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ECOP
Early Career Ocean Professionals

ECOP Programme Global survey report

One Ocean, One Voice: A global early career perspective on the priorities for the UN Ocean Decade

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One Ocean, One Voice: A global early career perspective on the priorities for the UN Ocean Decade

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Abstract

Intergenerational diversity is central to achieving sustainability goals. As such, one of the main challenges faced by the UN Decade of Ocean Science for Sustainable Development (2021-2030) is bridging the generation of Early Career Ocean Professionals (ECOPs) and the community of senior researchers and decision-makers currently at the helm of ocean sustainability. In this study we draw on the perspectives of 1,344 ECOPs across 108 nations to delineate the perceived research and capacity development priorities for the Ocean Decade, and barriers to ECOP engagement and capacity development. Results across geographic and professional areas show how research on climate change and its social and ecological impacts stands as the unifying research priority for the ECOPs surveyed. In addition, the heterogeneity of subsequent research priorities across regions reflected unique challenges and priorities in the way Ocean Outcomes were ranked. Increasing funding and training opportunities for inter- and trans-disciplinary research and the integration of ECOPs into decision-making spaces were identified as important priorities for a successful and intergenerationally integrated Ocean Decade. By creating and maintaining a representative intergenerational community of practice, the Ocean Decade can ensure the continuous evolution of priorities throughout the decade, ensuring a continuous inflow of ideas and perspectives, as well as the strategic integration of emerging ocean leaders beyond 2030.

1. Introduction

Homo sapiens has been an integral part of coastal and marine ecosystems for millennia (Fujita et al., 2016). Our species is rapidly venturing further and deeper into the ocean, on which it is becoming more dependent on space and resources (Jouffray et al., 2020; SOFIA, 2020). Unsustainable extractive practices (Levin et al., 2016), widespread pollution (Willis et al., 2021), and the growing impacts of climate change on ocean biochemistry (Rockström et al., 2009) are just some of the cumulative stressors which are progressively undermining the resilience of the global ocean. By disrupting the structure, functionality and phenology of biological and ecological processes, we are compromising the ocean's ability to simultaneously provide food for billions (SOFIA, 2020) and the critical function of regulating Earth's climate (Hoegh-Guldberg and Bruno, 2010; IPCC, 2019); these are fundamental services for human existence, especially given the predicted climate change trajectory and current growth rate of a human population with an increasing appetite for seafood (Béné et al., 2015; SOFIA, 2020). Yet, the journey towards ocean sustainability and resilience is subject to unique complexities derived from the scale, dynamism and interconnectedness of marine socio-ecological systems, as well as the widespread knowledge deficiencies on ocean processes which limit our ability to explain and predict the propagation of anthropogenic impacts. Furthermore, turning the tide on some of the most pressing challenges faced by the ocean, which include marine biodiversity loss (Eddy et al., 2021; Johnson and Watson, 2021), habitat deterioration (Lebreton and Andrady 2019) and climate change impacts (Hoegh-Guldberg and Bruno, 2010; Gissi et al., 2021), will require a concerted effort across generations of ocean practitioners, as many of our target-based efforts as many of these challenges stretch across multiple decades. The commitment to global time-bound sustainability targets is not a new approach in international diplomacy. Regrettably,

the international community has failed to meet the majority of goals and targets focused on ocean health and sustainability over the past two decades (Xu et al., 2021). The importance of including early career professionals in the planning and implementation of these processes and the potential barriers along the way cannot be overstated (Evans and Cvitanovic, 2018; Figurerola et al., 2021; Kelly et al., 2021).

In 2015, the 2030 Agenda for Sustainable Development set a historical precedent by dedicating one of the 17 goals to the ocean, SDG 14: *Life Below Water*. One of the essential elements needed to meet the 7 targets of SDG 14 and the broader ocean sustainability agenda is an up-to-date, representative body of actionable knowledge capable of guiding decision makers to successfully achieving SDG 14.

The UN Decade of Ocean Science for Sustainable Development (2021-2030), hereafter referred to as the Ocean Decade, is intended to provide actionable knowledge structured around 7 Ocean Societal Outcomes ('Ocean Outcomes') and 10 Ocean Challenges (Table S1) (https://www.oceandecade.org/). Ensuring that the most pressing knowledge gaps and capacity development roadblocks are identified and addressed is paramount to the success of the Ocean Decade; making the question of *who* decides what these are, a critical one. Given the duration and scope of the Ocean Decade, securing an intergenerational dialogue to co-identify and prioritize challenges and opportunities is key.

Ensuring intergenerational integration of the next generation of ocean professionals in both the Ocean Decade and the SDG 2030 Agenda will likely prove critical for ensuring their successful implementation.

Early Career Ocean Professionals (ECOPs) are individuals self-defined as being early in their career (10 years or less of professional experience) within any field related to the ocean (not only employed/paid positions). "Professional" inclusively covers all professionals across sectors of society. As the Ocean Decade unfolds, ECOPs must secure a seat at the table within their respective professional fields and communities of practice to help chart the implementation towards, and beyond, 2030. Through the decade, ECOPs will become the next generation of ocean leaders. It is paramount that ECOPs are integrated in decision making processes as early as possible, both to gain experience in high level governance and to ensure the Ocean Decade steers towards the ocean future they envision (Brasier et al., 2020). Realising this, IOC-UNESCO has facilitated seats in strategic planning groups, scientific advisory boards and Ocean Decade endorsed programs are advised to be inclusive of ECOPs at all levels. This includes the endorsement of the ECOP Programme by IOC-UNESCO. To evaluate and pinpoint the ECOP community's priorities under the Ocean Decade, the interim ECOP Informal Working Group launched a global priority survey in 2020. Our study assimilates the perspectives of the respondents who described where they, as a multi-disciplinary generation of professionals, believe the main (1) scientific knowledge and (2) capacity building gaps and opportunities lie in the Ocean Decade. We explore these differences and synthesise the main scientific knowledge and capacity developments gaps and opportunities across geographies and water bodies worldwide.

This study identified actionable scientific knowledge and capacity development gaps and priorities as expressed and analyzed by ECOPs, thus making it readily available to

decision-makers during the initial phase of implementation of the Ocean Decade. 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 as new ECOPs emerge and the Ocean Decade works towards intergenerational equity and integration.

2. Results

Our results elucidate the perspectives and priorities of 1,344 ECOPs across 108 nations and territories. ECOP respondents averaged an age of 32 (Q1 = 28; Q3 = 36) and were predominantly female (57%). The number of responses by waterbody varied from a low of n = 9 for the high seas to a high of n = 469 for the North Atlantic Ocean (Figure 1). Response volume also varied by nation, with the United States (n = 244) and Brazil (n = 233) having the most respondents, while the trailing 40 nations and territories (hereinafter nations) had only one respondent each. At the continental level, Europe had the most respondents (n = 405), while Oceania (n = 71) had the lowest.

The majority of ECOPs (n = 917) were not members of an early career network, and this pattern was stable across continents (average membership per continent = 32%) with a high of 43% for Africa and a low of 26% for North America. Slightly higher differences were found across continents in the per capita likelihood of belonging to different professional fields (Table S2) and sectors (Table S3). The largest differences in membership across continents by sector were observed between Oceania and South America in the field of Education (28%) and between North and South America in the field of Earth Sciences (20%). These inter- regional differences in sector and field membership should be factored in when interpreting the results. Overall, respondents were primarily skewed towards academia, the natural sciences and seafood production, while other sectoral activities, such as mining or maritime transportation were underrepresented. The three most prevalent ocean fields across ECOP respondents were Biology, Earth Science and Data, while the three least prominent were Ethics, Arts, and Finance. In the context of ocean sectors, the three most prevalent responses were Academia, Fisheries, and Education, while the three least common responses were: Transportation, Philanthropy, and Finance (Table S3).

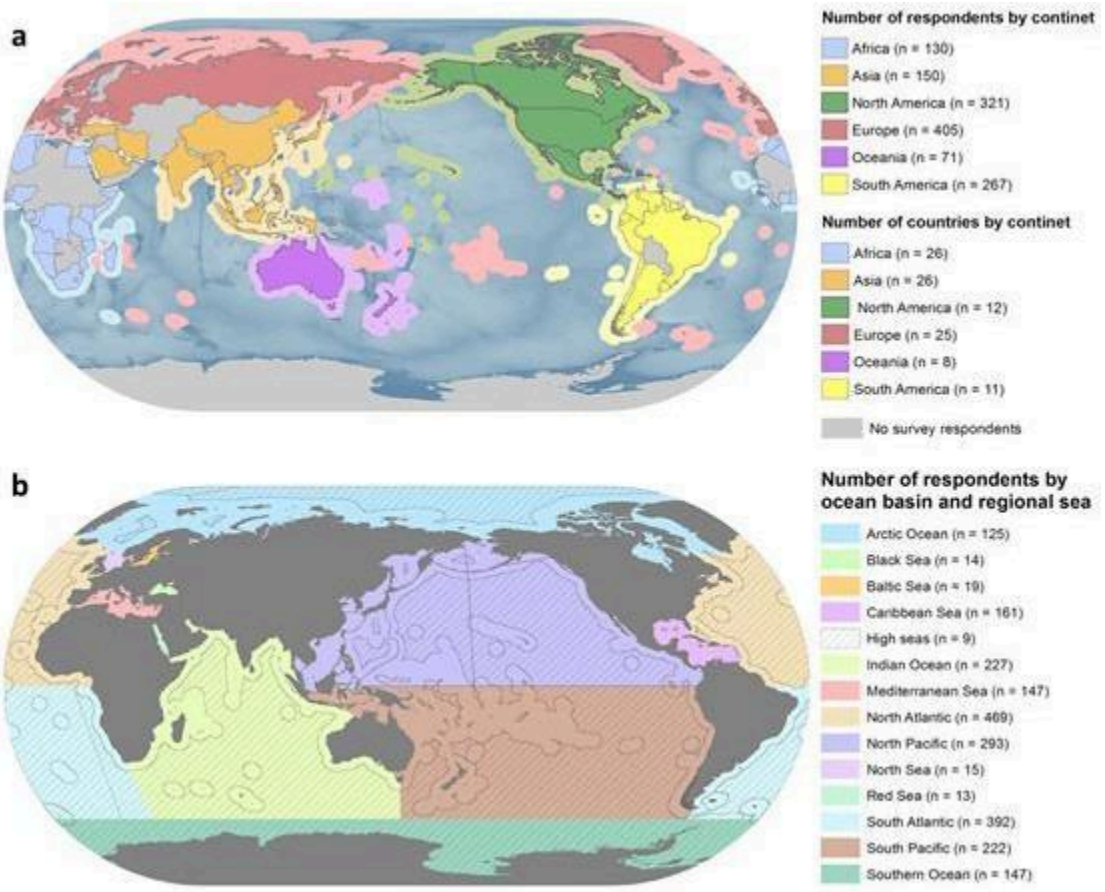

Figure 1: Distribution of ECOP responses across continents (a) and waterbody (b). Survey respondents linked their professional expertise to a UN list of all nations as well as a list of 14 waterbodies, which included all five ocean basins (split at the equator for the Atlantic and Pacific oceans), and 6 regional or enclosed seas. The European continent had the highest number of respondents of any continent, while Asia had the highest number of individual nations.

Results from the semantic analysis revealed key global research priorities (Table S4), and allowed us to untangle region-, waterbody- and Ocean Outcome- specific priorities (Figure S1; Table S5; Table S6). The impacts of climate change were the most cited priority, where the top most commonly used unigram terms used by ECOPs included, ‘marine’, ‘climate’, ‘change’, ‘impact’, ‘ecosystem’, indicating an interest to focus on climate change as a key driver of change in marine ecosystems. Similarly, ‘climate change’ was by far the most commonly used bigram (n = 209), appearing nearly four times as frequently as the next most used word pair, ‘deep-sea’ (n = 56).

Other high-priority research themes included biodiversity and human impacts on deep-sea ecosystems, the design and implementation of protected areas, marine pollution in its multiple forms, fisheries management and sustainability or research on marine ecosystem services (Figure 2; Table S3; Table S6).

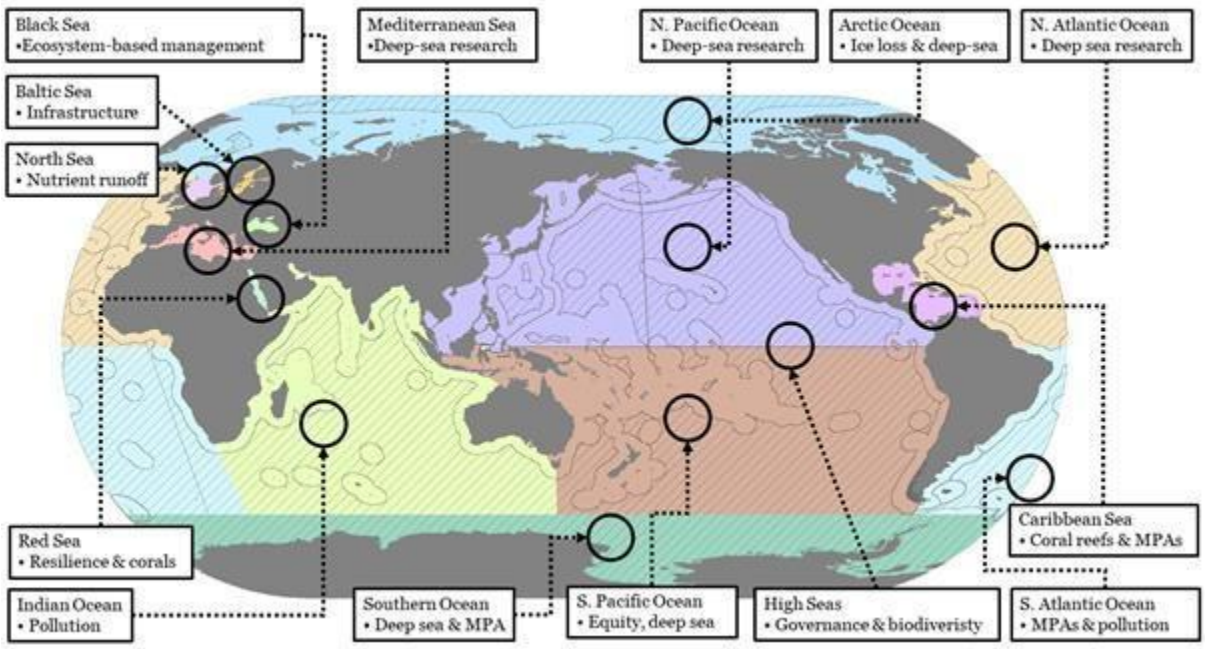

Figure 2: After climate change these are the principal research priorities across waterbodies. Emerging ocean industries, spatial protection and pollution emerged as the most common secondary priorities.

The capacity development index (CDI) score of respondents (Questions 23-29 in Table S7) were used to quantify average continental scores. Results show that, on average, North America and Oceania had the highest average CDI scores across all seven capacity development challenges, while Africa and South America scored the lowest (Figure 3; Figure S2). Importantly, while there are prominent disparities in the CDI scores across continents, the average scores per continent ranged between 0.6-0.85 (i.e. either neutral or positive). Intra-continental differences also emerged, showcasing the fractal nature of results across geographic scales and indicating that capacity development realities within a continent or a nation vary significantly.

Distilling the different capacity development needs by continent (Figure 3) allowed for the identification of unique geographic challenges. The widest CDI gap between continents across all 7 questions was found between North America and Africa and related to the access to ocean science equipment and infrastructure. While all continents scored relatively high on the question of access to data and information, they all scored lower on the question related to access to resources for publishing in scientific journals and attending conferences or training courses abroad.

Figure 3: CDI scores for the capacity development questions. CDI scores were plotted for Africa (blue), Asia (orange), Europe (red), North America (green), Oceania (purple) and South America (yellow).

Semantic analysis of capacity development needs identified by respondents include access to funding, and increasing networking and mentorship opportunities as the most prevalent themes where additional investment and attention is required to empower the next generation of ocean professionals.

3. Discussion

3.1 Identifying priorities and challenges across scales

The process of identifying ocean sustainability research and capacity development priorities needs to be simultaneously explored across multiple geographic and thematic scales. Here we provide landmark insights into the differences and similarities found on scientific priorities across scales and for different Ocean Outcomes. Our survey achieved very broad geographic and professional participation (Figure 1, Table S2, Table S3) strengthening the notion that there is a global and active community of ECOPs who are eager to guide the Ocean Decade. The survey captured responses from a wide range of sectoral and thematic backgrounds with most perspectives by ECOPs from natural science and academic backgrounds. The inclusion of ECOPs with policy and governance backgrounds are promising indications that priorities were identified through the lens of decision-making, while these were not evenly spread across ocean sectors.

At a global level, climate change impacts on ecosystems and the communities they support was the key priority for ECOPs identified through uni- and bigram including in five of the six Ocean Outcomes. This priority is unmistakably clear, especially considering the varied impact climate change has on each region and waterbody.

Conclusively, ECOPs globally see tackling anthropogenic climate change and derived stressors/impacts such as ocean deoxygenation (Laffoley and Baxter, 2019), rising sea levels (Mason et al., 2021), ocean acidification (Doney et al., 2020) or circulation changes (Caesar et al., 2018) as the priority for a better future ocean. Coral reef research was the top priority in the Red Sea, likely because coral reefs provide critical ecosystem and socio-economic functions to that basin (Kleinhaus et al., 2020; Osman et al., 2018). Importantly, climate change also ranked as the top bigram result in five of the six Ocean Outcomes, with the exception of *A Transparent and Accessible Ocean*, an outcome which is more oriented towards knowledge access and sharing.

Through a strong focus on intergenerational equity, ECOPs, can steer climate change mitigation and adaptation to the top of the agenda for the Ocean Decade in order to increase the production of actionable knowledge on predictability around the impacts of climate change on marine ecosystems and the communities which depend on them; essential aspects for adaptation planning (Payne 2016). The collective mind of the global ECOP community sits far beyond 2030.

The 'deep-sea', an emerging frontier for ocean sciences, was the second most commonly mentioned bigram area of research at the global level (Table S4). In particular, respondents focused on the impacts of deep-sea mining (impacts-deep-sea, deep-sea-mining); resonating with challenges identified in the scientific community (Ribeiro et al., 2020; Jones et al., 2019). Deep-sea research was within the top-two bigram terms for every ocean basin except for the South Atlantic and Indian basins (Table S6). Since the time that the survey was conducted, the Pacific nation of Nauru triggered the so-called "two-year rule", which forces the International Seabed Authority to finalize regulations governing deep-sea mining, so that extractive operations can commence; this significantly shortens the time that the UN Ocean Decade has to contribute additional knowledge in this space.

Coral reefs were the top research priority in the Red and Caribbean seas (Figure 2; Table S6). Corals in the deep-sea and nearshore provide important ecosystem services and are highly susceptible to changing ocean conditions leaving them prone to climate change impacts (Härder, 2018;Hughes et al., 2017). This translates into a drastic loss in coral reef biodiversity, productivity and ecosystem services such as flood protection (Eddy et al., 2021; Brandl et al., 2020; Beck et al., 2018). Therefore it is paramount that we curb climate change and meet the Paris Agreement, to minimise the impact on coral reefs globally and sustain the vital functions these and other ocean ecosystems provide for the communities that depend on them.

Across continents, respondents had similar priorities in Ocean Outcomes (Figure S1). 'A Healthy and Resilient Ocean' and 'A Clean Ocean' received the highest average ranking scores across 5 out of 6 continents, suggesting a general caring and nurturing, rather than exploitative mindset. The inter-regional differences per Ocean Outcome rankings reflect the importance of understanding the unique challenges of each geographic region and tailoring the implementation of Ocean Decade Programmes, Projects and Activities according to regional needs. For example, North America is the only continent in which 'A Sustainably Harvested and Productive Ocean' ranked second.

Also, African respondents assigned ‘A Safe Ocean’ a higher relative score than ECOPs from other regions, likely due to unique ocean safety challenges which may require different solutions to those in other regions.

The majority of the research priorities identified were related to anthropogenic impacts on the ocean rather than disciplinary areas of work. The top research priorities across Ocean Decade Outcomes were similar to global research priorities, which also included understanding the impacts of and mitigation of various forms of marine pollution, improving marine fisheries management and the quantification and monitoring of ecosystem services. These results reinforce the notion that the next generation of ocean professionals has an inter- and trans-disciplinary reading of the Ocean Outcomes and have an interest in monitoring and managing cross-sectoral impacts on marine ecosystems.

3.2 Capacity Development

Capacity development for the next generation of ocean professionals is a necessary investment to ensure the continuity of the ocean sustainability agenda beyond 2030. We explored ECOP CDI scores across regions (Figure 3) and the national Human Development Index (HDI) groupings generated by the United Nations Development Programme to bring to light the geographic dimension of different capacity development priorities (Figure S2); while keeping in mind the professional and demographic distribution of the responses (Figure 1; Table S2; Table S3). Overall, a pattern emerged whereby the average CDI score decreased the lower the HDI grouping, with the only exception of South America. Overall, CDI scores illuminate a pattern of capacity development needs, where the most urgent need for investment were the African and South American continents. Importantly, the HDI groupings were not a good predictor of CDI scores between continents, as the least developed groupings in some continents had higher CDI scores than higher development groups in other continents (Figure S2); this highlights the importance of securing capacity development investment across all regions regardless of metrics such as the HDI. Furthermore, higher education and access to data is relatively equally accessible, while large discrepancies are found between Africa and South America compared to the other continents in available funding and equipment (Figure 3). ECOPs highlight that knowledge generation and sharing is sufficiently developed and that the development focus should be placed on access to funding and equipment.

The potential influence of early career network (ECN) membership on CDI score was found to be negligible across all continents (Figure S3); this is not to say, however, that ECN membership is not important for the professional development and networking of ECOPs, but rather, that the ability of ECNs to support the capacity development questions we posed was not significant in the results.

4. Actionable recommendations

As the global community embarks on this decade-long journey to turn the tide on the production of actionable knowledge for sustainable ocean development, perhaps the most strategic focal area of investment is the next generation of ocean professionals who will have to navigate the

integration of the knowledge produced throughout the Ocean Decade in the implementation of sustainable ocean practices in decades to come.

Most of the knowledge and research gaps identified across maritime basins are in one way or another related to prominent ocean sectors and human activities, which inevitably implies that the next generation of professionals must be trained in translating scientific knowledge into discrete options for industry and policy representatives; in essence what academics define as *transdisciplinarity*, where research efforts across disciplines merge to innovate across theoretical, methodological or practical applications for other societal sectors. Unfortunately, early career capacity development represents an archetypal conundrum where access to new opportunities requires, in many instances, experience in the same opportunity space. Potential first actionable steps include increasing the access to funding for interdisciplinary science, short-term high-impact studies, or long-term data collection efforts, which were all identified as necessary areas of investment for ECOPs to generate *the Science We Need for the Ocean We Want*. Increasing these opportunities around the theme of climate change impacts was a dominant response. The limited access to funds for attending conferences, training events and workshops was also a prevalent theme of the responses (Figure S4), which were frequently mentioned together with opportunities for ECOPs to connect with a wider range of stakeholder groups, including governments, top scientists and experts, and industry leaders, among other key stakeholder groups. The appetite for opportunities to connect with the global community of ocean decision makers and experts was ubiquitous among the responses and could be addressed by ensuring the prominent presence of ECOPs in national Ocean Decade delegations.

Integrating ECOPs in planning and decision making processes is essential to ensure intergenerational knowledge transfer and to support the development of capacity across levels of expertise (Brasier et al., 2020). This may be achieved by enhancing the role of ECOPs across UN Ocean Decade Programmes, Projects and Activities and reflecting their perspectives in future decision making. Lastly, ensuring adequate financial compensation for the time and effort that ECOPs invest in the Ocean Decade is another way to demonstrate that their contribution is not taken for granted and support their dedication to this decade-long journey. These conclusions can and must be exported to the entire Ocean Sustainability Agenda. As government and civil society continue working towards SDG 14 and various other intergovernmental agreements and goals, elevating the role of ECOPs will cement intergenerational equity, cooperation and consistency in the production and implementation of the *Science We Need for the Ocean We Want*.

5. Methods

We base our assessment on the responses of an online survey launched by IOC-UNESCO via social media, numerous existing early career listservs, through the Ocean Decade communications channels, and via personal networks between December 2019 and March 2020 that targeted the global ECOP community. The online survey aimed to gather ECOP perspectives on the most pressing scientific knowledge and capacity development gaps, as well as characterise the professional interests and expertise of responding ECOPs, in order to account for the distribution and potential skewness of the data towards certain regions or

professional profiles. The survey was conducted in English and remained open for 4 months. The survey compiled the voices of 1,428 individuals; this number was reduced to 1,344 after removing those respondents who did not self-identify as ECOPs (n = 60) and those who were classified as non-ECOPs based on one of the following two conditions: younger than 20 or the combination of older than 50 & less than 10 years from their last professional degree (n = 21).

5.1. Survey structure

The survey consisted of 31 (short answer, multiple choice and ranking) questions (Table S7), which were structured around three main sections: (1) Information about the professional expertise of ECOPs in the context of the Ocean Decade; (2) Perceived *scientific gaps* for the Ocean Decade; (3) Identification of *key capacity development challenges* for the Ocean Decade.

While the individual identity of all survey participants was made confidential and will not be released in this or other studies, information about their geographic location and ocean basin(s) where their work takes place provided important georeferenced data to map out geographic differences in the interpretation of Ocean Decade priorities and challenges (Figure S1; Table S6).

Throughout the first section ECOPs shared their nationality, gender, age and time since their last professional degree; this information facilitated the demographic characterization of the ECOPs who partook in the online survey (Figure 1). Respondents were then asked to delineate their professional niche by providing information about the discipline(s) and sector(s) that best describes their current position, the nature of the primary institution where they currently work, as well as information on the waterbody where they undertake their work. The information gathered throughout the first section of the online survey facilitated the geographic attribution of capacity development challenges and scientific knowledge gaps. The second section of the survey asked ECOPs to outline up to three key scientific knowledge gaps for the Ocean Decade. Respondents were then asked to relate each of the scientific knowledge gaps to one of the six Ocean Outcomes that were being considered at the time when the survey was launched. This information was also linked to the regional seas or oceans which the respondents listed as their main focal waterbodies. The third and final section was centered around seven Likert style questions on the relative access to different key capacity development challenges and two short-answer questions which captured additional capacity development priorities and areas where the Ocean Decade could support ECOPs.

5.1. Data analysis

The assessment of survey results was structured according to the three sections of the online survey and allowed for the interpretation of results within and between geographic regions and continents. The analysis unfolded according to the following three phases:

Global exploration of the ECOP community who partook in the survey.

We begin our analysis by providing a geographic and demographic statistical breakdown of the profiles of survey respondents (Figure 1; Table S2; Table S3), the waterbodies where their work unfolds (Figure 1) and main Ocean Outcome of expertise. We then calculated the inter- and trans- disciplinarity of ECOPs across geographic regions by computing the percent likelihood of ECOPs belonging to different professional fields or sectors on the basis of their geographic location and provided age, gender and Ocean Outcome of expertise across geographic regions.

Characterization of the main scientific knowledge gaps and challenges (Questions 19-20 in Table S7).

The key scientific knowledge gaps for the Ocean Decade identified in the survey were categorized based on the Ocean Outcomes considered in this study, as well as the waterbodies which respondents identified as their main focal areas (including ocean basin, regional seas, high seas and global). Network analysis and n-grams were used to characterize the scientific priorities globally and as related to the specific ocean basin and Ocean Outcomes. We employed semantic network analysis, a content analysis method that uses word frequency and co-occurrence to reveal meaning embedded in text (Danowski, 1993; Doerfel, 1998). The basic network data set is an n x n matrix S, where n equals the number of nodes (words) in the analysis and sij is a measured relationship between nodes i and j. The measurement of word co-occurrence is the standard for creating links between words in a semantic network. We followed the convention of using a 3-word window for defining links between concepts (see Danowski, 1993); therefore, links were created for words that occurred within three words of one another within each survey response. The frequencies of n-gram co-occurrence were then calculated and ranked. The semantic networks were created using R version 4.0.1 (R Core Team, 2020) and the igraph package (Csardi and Nepusz, 2006). We used a series of pairwise keyness analyses to compare language differences across groups. Keyness is a weighted measure of word frequencies within a particular text corpus, relative to some reference corpus (Bondi and Scott, 2010), and can be calculated with a chi-square test. Word keyness scores of the highest absolute value are used disproportionately between groups, indicating the potential for interesting conceptual or terminological differences present that might warrant further investigation (Seale et al., 2010).

Capacity development challenge assessment as expressed by ECOPs at the national level and aggregated to regional level.

This final phase of the analysis consisted of a regional prioritization analysis of capacity development challenges guided by the outputs of the seven Likert analysis-type capacity development questions (Questions 23-29 in Table S7) and a semantic network assessment of the main barriers to capacity development (Questions 21-22 in Table S7). The seven capacity development challenges, which had five equidistant responses (Strongly disagree, Disagree, Don't agree nor disagree, Agree, Strongly agree), also gave participants the option to indicate that they 'Don't know', which we omitted in this analysis.

The first step in this analysis consisted of translating the qualitative responses into a quantitative Capacity Development Index (CDI) ranging from 0.2 for those who strongly disagreed, to a score of 1 for those who strongly agreed. Each of the answers had an equal spacing of 0.2. These CDI scores were then aggregated at the global and 5 continental levels (Figure 3) to explore the relative access to opportunities across spatial scales and as a function of early career network membership, gender, professional field and professional sector. We also explored the CDI scores across the four tiers of organization laid out by the Human Development Index (HDI): Very High Human Development, High Human Development, Medium Human Development, Low Human Development, to determine if there were any patterns between the HDI ranking of nations and the CDI scores obtained from the survey.

The interpretation of scientific knowledge and capacity development gaps, along with the resulting policy recommendations, was carried out by ECOP groups based in the relevant regions or working in the specified waterbodies, ensuring a reliable interpretation of the results.

Supplementary Materials

Table S1: UN Ocean Decade Ocean Outcomes, Ocean Decade Challenges and Challenge Descriptions.

Ocean Outcomes	Ocean Decade Challenge	Challenge Description
A Clean Ocean	1. Understand and beat marine pollution	Aims to understand, map and develop solutions for land and sea-based sources of pollutants and contaminants.
A Healthy and Resilient Ocean	2. Protect and restore ecosystems and biodiversity	Aims to understand the effects of multiple stressors on ocean ecosystems and develop solutions to monitor, protect, manage and restore ecosystems and their biodiversity.
A Productive Ocean	3. Sustainably feed the global population	Seeks to generate knowledge, support innovation and develop solutions to optimize the role of the ocean in sustainably feeding the world's population.
A Predicted Ocean	4. Develop a sustainable and equitable ocean economy	A development framework for maritime countries, addressing equity in development of, access to, and benefit sharing from marine resources.
A Safe Ocean	5. Unlock Ocean-based solutions to climate change	Aims to understand the ocean-climate nexus and generate knowledge and solutions to mitigate, adapt and build resilience to the effects of climate change.
An Accessible Ocean	6. Increase community resilience to ocean hazards	Aims at increasing coastal communities' preparedness to and ability to recover from impacts derived from ocean hazards.
An Inspiring & Engaging Ocean	7. Expand the global ocean observing system	Complete a system that provides countries and end- users with critical information on physical, chemical, and biological essential ocean variables, aimed at delivery for climate, operational services, and ocean health (ioc.unesco.org).
	8. Create a digital representation of the ocean	Aims to create a digital representation of the ocean and to underpin achievement of the other Ocean Decade Challenges through the generation, management and use of ocean data and related capacity development efforts.
	9. Skills, knowledge and technology for all	Recognizes the importance of co-designing and co- delivering services, applications and tools that facilitate the generation and use of data, information and knowledge for integrated ocean management and planning.
	10. Change humanity's relationship with the ocean	Aims at bridging ocean health and wealth, working with diverse stakeholders and harnessing the latest knowledge, the Ocean Panel aims to facilitate a better, more resilient future for people and the planet (Alison et al., 2020).

Table S2: Per capita likelihood of survey respondents belonging to a given professional field across continents. Biology and Earth Science had a significant lead over the third most likely field among survey respondents.

Field	Africa	Asia	North America	Europe	Oceania	South America	Global
Business or Entrepreneurship	5%	1%	4%	4%	4%	5%	4%
Biology	45%	43%	55%	54%	49%	53%	52%
Communication	5%	5%	12%	8%	11%	15%	10%
Culture	2%	0%	4%	3%	8%	6%	4%
Data	24%	7%	22%	20%	21%	21%	20%
Earth Sciences	43%	60%	41%	46%	45%	61%	49%
Economics	7%	3%	3%	5%	7%	6%	5%
Education	12%	13%	8%	7%	6%	25%	12%
Ethics	1%	1%	1%	1%	3%	2%	1%
Engineering	12%	5%	7%	9%	3%	13%	9%
Finance	2%	1%	0%	1%	0%	0%	1%
Geography	11%	5%	9%	11%	8%	15%	10%
Governance	23%	11%	16%	15%	20%	19%	17%
Humanities	4%	2%	1%	3%	3%	6%	3%
Health	3%	2%	1%	2%	1%	3%	2%
Law	7%	5%	5%	4%	6%	7%	5%
Policy	11%	11%	24%	13%	14%	11%	15%
Political science	3%	1%	3%	5%	3%	4%	3%
Social science	9%	5%	12%	11%	8%	11%	10%
Technology	15%	9%	9%	11%	8%	16%	11%

Table S3: Per capita likelihood of survey respondents belonging to a given professional sector across continents. Academia, Fisheries and Education ranked highest amongst survey respondents.

Sector	Africa	Asia	North America	Europe	Oceania	South America	Global
Academia	45%	57%	62%	69%	63%	64%	62%
Agriculture or Aquaculture	38%	18%	18%	16%	11%	13%	18%
Biotechnology	14%	11%	5%	11%	4%	14%	10%
Education	29%	33%	34%	30%	24%	52%	35%
Energy	15%	7%	13%	12%	8%	16%	13%
Finance	7%	1%	2%	2%	4%	1%	2%
Fisheries	63%	39%	50%	40%	46%	37%	44%
Health	6%	5%	6%	6%	6%	6%	6%
Communication Technology	11%	6%	6%	8%	13%	10%	8%
Infrastructure	12%	3%	7%	9%	10%	10%	8%
Minerals	5%	3%	4%	5%	11%	8%	6%
Policy	27%	24%	42%	29%	34%	24%	31%
Philanthropy	4%	1%	7%	2%	11%	5%	4%
Tourism or recreation	17%	11%	12%	10%	11%	15%	12%
Transportation	13%	3%	6%	4%	6%	4%	5%
Water	45%	31%	27%	30%	27%	48%	34%

Table S4: Global frequency distribution of top-ten semantic analysis outputs for bigrams and trigrams. Climate change was identified as the most common topic for future scientific inquiry for the Ocean Decade.

Bigrams	*Frequency*	*Trigrams*	*Frequency*
climat_chang	209	impact_climat_chang	28
deep_sea	56	effect_climat_chang	25
marine_ecosystem	40	marine_protect_area	21
impact_climat	32	climat_chang_impact	19
plastic_pollut	30	sea_level_rise	18
develop_countri	28	deep_sea_mine	14
high_sea	26	impact_deep_sea	9
effect_climat	26	marin_spatial_plan	9
sea_level	25	climat_chang_marine	7
protected_area	24	deep_sea_ecosystem	6

Table S5: Global frequency distribution of top-five semantic analysis outputs for bigrams across each of the Ocean Outcomes. Climate change was identified as the most common topic for future scientific inquiry for the Ocean Decade.

Healthy and Resilient Ocean	Transparent and Accessible Ocean	Clean Ocean	Sustainably Harvested and Productive Ocean	Safe Ocean	Predicted Ocean
climat_chang	better_understand	climat_chang	climat_chang	climat_chang	climat_chang
deep_sea	deep_sea	marin_pollut	fisheri_manag	sea_level	deep_sea
marine_ecosystem	open_access	marin_litter	impact_climat	level_rise	marine_ecosystem
coral_reef	best_practic	plastic_pollut	marin_resou	marin_protect	coral_reef
impact_climat	share_data	marine_environ	plastic_pollut	data_collect	impact_climat

Table S6: Top 3 bi-gram terms per waterbody. Climate change was, almost unanimously, the most frequent scientific challenge noted by respondents across all waterbodies, with the exception of the Red Sea and High Seas.

Waterbody	Top 3 bi-gram terms		
Global	climate_chang	deep_sea	marine_ecosystem
Arctic Ocean	climate_chang	deep_sea	chang_impact
North Atlantic Ocean	climate_chang	deep_sea	marine_ecosystem
South Atlantic Ocean	climate_chang	impact_climat	sea_level
Indian Ocean	climate_chang	plastic_pollut	marine_ecosystem
North Pacific Ocean	climate_chang	deep_sea	marine_ecosystem
South Pacific Ocean	climate_chang	deep_sea	high_sea
Southern Ocean	climate_chang	deep_sea	marine_ecosystem
High Seas	sustain_ocean	lack_understand	ecosystem_servic
Baltic Sea	climate_chang	marine_environ	impact_climat
Black Sea	climate_chang	coastal_zone	sustain_manag
Red Sea	coral_reef	climat_chang	plastic_ghost
North Sea	climate_chang	influence_increas	increas_nutrient
Mediterranean Sea	climate_chang	deep_sea	impact_climat
Caribbean Sea	climate_chang	deep_sea	coral_reef

Table S7: Survey questions, question type and whether it was included in the analysis.

ID	Survey question	Question type	Included?
1	What is your name?	Short answer	No
2	What is your last name?	Short answer	No
3	What is your email address?	Short answer	No
4	Do you identify as an early career ocean professional?	Yes/No answer	Yes
5	How many years have passed since completing your professional training?	Multiple choice	Yes
6	How old will you be on 1 January 2021?	Yes/No answer	Yes
7	Which gender do you identify with?	Multiple choice	Yes
8	In what country do you live?	Multiple choice	Yes
9	In which ocean basin(s) do you work?	Multiple choice	Yes
10	What institution/organization are you primarily affiliated with?	Yes/No answer	No
11	Please list the full names of all other organisations that you are involved with	Short answer	No
12	What is the nature of your primary organisation/institution?	Multiple choice	No
13	Which of the following keywords best describes your discipline?	Multiple choice	Yes
14	What sectors are most aligned with your career interest?	Multiple choice	Yes
15	Are you part of an early career professional network?	Yes/No answer	Yes
16	Where do you go to find out information and get updates about the Decade?	Multiple choice	No
17	In which of the Decade outcome areas is your primary area of expertise	Multiple choice	Yes
18	Which of the Decade Outcomes are most important to you?	Ranking question	Yes
19	Please identify up to three critical scientific challenges or knowledge gaps that should be addressed through the UN Decade of Ocean Science for Sustainable Development? For each, please indicate the scale of the challenge.	Three short answers	Yes
20	What is the scale of the scientific challenge or knowledge gaps that you identified in the previous question?	Three multiple choice	Yes
21	What barriers constrain your ability to contribute to achieving the Decade outcomes?	Short answer	Yes
22	Are there other capacity development needs that you would like to identify here?	Short answer	Yes
23	I can access data and information that I need for my work on ocean science for sustainable development	6 level Likert scale question	Yes
24	There are opportunities for me to access funds to publish in scientific journals, and/or to access scientific knowledge that I need	6 level Likert scale question	Yes
25	The country in which I reside has professional opportunities in my field of expertise	6 level Likert scale question	Yes
26	The country in which I reside has, or has access to, ocean science equipment and infrastructure	6 level Likert scale question	Yes
27	The country in which I reside has mentorship networks relevant to training in the application of ocean science to sustainable development	6 level Likert scale question	Yes
28	The country in which I reside has university degree options related to ocean science and sustainable development	6 level Likert scale question	Yes
29	The country in which I reside has funding opportunities to attend national or international conferences, workshops and meetings, including short training courses.	6 level Likert scale question	Yes
30	Please indicate if you would like to receive Decade news and updates via email	Yes/No answer	No

31	How would you prefer to receive invitations and news updates about the Ocean Decade?	Multiple choice	No

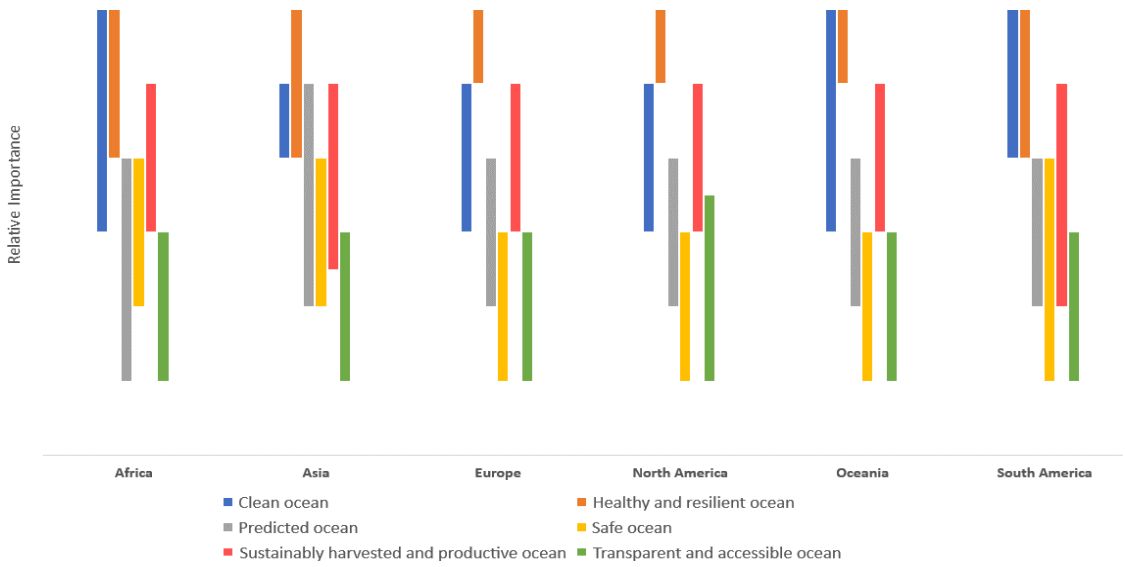

Figure S1: Ranking of Ocean Outcomes by continent. Similar Ocean Outcome rankings were obtained across continents. While inter-continental variability is observed, 'A Healthy and Resilient Ocean' and 'A Clean Ocean' were ranked the most important Outcomes across.

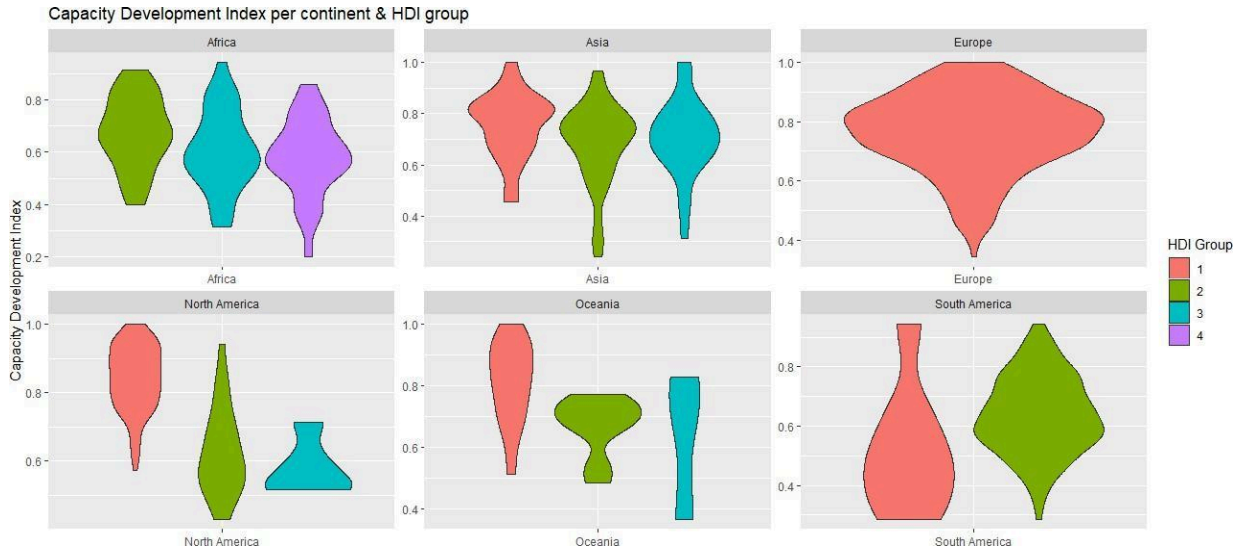

Figure S2: Relationships between the CDI score of each of the countries per continent when accounting for the national HDI groupings which are generated by the United Nations Development Programme.

Capacity Development Challenge	Member of an early career network?	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	NA or Do not know
I can access data and information that I need for my work on ocean science for sustainable development.	Yes	15%	37%	15%	9%	2%	22%
	No	13%	40%	12%	7%	2%	26%
	Both	14%	39%	13%	8%	2%	25%
There are opportunities for me to access funds to publish in scientific journals, and/or to access scientific knowledge that I need.	Yes	11%	26%	17%	14%	7%	25%
	No	10%	26%	16%	17%	4%	27%
	Both	10%	26%	16%	16%	5%	26%
The country in which I reside has professional opportunities in my field of expertise.	Yes	19%	29%	14%	11%	5%	22%
	No	17%	31%	13%	10%	6%	23%
	Both	18%	30%	13%	10%	6%	23%
The country in which I reside has, or has access to, ocean science equipment and infrastructure	Yes	26%	31%	8%	11%	4%	20%
	No	24%	31%	10%	8%	3%	24%
	Both	25%	31%	9%	9%	3%	23%
The country in which I reside has mentorship networks relevant to training in the application of ocean science to sustainable development.	Yes	15%	30%	11%	13%	5%	26%
	No	13%	28%	14%	11%	4%	30%
	Both	14%	29%	13%	12%	4%	29%
The country in which I reside has university degree options related to ocean science and sustainable development.	Yes	37%	33%	5%	2%	1%	22%
	No	36%	32%	4%	3%	1%	24%
	Both	36%	32%	4%	3%	1%	23%
The country in which I reside has funding opportunities to attend national or international conferences, workshops and meetings, including short training courses.	Yes	15%	25%	15%	15%	7%	23%
	No	14%	26%	13%	13%	7%	27%
	Both	14%	26%	14%	14%	7%	26%

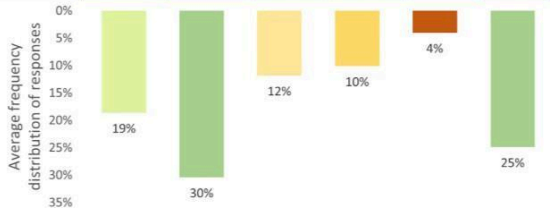

Figure S3: Likert scale results for the relationship between early career network membership and each of the capacity development questions.

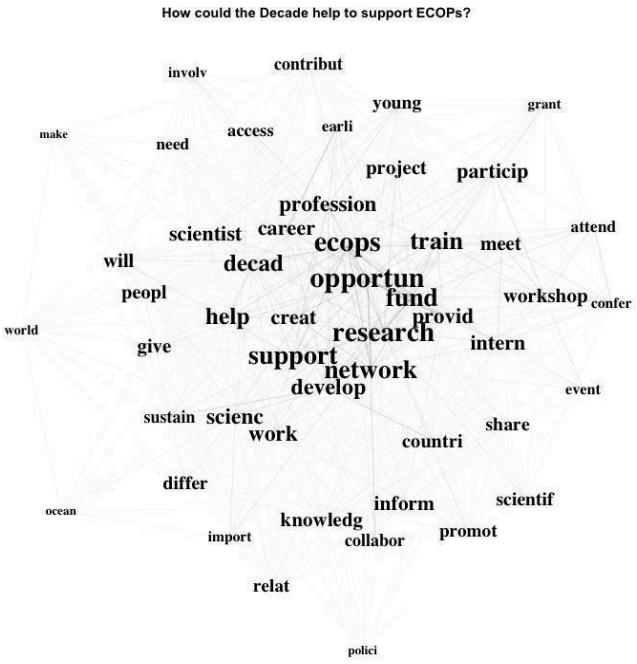

Figure S4: Results of the global unigram assessments on how the UN Ocean Decade could help support the ECOP community.

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

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