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Ocean Action Panels

ADVANCE UNEDITED

Ocean Action Panel 2: Increasing scientific cooperation, knowledge, capacity development, technology, and education to strengthen the science-policy interface for ocean health

Concept paper prepared by the Secretariat

Summary

The present concept paper was prepared pursuant to paragraph 24 of General Assembly resolution 78/128, in which the Assembly requested the Secretary-General of the 2025 United Nations Conference to Support the Implementation of Sustainable Development Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development to prepare concept papers on each of the themes of the Ocean Action Panels, taking into account the relevant ocean-related processes of the Assembly and other possible contributions. The present paper relates to Ocean Action Panel 2, entitled "Increasing scientific cooperation, knowledge, capacity development, technology, and education to strengthen the science-policy interface for ocean health". In the paper, the status, trends, challenges and opportunities for the achievement of relevant targets of Sustainable Development Goal 14 are set out, under the overarching theme of the Conference: "Accelerating action and mobilizing all actors to conserve and sustainably use the ocean".

I. Introduction

1. A healthy ocean underpins food security and livelihoods, supports sustainable and resilient economic growth, provides climate regulation, hosts vital biodiversity and ecosystems, and is a unique source of cultural values for many communities around the world. However, accelerating threats on the ocean such as climate change, land based and sea based marine pollution, and unsustainable loss of biodiversity and ecosystems ensures that the capacity of the ocean to continue to perform these functions is uncertain. Recent assessments of progress towards SDG 14 indicate that, despite some advancements, the overall scale and speed of progress remain insufficient. Negative trends are being reported across numerous issues including increasing pollution from nutrients and other sources, continued upward trends in ocean warming and acidification, decreasing oxygen, rising sea levels and intensifying impacts from harmful algal blooms. Climate change is amplifying these stressors, which interact in complex, poorly understood ways, jeopardizing marine and coastal ecosystems and the people and economies that depend upon them.

2. Looking forward, the global population is projected to grow by 2 billion people over the next 25 years, further intensifying the pressures on coastal and marine resources, and increasing the number of people vulnerable to coastal and ocean hazards. Concurrently, the ocean economy is expanding faster than most other sectors, driving unforeseen demand – and conflicts – for maritime space. This rapid growth is exacerbating pollution, habitat destruction, and other negative impacts from coastal and ocean-based infrastructure development. Despite many advances in the 2030 Agenda and its Sustainable Development Goals (SDGs) and targets, most States still lack the technological and human capacity to prepare and deal timely with these situations.

3. Identifying and operationalizing actionable solutions to mitigate threats and ensure sustainable ocean use requires a strong governance framework whose implementation is rooted in relevant and timely ocean science and knowledge. A rigorous and inclusive science-policy-society interface that supports the co-design and co-delivery of science and knowledge and that works along diverse impact pathways to inform decision-making at all levels from local to global is essential. Ocean-related scientific cooperation must foster collaboration across all societal actors, from industry to civil society and beyond. This includes achieving consensus on scientific priorities, addressing significant and systemic discrepancies in access to skills, data and technology that persist for Small Island Developing States (SIDS), Least Developed Countries (LDCs) and other marginalized and historically underrepresented groups including Indigenous Peoples and local communities, women and girls, and youth.

4. Resolution 79/144 of the General Assembly reaffirmed the cross-cutting role of ocean science in Sustainable Development Goal 14 of the 2030 Agenda and recalled the importance of marine science in understanding, preventing and reducing impacts on the ocean and preserving the integrity of marine ecosystems and in the development and implementation of management and decision-making tools. It highlighted the role of marine science in eradicating poverty, enhancing food security, conserving and sustainably managing marine environments and resources, understanding, predicting and responding to natural events, and supporting the sustainable development of oceans and seas.

5. A set of legal and policy tools is needed to achieve many common goals. In this regard, a comprehensive legal regime for marine scientific research is set out in Part XIII of the United Nations Convention on the Law of the Sea. In addition, the third cycle of the Regular Process for Global Reporting and Assessment of the State of the Marine Environment, including Socioeconomic Aspects (the Regular Process), from 2021-2025, and its third World Ocean Assessment (WOA III) will enhance the scientific basis for policymaking and governance. The UN Ocean Decade of Ocean Science for Sustainable Development (the Ocean Decade) provides a global framework for collaboration, to advance ocean science from knowledge to actionable guidelines for decision-making, addressing ongoing challenges and driving solutions. Other related initiatives such as the UN Decade of Ecosystem Restoration also contribute to enhancing collaboration, capacity enhancement and exchange and delivery of science outputs of benefit to marine ecosystems.

II. Status and notable trends since 2022

Governance and Policy Frameworks

6. Since 2022 there have been significant advances in the global legal and policy framework, all of which are dependent on science and knowledge - either through unlocking and increasing accessibility of existing data or through the generation of new knowledge. The 2023 adoption of the Agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (BBNJ Agreement) constitutes a landmark achievement. The Agreement is grounded in science, with the use of best available scientific information recognized as a guiding principle for its implementation and will play a central role in supporting the work of the Agreement's institutional arrangements. The 2022 adoption of the Kunming-Montreal Global Biodiversity Framework significantly increased the place of marine and coastal issues on the global biodiversity agenda and recognises the importance of science and knowledge for effective implementation of the Framework's targets including through National Biodiversity Strategies and Action Plans. The ocean-climate dialogue of the United Nations Framework Convention on Climate Change provides a formal entry point for ocean issues, including ocean science and knowledge, into the global climate agenda and negotiations are ongoing to develop an internationally legally binding instrument on plastic pollution including in the marine environment.

Sources of Scientific Knowledge

7. Established by the UN General Assembly, the Regular Process, through its WOAs, provides a synthesis of the latest science available on the state of the world's ocean and the social, economic and cultural activities related to the ocean and provides essential information for decision-makers to support sustainable ocean management and various international processes. The WOA III is nearing finalization and is scheduled to be approved by the UN General Assembly in December 2025. It includes enhancement of the socio-economic components of the assessment, expanded coverage of tools and frameworks for sustainable development, and broadened regional perspectives.

8. The 2025 Global Ocean Science Report, produced by the IOC to support reporting against SDG 14.a will provide updated information on investments in ocean science capacity and infrastructure. It will also provide information on disciplinary, gender, demographic aspects of ocean science and where and how science outputs are being applied.

9. The 59 global programmes and 535 national and regional projects endorsed under the framework of the Ocean Decade are generating science and knowledge across ten Ocean Decade Challenges ranging from marine pollution, to the ocean-climate nexus, sustainable blue foods and coastal resilience. The focus of the Ocean Decade in the second half of its implementation will be on consolidating and increasing accessibility of the vast amounts of science and knowledge being generated through this portfolio of Decade Actions.

10. Sectoral assessments also exist. For example, since 1971, FAO has been publishing regular analyses of the state of fishery stocks, including the summary updates presented in FAO's flagship publication *The State of World Fisheries and Aquaculture* (SOFIA) Report since 1994. At the 2025 UN Ocean Conference, the FAO *Review of the state of world fishery resources,* including an updated methodology for assessing global marine fishery resources, will be launched. Developed through a collaboration of over 650 experts from 92 countries and 200 organizations, this new approach evaluates approximately 2,600 fish stocks—making it the most comprehensive and participatory assessment ever conducted.

11.The special report of the Intergovernmental Panel on Climate Change Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC) has been critical to assess the role of the ocean and cryosphere in the Earth's climate system as well as to understand the impact of climate change on the ocean and assess the options to take science-based action.

Inclusive Scientific Cooperation

11. Since 2022, there has been significant growth in the recognition of the importance of co-design and co-delivery of ocean science involving knowledge holders, generators and users. There have been important investments in building skills and sharing approaches for co-design, including in SIDS and LDCs. There has also been increased analysis and understanding of the diverse impact pathways which allow science and knowledge to inform decision making at diverse scales and in diverse ways and a growing body of research on the tools, skills and resources needed for a rigorous and sustainable science-policy-society interface.

12. Increased recognition of the importance of inclusivity in scientific cooperation is reflected in the increased attention to Indigenous and local knowledge as an equally valuable source of information and insight. Most attention has focused on the increased engagement of Indigenous peoples and local communities in scientific initiatives, however further support is required for Indigenous-led research. Additionally, systematic barriers must continue to be identified and addressed to enable the full participation of marginalized and historically underrepresented groups, including women and youth, in the generation and application of ocean science for decision-making.

Capacity Development and Ocean Literacy

13. Full and active participation in ocean science by groups across society requires capacity development. Through targeted initiatives, innumerable UN agencies and partners have contributed to capacity development in ocean science at the global, regional and national levels since 2022. This includes the development of human resources at the individual and institutional levels; established or improved access to technology, physical infrastructure, data and information; promotion of ocean research policies in support of sustainable development; increasing visibility, awareness and understanding the values

of the ocean and ocean research in relation to human wellbeing and sustainable development. However, despite significant investments and advances capacity and skills associated with ocean science remains unevenly dispersed across locations, generations, and genders. A lack of coordination across different initiatives undermines effectiveness and sustainability of impacts.

14. Recognition of the importance of increased ocean literacy across all sectors of society as a means of triggering behaviour change has increased since 2022. Numerous initiatives are being implemented, with growing international coordination and collaboration including through the framework of the Ocean Decade. There have been significant achievements in the integration of ocean issues into educational curricula and expansion of ocean literacy programmes targeting policy makers and the private sector. There is ongoing work to develop national baselines of perceptions to ocean literacy and define methods to measure the translation of ocean literacy efforts to individual and institutional behaviour change.

Marine Technology

15. Marine technology provides opportunities for enhancing cooperation, capacity development and education. Innovation in technologies, particularly in the development of low cost, widely deployable equipment, expansion and sharing of satellite derived observations, and analysis ready tools and modelling platforms contribute to empowering under-served Member States to build and maintain their own infrastructure. Since 2022, the Global Ocean Observing System has continued to expand, with the Argo platform now collecting information on ocean warming at depths below 2000m (DeepArgo) and on ocean carbon storage (BGC Argo). Expansion of an array of new or enhanced automated technologies (e.g., uncrewed surface and subsurface vehicles, drones, satellites), and the involvement of industry (e.g., through the Fishing Vessel Ocean Observing Network) is also expanding observing in coastal and ocean systems. Marine life in remote, hard to access regions are now being regularly monitored using satellite and automated technologies supporting conservation and management efforts.

16. Artificial intelligence and machine learning is assisting in processing and translating observations collected into information for a wide range of users, including managers and regulator. Modelling efforts integrating multiple data streams are progressing the development of digital twins in a number of regions providing for improved understanding of the impact of human activities, interactions between users and impacts, and testing of management strategies to mitigate impacts and provide for equitable sharing of resources and their benefits. Developments in data processing and expansion of observation are building new capacities in early warning systems including forecasting marine heatwaves and harmful algal blooms, building resilience in fisheries and aquaculture. The S-100 universal hydrographic data model will contribute to safer and more efficient navigation, marine spatial management and protection of the marine environment.

III. Challenges and opportunities that have emerged or become more urgent since the 2022 Ocean Conference. Where relevant, this section will identify interlinkages and synergies between SDG 14 targets and other SDGs

Ocean observations and data underpinning scientific knowledge

17. The central role of ocean observation systems as the fundamental and first step in the value chain of ocean-related scientific knowledge cannot be over-emphasized. Ocean observation systems need to be recognised as critical infrastructure and resourced accordingly. However, observation systems continue to suffer from a lack of investment and coordination. There remain significant gaps in the coverage of existing networks, spatially and in terms of the variables observed, as well as in the form of barriers to accessing, sharing and using the acquired data. There is a need for substantive expansion of coastal observations within and beyond national jurisdiction, marine biodiversity, carbon and deep ocean observing. To achieve this, national level coordination challenges where multiple agencies may be involved in ocean observations and research must be overcome. International coordination is also essential, in particular in addressing data and information gaps in areas beyond national jurisdiction The Global Ocean Observing System (GOOS) 2030 Strategy recognizes the existing challenges and provides a framework to expand and strengthen the ocean observing system to meet the growing demands of policy makers, private sector users and the general public. However, in order to attain an interconnected system that meets the demands of society, substantive resource commitments will need to be made at national, regional and international levels as well as investment in the GOOS coordination.

18. Access to data, information and knowledge is critical for an integrated, science-based approach to the management of human activities in coastal and open ocean areas. Lack of quality control in datasets, lack of interoperability of different data platforms, 'hidden' or unexploitable datasets, lack of datasets tailored to regional or national scales, and a lack of skills in accessing and analyzing data are among the challenges faced for understanding ocean processes. This hinders the capacity of stakeholders from across society to use relevant data to make informed decisions. Prediction, forecasting and modeling applications and services are essential to deliver societal outcomes and benefits of ocean knowledge including for example early warning systems for ocean hazards. Stakeholders in LDCs and SIDSs are particularly affected by lack of accessible data.. in order to achieve a holistic digital ecosystem and integration of science-based approaches at scale, nations will need to increase cooperative efforts, investments in infrastructure, scale up adoption of innovative technologies, and address current inequities to the access and use of quality assured observations and datasets.

19. This is particularly important where the utilisation of internationally accepted technical standards and the associated regulatory frameworks allow scientific data to be made available to ocean users who would otherwise not have access to relevant science. For example, the IMO's E-Navigation Strategy sets out the future regulatory environment for shipping, including the use of new technology such as S-100, which allows for interoperable thematic layers such as MPAs and real time oceanographic data to be presented in navigations systems, reducing the impact on ecosystems and reducing pollution through more efficient route planning.

20. Public-private collaborations to unlock privately held datasets, advance the development and deployment of technologies and modelling systems and advance data management will be important, particularly to unlock industry held datasets in a manner that works harmoniously with commercial and legal requirements concerning data sharing. There is also a need for significant efforts in capacity development and technology transfer to developing countries to ensure access to new technologies and data, for which the BBNJ Agreement, with its Part V dedicated to capacity-building and the transfer of marine technology, will provide significant opportunities when it enters into force.

Persistent and emerging gaps in scientific knowledge

21. There remain persistent gaps in our knowledge and understanding of the ocean, as well as knowledge gaps emerging due to the rapid acceleration of threats to the ocean including climate change and new technologies or economic activities. A year-long process, Vision 2030, coordinated in the framework of the Ocean Decade in the lead-up to the 2024 Ocean Decade Conference engaged over 150 experts from across all sectors of society to identify gaps and needs in ocean science to inform policy and decision making. The results of this process were discussed at the 2024 Ocean Decade Conference and the emerging Barcelona Statement synthesized a series of priorities for the generation and use of co-designed and co-delivered science. These priorities have since continued to be refined, including through reference to the recommendations of the Scientific Commission of the 2025 One Ocean Science Congress. They will inform the implementation of the Ocean Decade in the second half of its activities and provide a foundation for discussion at the 2025 United Nations Ocean Conference on the most pressing needs for collaborative action in science and knowledge generation:

- Understand global distribution and human health and ecosystem impacts of marine pollution across the land-sea continuum, including the identification of priority pollutants and consideration of emerging and unregulated pollutants.
- Enhance and scale-up marine and coastal ecosystem-based management approaches including a focus on better understanding of, and solutions for, multiple stressors including human impact and climate change.
- Better understand deep-sea biodiversity, ecosystems and ecosystem services and improve knowledge of vulnerability to climate change and the impacts of new or emerging economic activities.
- Increase knowledge to underpin sustainable, resilient, and equitable small-scale fisheries and aquaculture and facilitate sustainable management of industrial fisheries.
- Better understand the role of the ocean as a food source to strengthen sustainable aquatic food production and innovation for new frontiers with a focus on developing countries and strengthened public-private partnerships. Aquatic foods have a great potential to contribute to healthy diets and improve food security and nutrition. They are an excellent source of macro and micronutrients, but there are some challenges to fully understand their potential contribution for feeding a growing population.
- Advance climate informed fisheries management, by systematically integrating climate change considerations into the fisheries management planning and implementation cycle, which may include, for example, incorporating finer-scale climate projections into fisheries policies and decision support tools, strengthening scientific evidence for climate-proofed fisheries infrastructure, and enhancing monitoring and early warning systems (e.g. for harmful algal blooms) to support the adaptive management of fisheries resources.
- Accelerate efforts and investments to achieve a fully mapped seabed by creating a favorable policy environment that results in increased funding, advancement of suitable technology, and increased data sharing based on fair principles. Whilst progress has been made toward a fully mapped seabed (from 6% mapped in 2016 to 26.1% in 2024) upward of 70% still remains unknown. Given that the shape and nature of the ocean floor

underpins our understanding of fundamental ocean processes, targeted effort will be required to achieve a fully mapped seabed.

- Generate data, information and skills to support the development of sustainable ocean-based economies including through evidence-based Sustainable Ocean Plans at the national level and in relevant transboundary areas. This includes use of national ocean accounting systems with the aim of encouraging sustainable and climate resilient ocean economy projects, prioritizing those that integrate environmental conservation with socio-economic benefits for local communities and that are founded on partnerships with the private sector.

- Rapidly generate knowledge to scale up climate mitigation including through marine renewable energy and management of coastal ecosystems and allow timely understanding of the technical, ecological, and social feasibility, potential impacts of proposed marine carbon dioxide removal (mCDR) initiatives and contribute to future policy and regulation development.

- Generate science and knowledge to underpin adaptive governance and management systems and decision support tools for the assessment of vulnerability and risk to coastal communities and marine industries from ocean and coastal hazards, including climate change and to support the development of multi-hazard early warning systems.

- Develop the evidence base to support economic models, policies, and innovative financial instruments to diversify and accelerate investment in ocean science, including for enhanced digital representation of the ocean, and sustained and sustainable ocean observing and infrastructure.

- Unlock and generate new knowledge drawn from transdisciplinary social science and ocean literacy research on human-ocean connection, behavior change, and cultural engagement that can be integrated into Ocean Decade digital infrastructure and used to map and measure the impact of ocean literacy initiatives.

- Increase engagement with the health sector as a means of better understanding connections and knowledge gaps in relation to the links between ocean health and human health.

- Increase empowerment of Indigenous leadership in the co-design and co-delivery of ocean science and knowledge, and support Indigenous-led research.

Capacity development and transfer of marine technology

22. Part XIV of the United Nations Convention on the Law of the Sea, relates to the development and transfer of marine technology, and it requires States to cooperate in accordance with their capabilities to actively promote the development and transfer of marine science and marine technology on fair and reasonable terms and conditions. However, *ad hoc*, poorly coordinated, and unsustainable capacity development and transfer of marine technology activities exacerbate the geographical, gender and generational disparities in the effective generation and use of ocean science and knowledge. The need for capacity development has never been more pronounced. The global legal and policy framework for ocean issues identifies the role and specific needs for capacity development at multiple scales. Yet States lack the capacity to promptly act and solve emerging issues affecting the health of the ocean. Major gaps are related to insufficiently trained human resources, deficient technological infrastructure, and non-

existant embargoed data and information that relates to the use and management of the ocean.

23. Effective capacity development is an essential tenet to achieving more evenly distributed capacity across the globe, across generations, and across genders and thus reversing asymmetry in knowledge, skills and access to technology. Aligned with the IOC Criteria and Guidelines on the Transfer of Marine Technology (CGTMT), the strategic framework of the IOC capacity development strategy emphasizes innovations in marine science and technology to stimulate sustainable socio-economic benefits derived from ocean-related activities. The guidelines have been instrumental in advancing the objectives of the UN 2030 Agenda, particularly Sustainable Development Goal 14 (SDG 14), which prioritizes enhancing scientific knowledge, research capacity, and technology transfer to safeguard ocean health and support developing States, including SIDS and LDCs. The BBNJ Agreement, which includes the objective of promoting international cooperation in marine scientific research and in the development and transfer of marine technology as well is also expected to contribute significantly when it enters into force, including with a dedicated Capacity-building and Transfer of Marine Technology Committee.

24. Ocean observation provides a clear example of the multiple, inter-related challenges that exist in research capacity and transfer of marine technology. Developing research capacity and transfer of marine technology for sustained ocean observations requires investing in people and their institutions so that they can build infrastructure and long-term support networks with better access to data, tools and technologies. While this can be facilitated by international initiatives, it needs support nationally and internationally if it is to be sustained. Capacity development needs to occur at all stages of the ocean observing process, from identifying needs and designing systems through to the transformation of data into products and information. This includes the use of best practices at all levels of the process, from instrument deployment to data collection, data analysis, data modelling and management, and in the final reporting.

25. Extended training of ocean practitioners can be a successful mechanism to accelerate equitable capacity development. When individuals enhance their capabilities, there is a higher chance that this knowledge is multiplied to the institutional levels with long-lasting impacts. Recent development of marine and maritime academies and training programmes have enabled knowledge-sharing beyond excellence centers and largely increased upskilling opportunities. These initiatives, often outside of formal educational systems, tackle specific knowledge gaps and are designed to address societal demands. For example, to improve effective implementation of MPAs, a new online marine protected area (MPA) tool hub and learning platform, MPAth[1], has been launched by UNEP, TNC, WWF and partners to support effective and equitable MPA development and implementation. At its core, MPAth provides an innovative, easily accessible MPA ‘problem-solving’ and ‘learning journey’ platform applying machine learning algorithms to identify insightful guidance, decision-support tools and practical knowledge to support MPA planners and practitioners at different MPA design and implementation stages.

Working across the science-policy-society interface

26. Strengthening the science-policy-society interface to ensure that decision makers understand the value of ocean science and knowledge to inform decision making, and to

[1] https://mpath.unep.org/

ensure that knowledge is available in readily accessible forms and ultimately incorporated into policy and decisions is critical to numerous facets of sustainable development. Despite increased recognition of the need for science to inform policy and management, gaps remain between the science community on one side and policy and decision makers on the other. While there are numerous national and regional examples of bridges being successfully constructed between these two communities, there is a need to further increase efforts to systematically engage policy and decision makers in co-design approaches that allows the generation of relevant and timely knowledge, and the uptake of that knowledge in accessible forms. This approach is required at the global, regional and national levels, for example to ensure that Member States can fulfil national commitments to global policy frameworks.

27. At the global level, the WOA represents a comprehensive scientific basis with up-to-date knowledge on various ocean-related issues for consultation by Governments, intergovernmental processes, and all policymakers who are involved in ocean affairs to position their decisions more effectively in the context of ocean science. Tailored assessments and syntheses are required to meet regional and national needs and inform decision making across all scales.

28. Sustainable ocean planning as committed to by the members of a High-Level Panel for a Sustainable Ocean Economy is an emerging framework to strengthen the science-policy interface. It is a broad concept that incorporates diverse tools and approaches, but which fundamentally relies on participatory, multi-sectoral approaches to use natural, economic and social science for spatial and temporal decision making in coastal and marine areas. Marine spatial planning is one example of a tool that represents an important opportunity for improved integrated management by adopting a multi-stakeholder participatory process to decision making.

29. Area-based management tools offer an opportunity for improved integrated management through the adoption of a multi-stakeholder participatory process for decision-making (e.g. other effective area-based conservation measures (OECMs) for fisheries, and measures such as area-based management tools, including MPAs, under the BBNJ Agreement). Many other examples of science-based planning tools exist across the United Nations system. Areas where further research is needed to improve the science-policy interface include existing and new technologies for compliance and ecological monitoring in remote areas (such as satellites or vessels emissions for combating illegal, unreported and unregulated fishing).

30. In the context of marine fisheries, Regional Fisheries Management Organizations (RFMOs) is an example of means for enhancing the effectiveness of the science-policy interface by ensuring existing organizational structures channel science into decision-making. For example, the FAO General Fisheries Commission for the Mediterranean (GFCM) adopted several binding recommendations that require climate drivers to be taken into account in fisheries management and has two capacity development progammes aimed at supporting the formulation of science-based decisions.

Ocean literacy and strategic communication of ocean science

31. To catalyse action, it is necessary to communicate ocean science to users across all sectors of society, and to ensure that individuals and institutions have the skills to undertake, interpret and apply ocean science. achieving a collaborative effort between scientists, professional educators, communicators, ocean literacy experts and marine

social scientists is required – an important consideration which is reflected in the work and activities undertaken under the Regular Process, the Ocean Decade, and beyond.

32. Ocean literacy is an area that has seen rapid evolution since the 2022 United Nations Ocean Conference. from its beginnings as a school-based initiative to teach ocean science, to a global community that recognizes the ocean's vital importance to our future.. Priority actions to increase the impact of Ocean Literacy including *inter alia* increased participation in coastal and urban planning processes, support to transdisciplinary research to understand behavior change in relation to the ocean, and continued investment in development and implementation of a solid and adaptable Ocean Literacy framework for formal and non-formal educational systems for all stakeholders.

33. Effective Ocean Literacy activities and competencies need to be grounded in evidence and, to this end, additional efforts in marine social sciences are needed for example in relation to public perceptions of ocean research; marine citizenship and identity research; behavioural science research linked to ocean-climate education and communications; research on how ocean literacy can be measured and monitored over time, and the impacts of an ocean literate society on ocean health; and research on pluriversal and critical ocean literacy as a policy tool.

34. Success of Ocean Literacy initiatives will also depend on the generation, sharing, and use of priority datasets including human-ocean connection/human-ocean values dataset(s); pro-ocean behaviour change methodologies, case studies, and effective practices; impact mapping of regional and key global ocean literacy initiatives; and ocean culture mapping that includes a global body of evidence (contextual, local knowledge) that demonstrates and supports cultural engagement as an enabler of ocean-human health.

Advancing diversity, equity and inclusivity in ocean science

35. Despite growing recognition of the need for systematic processes to identify and dismantle barriers to ensure diversity, equity and inclusivity in ocean science cooperation and capacity development gaps persist including for women and youth. The latest available data from the Global Ocean Science Report indicates that in 2020, women represented 38 percent of scientists in the marine domain and there remains an under-representation of women in scientific fields and professions.

36. Supporting the next generation of ocean professionals is also vital. The Ocean Decade programme on Early Career Ocean Professionals (ECOPs) is at the heart of the UN Decade of Ocean Science for Sustainable Development. It aims to support young ocean professionals in their capacity development and work by providing meaningful networking, training, funding opportunities and creating capacity for cooperation and knowledge exchange. A dedicated programme for young ocean professionals guarantees a space for them to elevate and strengthen the diverse perspectives through a collective voice, but also ensures that knowledge is exchanged between experienced professionals and ECOPs to incorporate innovative ways of thinking into global ocean sustainability and stewardship challenges.

37. Geographic barriers persist, particularly for individuals and institutions in SIDS and LDCs and significant, coordinated and long-term investments are needed across all facets of the ocean-science value chain ranging from support to fundamental ocean observations and data infrastructure, to empowering local scientific institutions and individuals to lead the co-design and co-delivery of research initiatives, support to Indigenous-led research,

and enhancement of spatially and temporally appropriate science-policy-society pathways to ensure knowledge informs local and national decision making.

Investment and financing for ocean science

38. Addressing the challenges and seizing the opportunities identified in previous sections will require significant resources. SDG14 (Life under water) is the least well-funded of all the SDGs, receiving a 0.01% share of all SDG funding from official development assistance up to 2019. Estimates from 2020 indicate that only 15% of funding needs have been met for achievement of SDG 14. Due to SDG 14's interdependence with many SDGs, including its central role in meeting SDGs related to climate action and food security, deficits in investment in SDG14 hamper the realization of the entire 2030 Agenda.

39. SDG target 14.a tracks investment in ocean science and is reported through the Global Ocean Science Report. The 2020 data indicates that while national governments remain the primary source of funding for ocean science, the availability and allocation of funding for ocean science continues to vary widely between countries and regions, with much lower budgets in developing countries. Overall, the share of gross domestic expenditure on research and development (GERD) dedicated to ocean science is low with, on average, around 1.7% of total GERD attributed to ocean science in 2017. The lack of standard, replicable and transparent definitions, data and methods for calculating the benefits of investment in ocean science leads to a lack of credibility and transparency and a future focus of work under the UN Decade of Ocean Science for Sustainable Development will be on generating a robust and reliable evidence base to support decision making in relation to investment in ocean science and knowledge.

40. There is an ongoing need to enhance cross-sectoral collaboration, as well as partnerships across scales to support uptake of science, management, and policy. In addition, an emphasis should be placed on closely linking business and industry with other ocean-science actors, and recognizing private-public partnerships as critical to generating ocean science. Partnerships led by and involving low- and middle-income countries should especially be promoted, given the persistent bias towards ocean science knowledge, capacity and infrastructure investment in developed countries. These partnerships would help ensure equitable ownership over science and advance effective governance.

IV. Action oriented pragmatic solutions

41. Building on the section above, this section will offer action oriented pragmatic solutions to challenges and opportunities. Including spotlights/snapshots of impactful initiatives that can be scaled up and serve as best practice. Only five years away from the 2030, initiatives that have been completed and/or are well on their way to completion should be highlighted alongside a discussion on their impact

42. Pragmatic solutions exist to the range of challenges and opportunities identified in the previous section but require greater coordination, replication and scaling up over the next five years if the SDG14 targets are to be met.

43. Coordinated by IOC since 2021, the United Nations Decade of Ocean Science for Sustainable Development (2021–2030) is arguably the largest coordinated global ocean science initiative ever undertaken. The Decade has galvanised over 20,000 individuals working in multi-disciplinary, international teams to implement 59 endorsed global Decade programmes and over 500 regional and national Decade projects. These Decade Actions are led by research institutes, NGOs, private sector and government partners in 76 countries. Thirteen regional and thematic decentralised coordination structures are hosted by partners including a newly launched Decade Collaborative Centre for sustainable ocean economy hosted by Barcelona City Council. 40 countries have established National Decade Committees. The 2024 Ocean Decade Conference, hosted by Spain in April 2024 in Barcelona, convened over 2600 in-person participants to discuss the science and knowledge needs that will guide the future priorities of the Ocean Decade, as well as opportunities related to partnerships and resources and the means of ensuring the full engagement of under-represented groups. The Ocean Decade remains the central UN-wide action framework to facilitate the generation and use of ocean science for sustainable development.

44. The third cycle of the Regular Process will result in the publication of the WOA which is scheduled to be approved by the UN General Assembly in December 2025 and will provide an invaluable synthesis and review of scientific knowledge regarding the state of the marine environment, including socioeconomic aspects, and as a resource for policymakers that can be translated to regional and national levels. There is a potential to update the publication "Marine Scientific Research: A revised guide to the implementation of the relevant provisions of the United Nations Convention on the Law of the Sea" developed by the Division for Ocean Affairs and the Law of the Sea in 2010 to incorporate any new practice in marine science and technology development and act as an important capacity development tool.

45. Voluntary commitments to implement Sustainable Ocean Plans as a means of developing evidence-based inter-sectoral policy and spatial solutions in support of a sustainable ocean economy are growing. In advance of the 2025 United Nations Ocean Conference, the 100% Alliance initiative is seeking to increase formal commitments from Member States to implement Sustainable Ocean Plans by 2030 and the Ocean Decade Sustainable Ocean Planning Programme and the Ocean Action 2030 Coalition are collaborating to provide technical and financial resources to assist States to meet their commitments.

46. New initiatives to strengthen the science – policy- society interface are emerging including the proposal for an International Platform for Ocean Sustainability (IPOS) as a demand-driven mechanism to provide evidence and scientific knowledge to support States to fulfil their commitments under global, regional and national policy frameworks. Enhanced ocean modelling capabilities are also critical to inform decision-makers on the state of the marine environment, marine life and the impact of human activities. The transition of MERCATOR OCEAN INTERNATIONAL – recognized as Decade Collaborative Centre for Ocean Prediction by IOC/UNESCO in 2022 at UNOC2 – into an international intergovernmental organisation will support this by facilitating the pooling of knowledge, technical expertise and resources, including those of national oceanographic organizations. It will conduct targeted joint research and developing free and open Digital Ocean Information Services and Digital Twins of the Ocean.

The 2025 United Nations Ocean Conference will also see an emerging focus on the science-policy interface at the sub-national level through the launch of the Ocean Rise

and Resilience Coalition which includes a focus on connecting municipal level decision makers to scientific knowledge and which builds on work on coastal cities carried out as part of the Ocean Decade.

47. The United Nations Food and Agriculture Organisation (FAO) is spearheading numerous initiatives to enhance the generation and uptake of science and knowledge to inform fisheries management and sustainable aquatic food production. Notably, the EAF-Nansen Programme enhances knowledge on marine resources, ecosystems and biodiversity through extensive data collection on fish stocks, habitats, environment and ecosystems through the surveys with the research vessel (R/V) Dr. Fridtjof Nansen, which operates year-round in waters of 32 partner countries and organizations in Africa and the Bay of Bengal. In addition, FAO is collaborating with the Fisheries and Marine Ecosystem Model Intercomparison Project (FishMIP) team, which is a global network of marine ecosystem modelers and scientists that provides projections of future climate change impacts on marine systems at global and regional scales. The Common Oceans Tuna Project modelled climate change and its impacts on tuna stocks in the Pacific, this work is currently being applied to Atlantic and Indian Ocean basins

48. ISA is strengthening its regulatory framework through among others consolidating scientific foundations. For example, with the assistance of an intersessional expert group, the Legal and Technical Commission is developing binding environmental threshold values aiming to set measurable requirements with regard to levels of harm from activities in the Area. To better understand and manage the possible effects of anthropogenic activities on deep-sea ecosystems, ISA launched the Sustainable Seabed Knowledge Initiative (SSKI) with the goal of describing over one thousand new species by 2030 from the regions of the Area that are currently being explored for mineral resources.

49. The International Atomic Energy Agency (IAEA), through its Marine Environment Laboratories in Monaco, deploys multiple global initiatives aimed at enhancing ocean health. These initiatives support capacity building trainings and activities, including the transfer of advanced technologies to its Member States and the generation of scientific knowledge in key areas such as ocean acidification, harmful algal blooms, biotoxins, blue carbon, radioactive and non-radioactive marine pollution and plastic pollution. Notably, the IAEA's NUTEC Plastics initiative is driving efforts to better understand microplastic abundance and its impact on marine and coastal ecosystems. Through this initiative, the IAEA is collaborating with more than 100 Member States to establish a global network of analytical laboratories across all continents, capable of producing scientific data and information on microplastic abundance.

50. Collaborations across UN agencies are also developing actionable solutions. UN-Oceans is an inter-agency mechanism that seeks to enhance, strengthen and promote coordination, coherence and effectiveness of the activities of the United Nations system and the International Seabed Authority (ISA) on ocean and coastal issues, including marine science. UN-Oceans can support efforts to identify priorities, enhance coordination and foster upscaling of successful initiatives to meet the ocean science challenges that persist.

51. Since 2020, IMO and FAO have been working together through a series of projects to assist countries, in particular LDCs and SIDS in preventing and reducing marine plastic litter from the maritime transport and fisheries sectors. The projects aim to achieve its objectives by focusing on a number of areas identified in the IMO Action Plan to Address Marine Plastic Litter from Ships, and in complementary actions as identified by FAO,

including supporting the provisions of the FAO Voluntary Guidelines for the Marking of Fishing Gear (VGMFG).

52. Financing and investment mechanisms that convene multiple partners around common goals are an effective means of leveraging resources to address challenges beyond the capacity of any individual stakeholder or partner. The Common Oceans Program financed by the Global Environment Facility contributes to the mobilization of co-financing and brings together UN agencies, international environmental NGOs, foundations, academia, and importantly the private sector, with representatives from the key sectors operating in areas beyond national jurisdiction. Other examples include the Belmont Forum that is developing a new oceans focused call that will convene resources from public and private financing sources, the OceanMatcher philanthropic investment tools under the framework of the Ocean Decade which aims to provide direct links between funders and research projects, and the Pink Flamingo Society that convenes a group of international philanthropic research vessels for coordinated and collaborative initiatives.

53. Initiatives to enhance gender inclusivity in marine science exist. For example, ISA has a vision of women from developing States playing a pivotal role in marine scientific research and mainstreams this commitment in all its programmatic documents including the ISA Strategic Plan and High-Level Action Plan 2019-2023, the ISA MSR Action Plan in support of the United Nations Decade of Ocean Science for Sustainable Development and the Capacity Development Strategy, respectively adopted by the ISA Assembly in December 2020 and July 2022. Another example is the IHO 'Empowering Women in Hydrography' Project, which was endorsed as a UN Ocean Decade project. IOC is developing a gender responsive strategy to enhance the role of women in ocean science.

54. Various initiatives involving the International Hydrographic Organisation (IHO), Organisation for Economic Cooperation and Development (OECD), IOC and other partners are striving to enhance the evidence base describing the economic, social and financial benefits of investment in ocean science and ocean science infrastructure as a means of enhancing investment from across society.

55. To achieve global seabed mapping goals, the General Bathymetric Chart of the Oceans (GEBCO) programme, jointly managed by IOC UNESCO and the IHO, has developed a new strategy, the five pillars of which (Data, Technologies and Standards, Capacity, Community, and Governance) indicate the breadth of activity that will be required to achieve a fully mapped seabed. The Nippon Foundation - GEBCO Seabed 2030 Project is acting as an 'accelerator' for gaining access to datasets that have previously not been in the public domain, as well as advocating for the need for new data collection and prioritising areas to be mapped. In recognition that greater effort is required, the UN Ocean Decade Alliance has developed a Seabed Mapping Initiative, designed to use the convening power of the Patrons to use the opportunity presented by the 2025 United Nations Ocean Conference, to secure commitment to a fully mapped seabed through delivery of the GEBCO Strategy. AREA2030 is a collective initiative implemented to foster partnerships and collaboration for the high-resolution mapping of the international seabed area (the Area) by 2030. Over the years, ISA Contractors have collected vast amounts of geological and environmental data during their exploration of the Area. AREA2030 aims to compile and analyse all the bathymetric data shared voluntarily by ISA Contractors, in line with the vision of ISA Members to help achieve agreed global objectives.

56. Ocean literacy is rapidly emerging as a critical tool for fostering global awareness and inclusive action on ocean sustainability to advocate for ocean conservation through transdisciplinary approaches that integrate education, research, and policy. For example, the IHO Capacity Building Strategy promotes a holistic approach to support coastal States, including academic capability development, while fostering to include Blue Economic and Environmental concerns within their national priorities. The youth community is also playing a vital role in ocean literacy efforts. The Ocean Literacy Task Team of the ECOP Programme, part of the Ocean Decade, supports ocean literacy initiatives through co-creating global projects, offering opportunities to showcase efforts, and collaborating with international partners for capacity building and mentoring. These case studies underscore the importance of participatory processes, along with transdisciplinary research and inclusive education, in building a more ocean-literate society. Citizen science initiatives are growing in number, and a new platform under the Ocean Decade aims to provide a single-entry point for such initiatives to allow individuals to take concrete science-based action.

V. Conclusions and recommendations

57. Many of the underlying challenges identified during the 2022 United Nations Ocean Conference with respect to ocean science and knowledge unfortunately remain relevant today with urgent actions associated with advancing ocean knowledge and capacity development still yet to be adequately deployed. Although the capacity to generate new knowledge and unlock existing information and data continues to increase, it is not occurring at a speed that meets global, regional or national needs. Without significant acceleration in the generation and uptake of science and knowledge there is a risk that SDG14 and the many related SDGs will not be met by 2030.

58. Global governance mechanisms aimed at improving outcomes for the ocean will not be able to be implemented effectively without a paradigm shift in efforts to either unlock existing data and information, or generate new data, information and scientific knowledge. In parallel, despite growing recognition of the importance of a strong and inclusive science-policy-society interface, efforts are still needed to ensure that effective mechanisms are in place to render knowledge accessible, and to develop capacity and awareness for the uptake of knowledge to inform decision making.

59. Investment lies at the heart of this issue. SDG14 is the least well-funded of all the SDGs. With less than 1.7% of national research budgets dedicated to ocean science, funding for ocean science is woefully insufficient to fill existing knowledge gaps and deliver the information needed for decisions, tools and solutions leading to a sustainable ocean. Increased investment and cooperation, including with private partners through public-private partnerships, will be essential to fill these gaps. Given the fundamental role of the ocean in supporting life and the livelihoods of humans on Earth, a lack of investment in achieving the targets of SDG14 has implications for almost all other SDGs.

Persistent spatial and thematic gaps in ocean observations, data, and knowledge remain, primarily due to a lack of sustained investment in ocean science infrastructure and research, for example around 70% of the global seabed is yet to be mapped despite growing, irrefutable quantitative and qualitative evidence of the benefits of seabed mapping to sustainable development. The situation is further compounded by a rapidly

changing climate and the complex interplay of multiple stressors which generate new and emerging knowledge gaps.

60. Weak uptake of scientific knowledge in decision-making stems from various factors, including the inaccessibility of knowledge in decision ready formats and a lack of recognition of ocean science as a fundamental contribution to nearly all facets of sustainable development. These gaps and challenges are particularly pronounced in SIDS and LDCs, where capacity, access to data, information and technology, and funding availability are more limited. Reflecting these challenges, new advancements in the law of the sea emphasize the necessity of accessible scientific information and data, including the requirement in the newly adopted BBNJ Agreement in relation to non-monetary benefit sharing, for open access to scientific data that is findable, accessible, interoperable and reusable.

61. The 2025 United Nations Ocean Conference provides an opportunity for a comprehensive stocktaking of progress towards SDG14 and the creation of new partnerships and initiatives to redress gaps in the remaining five years of the 2030 Agenda. The Conference also falls at the mid-point of the UN Decade of Ocean Science for Sustainable Development and has the potential to consolidate and strengthen momentum of the Ocean Decade to 2030. The Ocean Decade, which is coordinated by IOC UNESCO on behalf of the UN system, provides a global action framework for the generation and application of ocean science and knowledge and has already mobilized tens of thousands of stakeholders around the world in the largest, structured, global ocean science initiative ever seen. Through the Barcelona Statement, the Ocean Decade has identified a number of science and knowledge priorities to contribute to the achievement of the 2030 Agenda and complementary policy frameworks and these priorities should form a solid basis for discussion to identify action at the 2025 United Nations Ocean Conference. Equally important, the 2025 United Nations Ocean Conference should catalyse dialogue and partners to support the critical elements of a reinforced enabling environment for effective ocean science including **s**upport to the co-design of inclusive and interdisciplinary science and knowledge, that spans across sectors to support decision making and action and that fosters and catalyses innovative partnerships across society.

VI. Guiding questions

- What have been the main obstacles to overcoming the challenges that were identified in 2022 in the generation and uptake of ocean science and knowledge and how can we create the paradigm shift needed to achieve SDG14 before 2030?

- How can we leverage the strengthened global ocean governance and policy framework (including through the BBNJ Agreement, KMGBF, UNFCCC etc.) to increase support and resources for ocean science and knowledge?

- How can successful examples of work across the science-policy-society interface to inform decision making be shared, replicated and upscaled?

- How do we ensure that the knowledge of underrepresented groups including Indigenous Peoples and local communities, women and girls, and youth is taken into account and that they benefit from the progresses made in ocean science and knowledge?

- How well do the science and knowledge gaps identified in the background paper reflect the realities of Member States and other actors in SIDS and LDCs and how can we collectively support SIDS and LDCs in relation to ocean science and knowledge generation and uptake?

- How can we learn from other sectors or disciplines to build a stronger value proposition for investing in ocean science, including the recognition of ocean observations and data infrastructure as critical infrastructure that is resourced accordingly?