereas those from lower CDIs indicated this less. Thus, there is a need to support and share knowledge and resources from regions across high and low CDI nations. The largest disparity between regions pertained to access to ocean science equipment and infrastructure (Ortuño Crespo et al. 2024). Beyond international collaborations, ECOPs from these regions need financial and infrastructure support to ensure they can access the tools needed to produce science and other ocean-related works (e.g. community programs, artistic works, and local government reports). Ocean professionals from the Global South have expressed a need to ensure workloads on shared international projects are fair, that equal recognition of work is given to partners in the Global South, and that collaborations provide opportunity and increase capacity of local ECOPs (Ocampo-Ariza et al. 2023; de Vos 2022).

Reflections on the results and impact of the survey

Understanding and addressing climate change and its social and ecological impacts was identified as a key priority for ECOPs globally. ECOPs also called for increased professional development, mentorship, and networking opportunities, while highlighting the unequal access to funding, infras-

tructure, and ocean science tools, particularly for the ECOPs in the Global South and island nations/states. Researchers and practitioners around the globe have increasingly been working on efforts related to these topics and the Ocean Decade has been one way to align these efforts under a shared vision (Ryabinin et al. 2019). For example, of the 605 Decade Actions, 24% of Ocean Decade Actions were focused on addressing both climate change and capacity/early career development, 24% were focused on addressing climate change (but not capacity development), and 26% were focused on capacity/early career development (but not climate change), with the rest (26%) focused on other topics (Fig. 4; for Decade Action assessment methods, see Appendix 1). We briefly showcase some ways that the key topics of climate change, professional opportunities, and knowledge and capacity sharing have been addressed by the international community and within the Ocean Decade.

(1) Addressing climate change through research, action, and stewardship

We found that climate change and its social and ecological impacts are the unifying topical priority for ECOPs globally. This emphasis is logical because ECOPs, youth, and future generations will be the most affected by the impacts of climate change. Since the launch of the survey, the international community has continued to advance international processes and landmark agreements that address the priority areas identified by ECOPs. For example, the Kunming-Montreal Global Biodiversity Framework has incorporated climate change and biodiversity dimensions. Additionally, many Ocean Decade Actions focus on “unlocking ocean-based solutions to climate change” (Challenge 5), such as better understanding how the ocean and climate interact, finding ways to address climate change effects around the globe, and improving forecasting for ocean, climate, and weather services (Intergovernmental Oceanographic Commission 2023, Fig. 4).

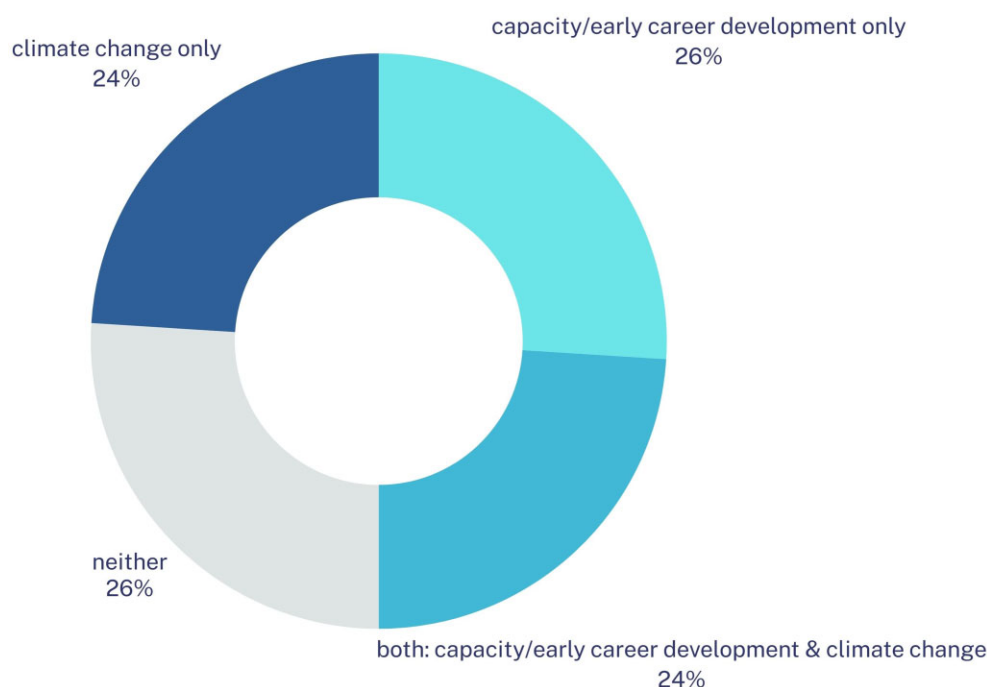


Figure 4. Pie chart displaying the percentage of Ocean Decade Actions (as of September 2024) focused on both capacity/early career development and climate change (142), capacity/early career development only (158), climate change only (145), and neither (160). Methods for the analysis of Decade Actions are included in Appendix 1.

To support the vision of addressing climate change, bridging inequities along with intergenerational and international collaboration are central priorities (Kent *et al.* 2022, Satterthwaite *et al.* 2022). For example, the Sustainability of Marine Ecosystems through Global Knowledge Networks (SMART-NET) program, is an exemplary program emphasizing mutual research interests such as climate change, fisheries and ecosystem-based management, and social and ecological dynamics, and prioritizes cross-cutting inclusivity themes including gender equality, early career engagement, and involvement of Indigenous Peoples and local communities and developing nations in joint activities (Bograd *et al.* 2021).

(2) *Professional opportunities to exchange and share knowledge through the ECOP Programme*

ECOPs called for support and access to professional development, including networking, mentorship, training, and professional opportunities. A direct outcome of this survey was the development of the ECOP Network Programme, which became an endorsed Ocean Decade program in 2021 (Kostianaia 2022). A significant portion of the ECOP Network Programme's structure, activities, and decisions were shaped by the global survey results. For example, the initial task teams were strategically crafted to align with the expressed needs of ECOPs. The task teams support many of the activities of the ECOP Programme and initially included training and mentoring; diversity, equity, and inclusivity; OceanBRIDGES [Bridges (Ocean) Research, Innovation, and Diversity across Generations of Experts and Stakeholders]; and ocean literacy. Some recent efforts include the development of webinar series and training courses around ocean governance, careers, marine spatial planning, ocean leadership/stewardship, and data science; leading workshops and networking events; and giving talks at international conferences. The direction taken by

the ECOP Network Programme following the global survey has demonstrated its commitment to listen to the voices of the ECOP community and continue to grow to meet evolving needs. The success of this program can be measured by the establishment of over 40 regional and national nodes representing ECOP interests across the globe.

Additionally, ECOPs are becoming more involved in influential international roles, as evidenced by their participation in governing bodies, working groups, panels, expert groups, and training sessions. This trend is highlighted in the Ocean Decade's activities and processes. For example, endorsed Ocean Decade programs and contributions have dedicated ECOP liaisons, and thousands of ECOPs are directly engaged in Decade Actions (Intergovernmental Oceanographic Commission 2023). ECOPs have played other pivotal roles, such as serving on expert working groups (e.g. Vision 2030 process) and speaking and leading sessions at UN conferences (e.g. 2022 UN Ocean Conference and 2024 UN Ocean Decade Conference). This marks a significant evolution from the initial Ocean Decade Global Planning Meeting in early 2019, where ECOP participation was minimal. Their growing presence underscores the importance of intergenerational collaboration and the need for strategic investments in the new and coming generations of ocean professionals (Kelly *et al.* 2022).

(3) *Knowledge and capacity sharing across countries and regions through ECOP nodes*

ECOPs indicated that access to funding, infrastructure, and ocean science tools is not globally equal, with survey results highlighting a priority need for ECOPs in the Global South and island nations/states. Thus, it is imperative that intergenerational and international knowledge and capacity sharing are a part of global sustainability efforts such as the Ocean Decade. Indeed, these topics have been actively ad-

addressed through various Ocean Decade initiatives. For example, the Ocean Decade Capacity Development Facility was established to identify and address the capacity development needs of partners involved in Ocean Decade Actions. This includes connecting experts worldwide to foster engagement and strengthen support for ECOPs, as well as for Small Island Developing States and Least Developed Countries. Additionally, the development of regional and national ECOP nodes was initiated to continue to understand and address localized needs and provide pathways for knowledge and capacity sharing across regions of the world. This was complemented by the initiation of regional and national surveys, spanning diverse geographical regions across North America, Latin and Central America, Asia, Africa, and Europe. These regional surveys have helped to inform strategies for the nodes and the ECOP Programme as a whole, helping to address regional differences while aligning with international priorities.

Building on the foundation laid by this survey and envisioning the future

The global survey (Ortuño Crespo et al. 2024) and high-level findings represent essential baseline information to assess the success of the Ocean Decade and another survey could be conducted to monitor the success of the Ocean Decade in addressing the needs of ECOPs and, importantly, to assess whether the perspectives of ECOPs have changed in the process. Other efforts have continued to expand upon this work in a more regionalized context, across sectors and local communities, and with a diversity of career stages. Additionally, the approach and outputs of this study provide a benchmark for identifying the priorities of the current generation of ECOPs and allow for progress to be tracked across regions and over time.

While the Ocean Decade Actions provide an important anchor for research, it is important to acknowledge that the Ocean Decade Actions do not exclusively pertain to research activities. Many non-academic, ECOP-led activities may not be captured through scientific publications, though the evidence exists in various sources of gray literature. For example, of the formal Ocean Decade Actions listed, many help to connect knowledge to action and include social (e.g. ECOP Programme and Global Ecosystem for Ocean Solutions) and technological solutions to ocean challenges (e.g. The Ocean Cleanup), resource-sharing platforms (e.g. Ocean Image Bank), ecosystem restoration programs (e.g. Coral Farmers), observation and monitoring programs (e.g. Ocean Observing Co-design and OBON), and cultural and educational programs (e.g. Cultural Heritage Framework Programme). It is therefore important that support networks for ECOPs and funding pathways remain as diverse as the ECOPs they choose to support.

To support the integration of new knowledge into sustainable practices, it is crucial to provide the knowledge of and access to professional development opportunities such as international networking, mentorship, training, and career advancements across diverse disciplines. Enhancing connections between ECOPs and both domestic and international stakeholders, encouraging their involvement in leadership and decision-making, and ensuring equitable financial recognition are vital for advancing this collective vision and promoting intergenerational knowledge exchange (Brasier et al. 2020). For example, this could include enabling ECOPs to take on leadership and principal investigator roles, enabling their represen-

tation in committees and international initiatives, and amending organizational bylaws to guarantee their participation.

The unequal access to funding, infrastructure, and ocean science equipment, especially for ECOPs in the Global South and island nations/states, highlights an urgent need for the investment in knowledge and capacity sharing and development (Van Stavel et al. 2021). This could include increased knowledge of and access to funding and equipment, small grant programs for innovative applied research, and the inclusion of underrepresented countries and communities in domestic and international committees (Graham et al. 2022). For example, developing a comprehensive database of available opportunities, such as from existing regional databases of opportunities, could help to increase awareness of the existing opportunities globally.

A diversity of voices will be the key to navigating global, regional, and national-scale ocean issues during and after the implementation of the Ocean Decade. ECOPs surveyed at the start of the Ocean Decade have demonstrated their international engagement and highlighted regional needs for increasing their contributions to ocean sustainability. With continued global support, ECOPs around the world can lead us toward a sustainable relationship with the ocean and thus a vibrant and desirable future.

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Author contributions

All authors contributed to the writing, review, and editing of drafts and approved the final version of the manuscript. E.V.S., M.J.R., and G.O.C. contributed to the analysis and visualization of results.

Supplementary data

Supplementary data is available at *ICES Journal of Marine Science* online.

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Data availability

No new data were generated in support of this research. The ECOP Programme Global Survey Report (Ortuño Crespo *et al.* 2024) is available at <https://doi.org/10.5281/zenodo.14426782> with the supporting survey data available at <https://doi.org/10.5281/zenodo.14426594> (Satterthwaite *et al.* 2024). The data used to analyze the Ocean Decade Actions were accessed in September 2024 and available online from the Ocean Expert database at <https://oceanexpert.org/document/29188>.

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