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Intergovernmental
Oceanographic
Commission



2021 United Nations Decade
2030 of Ocean Science
for Sustainable Development

First Global Planning Meeting: UN Decade of Ocean Science for Sustainable Development

13-15 May 2019

National Museum of Denmark, Copenhagen

DRAFT

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The UN Decade Series No.2

Background

To reverse declines in the health and functioning of the ocean system and to catalyse new opportunities for sustainable ocean uses, the United Nations General Assembly has called for an acceleration of ocean science by declaring a **UN Decade of Ocean Science for Sustainable Development** to be carried out from 2021-2030 to bring together scientists and stakeholders from all relevant sectors to generate the scientific knowledge and to develop the partnerships needed to inform policies to support a well-functioning, productive, resilient, and sustainable ocean. The Decade offers the ocean community a once-in-a-life-time opportunity to join efforts, mobilize resources, create partnerships with the private sector and the public at large, and engage governments in moving towards the ***Ocean We Need for the Future We Want***:

A clean ocean whereby sources of pollution are identified, quantified and reduced and pollutants removed from the ocean.

A healthy and resilient ocean whereby marine ecosystems are mapped and protected, multiple impacts, including climate change, are measured and reduced, and provision of ocean ecosystem services is maintained.

A predicted ocean whereby society has the capacity to understand current and future ocean conditions, and forecast their change and impact on human well-being and livelihoods.

A safe ocean whereby human communities are protected from ocean hazards and where the safety of operations at sea and on the coast is ensured.

A sustainably harvested and productive ocean ensuring the provision of food supply and ocean resources.

A transparent and accessible ocean whereby all nations, stakeholders and citizens have access to ocean data and information technologies and have the capacities to inform their decisions.

The Intergovernmental Oceanographic Commission of UNESCO (IOC) has been tasked to lead the preparation phase for the Decade, including (i) developing approved governance arrangements for the planning phase of the Decade, (ii) outlining the form and structure of the Decade, (iii) engaging and consulting relevant communities concerning preparations for the Decade, (iv) developing a resource mobilisation (business) plan, (v) communicating the purpose and expected results of the Decade to all stakeholders, and (vi) drafting an implementation plan for the Decade.

An Executive Planning Group has been established to advise the IOC governing bodies and assist in the formulation of the Decade's Implementation Plan, which will be developed through a process of consultations and engagement with a wide range of stakeholders at global and regional levels. Consultation is essential throughout the Preparation Phase (2018–2020) and through the Decade itself (2021-2030), to guide the development and evolution of the Decade's activities and to ensure that outcomes respond to specified policy requirements and regional priorities. This consultation will also ensure that the Decade's activities are in harmony with other UN, non-UN and non-governmental initiatives. The first Global Planning Meeting is the first step in that process.

The First Global Planning Meeting: Aims and Objectives

The first Global Planning Meeting was held from 13-15 May 2019 at the National Museum of Denmark, Copenhagen. This meeting was the first forum for international, interdisciplinary and multi-stakeholder dialogues to contribute to the preparation phase of the Decade. The specific objectives of the Global Planning Meeting were to:

- (i) identify the science questions, including additional Research and Development (R&D) priorities that need to be tackled in order to meet the societal outcomes that the Decade aims to achieve by 2030,
- (ii) elaborate plans to address these science questions, including potential programs, partnerships and resources,
- (iii) address cross-cutting priorities that are crucial to success of the Decade, such as capacity development and marine technology transfer, financing and partnerships, data and information sharing and knowledge exchange and communication, and
- (iv) connect with key stakeholders to build ambition and amplify engagement with the entire ocean community to prepare for the Decade.

The intended outputs of the meeting are to inform the preparation phase of the Decade and the development of the implementation and resource mobilization plan by identifying:

- (i) the research priorities and the related capacity-development needs as well as possible synergies with the Decade strategic objectives,
- (ii) the contribution of existing ocean research and capacity development communities of actions, workings groups, networks or programmes that are under development or planned (as well as their timeline) and how these can respond to the Decade priorities and objectives as well as knowledge gaps,
- (iii) consultations around themes addressing one or more core areas of work of the Decade (for eg. ocean observation, ocean data, ocean literacy) to be organized beyond this global meeting depending on the interest of various communities and partners, and
- (iv) opportunities for investment and resource mobilization for the Decade.

These outputs will be consolidated into a series of plans that will address the science questions and include potential programs, partnerships and resources. These plans will be further developed and complemented through a series of regional workshops, which will also prioritize the identified issues and define specific needs of the different regions and ocean basins.

A report of the Global Planning Meeting will be presented at the IOC Assembly in June 2019. The outcome of the Global Planning Meeting will also be presented at the UN Informal Consultative Process (ICP) on Ocean Affairs and Law of the Sea (10-14 June 2019, UN Headquarters). Further inputs to the planning process are also expected from relevant UN bodies and programmes through UN-Oceans, the inter-agency coordination mechanism for ocean affairs.

The meeting was attended by 248 participants from 50 countries from a range of disciplines and communities: 27% ocean policy and sustainable development, 25% ocean science and technology, 17% government representatives, 8% UNESCO/IOC staff, 8% civil society and NGOs, 6% business and industry, 5% host organization invitees, 3% donors and foundations, 1% press.

The agenda of the meeting is given in Annex I. A participant list is given in Annex II. A list of acronyms used in this report is given in Annex III.

Opening Remarks

IOC Executive Secretary Vladimir Ryabinin opened the meeting by welcoming the participants, introducing the panel members and thanking the local hosts, the National Museum of Denmark. He briefly discussed the goals for this meeting and encouraged the participants to stay focused on developing research priorities and capacity-developing needs within the framework of the Decade's strategic objectives, and to identify key partnerships for stakeholder involvement and investment. He also hoped that the meeting would generate real enthusiasm and excitement, a sort of 'snowball effect' for the Decade and that participants would return to their institutions and organizations to communicate the objectives of the Decade and build support and increased participation in the development process.

Rane Willerslev, Director of the National Museum of Denmark, welcomed the participants, stating that the museum was proud to host this first Global Planning Meeting for the Decade. He described the long history of the museum in cultural and underwater heritage and maritime archaeological research, as well as the museums concerns about the degradation of ocean health, pollution, and the impacts of climate change that are so important to maritime countries such as Denmark. He wished the participants a fruitful meeting and reminded them that the ocean expects and deserves the best from their efforts.

IOC Chair Peter Haugan thanked the Executive Planning Group (EPG) and the Secretariat, in particular Julian Barbière, for their hard work in planning this important meeting, and thanked the Danish Government and the National Museum of Denmark for hosting it. He reminded the participants that the UN General Assembly adopted a resolution in December 2017 that called for the UN Decade of Ocean Science for Sustainable Development, noting that ocean science is key to achieving many of the Sustainable Development Goals. This programme, he noted, is a triumph for multi-nationalism and must be an inclusive process where non-governmental partners will play key roles. He described how the programmes of the IOC, with 150 Member States, feed into UN Agenda 2030 for Sustainable Development in areas such as the Law of the Sea, multi-hazard warning systems, risk reduction, biodiversity, and observing systems. He recalled that the idea for the Decade was born at the IOC through the efforts of former IOC Executive Secretary Gunnar Kullenberg, noting the success and legacy of the UN Decade of Ocean Exploration (1971-1980). Mr. Haugan stated that it was a critical time to tackle the issue of sustainable development for the oceans, noting that science and knowledge are needed to underpin SDGs and that the services of the ocean science community are in demand, further emphasizing that this is an opportunity not to be missed. The Decade represents a once-in-a-lifetime opportunity to address these issues within the framework of a UN initiative, with both global and regional participation. He emphasized the challenge of developing such a programme that must work at the intersection of top-down ambitions and bottom-up actions. He reminded participants that this is the first global meeting for consultation about the development of the implementation plan for the Decade, and encouraged the participants to keep in mind that this meeting should produce a clear image of how to make a better world for future generations.

H.S.H. Prince Albert II of Monaco addressed a video message to the meeting participants, stating that the UN Decade of Ocean Science for Sustainable Development was of the highest importance and that action was urgently needed to redress degradation to ocean health. He highlighted the double mission of the Decade: to

carry out the ocean science needed for sustainable development and to transform society to adopt a sustainable development pathway. He encouraged participants to work together to define scientific objectives but also ways of life and development pathways needed for ocean health and human well-being.

H.E. Carsten Staur, Ambassador of the Kingdom of Denmark to UNESCO, described the many important links of Denmark with the IOC, noting that it was a UNESCO conference at the Danish Parliament that saw the birth of the IOC, and that Anton Bruun, the first chair of the IOC, was Danish. He also stated that Denmark was proud to host the IOC Science and Communication Centre on Harmful Algae at the University of Copenhagen, and hoped that this centre would be active in implementing the Decade. He noted that Denmark was a small country but with more than 1000 islands, giving it a coastline longer than 8500 kilometres. He further noted the importance of the maritime sector in Denmark, as well as the historical, economical, and cultural importance of the ocean for his country, and stated that Denmark intends to play an active role in the Decade to develop a sustainable future for the next generation. He reminded participants that failure is not an option.

H.E. Peter Thomson, United Nations Secretary-General Special Envoy for the Ocean, opened his remarks by informing participants that on the 9th of May the UN General Assembly adopted by consensus plans for a UN Ocean Conference to be held in Lisbon from 2-6 June, 2020, stating that this conference has the possibility to be a global game changer, with 193 Member States working together to scale up ocean actions through science and innovation. He stated that this conference would make an excellent launching pad for the Decade and that the timing was excellent. He reminded participants that these are critical times on planet earth, with changes in climate, biodiversity, and ocean system functioning, and that we are facing challenges that our species has never faced before. He emphasized that science is needed to provide the correct answers and solutions to these problems and that the Decade will take on this critical role at this critical time. He emphasized the need for the precautionary principle between now and 2030 as the Decade works to close the huge gaps in knowledge about little known areas of the ocean, particularly with regards to the deep sea and mining practices. He reiterated that the SDGs call for increased scientific knowledge, emphasizing the critical importance of capacity development, transfer of technology, and development especially for Small Island Developing States (SIDS) and Least Developed Countries (LDC). He provided specific examples of Pacific Island states, noting that there is great anticipation and enthusiasm for the Decade and the partnerships that will lead to sustainable development by 2030.

Setting a Vision for the Decade

IOC Media Advisor Mr. James Nikitine moderated this session and opened with a video of interviews of the EPG members to set the scene for the Decade and the preparation work ahead. He noted that meeting the SDGs will not be accomplished through increased data alone but will require new partnerships and planning with new communities and stakeholders, and capacity development. He emphasized that what was at stake was protecting the natural systems we rely on for our existence, that we cannot miss this opportunity, and that timing is critical.

Craig McLean, Assistant Administrator, U.S. National Oceanic and Atmospheric Administration, represented the EPG and provided the perspective of the EPG on the Decade and what it will take for the Decade to be a game changer. He noted that the phrase 'The ocean we need for future we want' can first be addressed by undertaking 'the science we need for ocean we want', and most importantly, keeping in mind the societal purpose for the science we undertake. He reiterated that this is a unique and critical time for the Decade, when the ocean is changing faster than we can measure baselines. More nations now have the capacity to participate in ocean science, philanthropic enterprises and private organizations are increasingly supporting ocean science and

conservation, and new technology and innovation is allowing significant rapid advances. He emphasized that the driving idea for defining research and development priorities for the Decade is the focus on answering the question, “What can we accomplish together that we cannot accomplish working separately?” Mr. McLean pointed to the legacy of the International Geophysical Year (IGY, 1957-1958), which helped to launch SCOR, the IOC, and pave the way for observing programmes (eg. the Global Ocean Observing System (GOOS)) that form the foundation of international ocean science coordination today. He noted that the IGY, like the Decade, began with small steps to finish with lasting impacts. He stressed that capacity development is of critical importance to the success of the Decade, and that small economies need to participate at each step and at all levels. He concluded by emphasizing the importance of using the Decade to address societal issues and the need to include social scientists in the design of the programme to deliver and communicate relevant science to meet SD goals.

Ed Hill, Executive Director, UK National Oceanography Centre, addressed the key challenges to achieve Agenda 2030 goals, noting that the Decade should be transformative in its impact but also transform the science we do and the way we do it. He highlighted three key focus areas that the Decade should seek to shift significantly: priority areas of science and technology research, scientific infrastructures, and the dialogue between science, policy makers, business leaders and society. He remarked that a decade is not a long time, that planning and implementation of actions are beginning now, and scientists cannot wait for new research findings before engaging. He stated that it was important to capitalise on existing, albeit incomplete, knowledge of marine systems to provide the best possible advice that can be given today. He felt that the focus of scientific research must focus on understanding an essentially highly complex, connected, non-linear system (both from a physical and ecological perspective), prone to instability and tipping points, and forced by human activities in unprecedented ways and rates, making prediction especially difficult. Research needs to be truly trans-disciplinary, embracing natural sciences, human and economic sciences and engineering and technology. He stated that GOOS needs to be expanded from a physical climate focus to incorporate biodiversity and biogeochemical parameters, saying that technology and innovation can transform ocean science. He emphasized that GOOS itself is currently unsustainable in the way it is funded and implemented and that a sustainable business model for GOOS is needed for the system to be sustainable by 2030. He concluded by stating that science outcomes must be more effectively communicated to society, governments and businesses.

Sigi Gruber, Head of the Marine Resources Unit, DG Research and Innovation, European Commission addressed how the European Commission (EC) will partner with the Decade, stating that there were many common areas of interest and action such as sustainability, leveraging technology and innovation, and developing useful information at all levels. She announced that the new framework for research and innovation in Europe will be published soon (currently pending approval) and ocean issues are well embedded in the programme. She highlighted several major novelties, including a systems approach to connect how we look at oceans from climate models, climate neutrality, adequate food resources, land-use issues, and specifically putting people first in addressing science issues. She also mentioned the importance of leveraging science and technology innovations for ocean sciences, structured partnerships with interconnected programmes where resources can be pooled. She emphasized that the EC is committed to ensuring broad access to data, noting that open access to publications and data from EC programmes is an obligation, and more importantly, ensuring broad access and accessibility to research results, not just data. She stated that the EC would like to partner with the Decade and IOC to bring results of research back to society, using new technologies adapted to ocean needs, and addressing our collective responsibilities through leveraging our networks for real success in 2030.

Erik Giercksky, Head of Sustainable Ocean Business of UN Global Compact, noted that there are 10,000 companies now committed to SDGs with an increasing recognition that big businesses must move toward a pathway to

sustainable development. He addressed how the Decade might harness these commitments from the business community as contributors and end users. He noted there was a sense of urgency about the oceans, that people recognize that the oceans are under considerable pressure, and companies want to be part of the solution, even land-based ones. He asked how we might use these interests to create business opportunities for achieving SD goals and putting businesses on a sustainable pathway. He discussed potential partnerships between the private sector and ocean science, such as pollution issues that create waste management opportunities. He challenged the participants to think of the business opportunities that may exist in the major ocean sustainable development challenges, including acidification and renewable energy. He informed participants that the UN General Assembly will be launching a set of ocean principles for the business community in September, and businesses will report on their impacts on the oceans through existing reporting regimes, explaining that the motivation for this is that businesses recognize that investors will not support a company that harms the oceans. This represents an opportunity for partnership between the business community and the Decade and IOC. He further reminded the participants that many industries also make ocean observations and have large amounts of data, as well as cutting-edge technology, that will be of use in this global partnership.

Erica Key, Executive Director of the Belmont Forum, addressed how international cooperation can be used to meet the goals of the Decade and facilitate participation of all countries. She explained that the focus of the Belmont Forum is to facilitate inclusion and diversity in understanding, mitigating and adapting to global environmental change. The model of cooperation of the Forum is based on inclusion, communication and coordination among projects, joint implementation with resource pooling and in-kind support, bringing together scientists with policy makers, open data sharing and building trust among nations to work together, and ensuring that research results are communicated and shared. She encouraged the participants to keep in mind that just because countries may not be bringing money to the table doesn't mean that they can't contribute to the programme. Participation and in-kind support brings advantages to all.

Mathias Jonas, Secretary General of the International Hydrographic Organization, stated that the primary focus of the IHO in the Decade is to produce a Digital Atlas of the ocean. He described the history of the IHO and its work mapping the deep sea, starting with the GEBCO programme in 1905 initiated by Prince Albert the First of Monaco. With this nautical charting history, he explained that the major contribution of the IHO to the Decade is their expertise with marine spatial data infrastructure and their experience in coordinating the relevant organizations and agencies for ocean mapping, including adopting methods and approaches. He further noted that the Decade is a valuable partner in the creation of the Digital Atlas for motivating experts and amateurs to collect and contribute more marine data. He warned that there is a sort of scientific egoism with data, where the research community treats their data in a proprietary way and believes that data collected through other non-research organizations is not of sufficient quality to have value, stressing that this must be overcome to increase data flow, particularly in data-sparse areas or in developing countries. He further stressed that addressing SD goals requires interdisciplinary data streams from multiple sources, and that these data streams need to be made inter-operable to enable better nowcasts and forecasts. He finished by saying that the ambition should not be to create simply a Digital Atlas of bathymetry but rather a Digital Aquarium that allows anyone to dive and explore the ocean virtually for a better understanding and application of science.

Lysa Wini, Ministry of Environment, Climate Change, Disaster Management and Meteorology of the Solomon Islands, described some specific challenges facing SIDS and how the Decade should help. She asked participants to try to understand how islanders perceive the world, noting that the very terminology used to describe rich-country issues has no application for many SIDS, where urban transportation systems are canoes and the economy is built on back-breaking labour. She noted that the challenge is how to adapt global experiences to

local living, and encouraged the participants to co-design the Decade at a global level so that goals can be attained by everyone and with strategies that are adapted for poor countries. She stressed the knowledge gaps and lack of local capacity that exist in many areas, where there are few ocean scientists and where they are unable to implement programmes. She emphasized the need for capacity development but also stressed that it is crucial for poor countries to retain local capacity. She pointed out that traditional knowledge and local indigenous communities have much to offer the Decade, and that these communities have been addressing local environmental problems and sustainable living as part of their culture for centuries. She noted, however, that many ways of life are destructive and unsustainable, and that the global agendas developed are often not theirs. She encouraged the Decade planners to listen to their stories and to consider not only their capacity development needs but also what they have to offer to address SDGs that could be valuable for everyone.

Ludgarde Coppens, Head of the SDG and Environment Statistics Unit, Big Data Branch, Science Division of UN Environment, emphasized the need to improve our way of communicating and the ways in which UNEP could partner with the Decade. She noted that communication is the bridge between what we know and actions needed to address very complex problems, with the very real challenge of effectively communicating that complexity to policy makers. She stated that an important transformation of the Decade will be to include socio-economic and social and ethical sciences in the design of science plans and the communication of research results to groups beyond the scientific community. She described the experience of UNEP in linking science with policy, stating that policy makers need improved and targeted forecasting and knowledge for long-term planning, and noting the importance of inter-ministerial coordination to address SDGs. She noted that Agenda 2030 is about inclusiveness and leaving no one behind, and that the design of the Decade must look up from local levels to global levels to include other forms of science from new communities, such as citizen science programmes. She suggested that the Decade needed to encourage the development of those programmes and ensure that the quality of the data is sufficient to build trust and acceptance of these important local sources of data. She finished by offering the support, coordination and partnership of all departments of UNEP for the Decade.

Decade Preparation: Introduction to the Preparatory Phase for the Decade and Aims for the Global Meeting

Vladimir Ryabinin, IOC Executive Secretary, described the Decade as a new social contract for ocean science that requires the commitment of all scientists to work towards moving society forward to achieve sustainable development goals. He emphasized that ocean observations and data will form the backbone of all aspects of the work for the Decade, from knowledge gaps for the deep ocean to predictive skill for defining development pathways and moving from science to societal benefit. He further noted that societal benefits and applications must motivate the work of the Decade and that social scientist must be involved in the design of the Decade. He reaffirmed that the Decade must be based on a strong foundation of capacity development with no nation left behind. He encouraged participants to use this meeting to think about the work of the Decade on global, regional and national scales and to identify ways to engage in the design process for the development of a first-draft implementation plan for the UN Ocean Conference in Lisbon in June 2020. He charged the meeting participants to be ambitious in their brainstorming but to stay focused on identifying research priorities that contribute to sustainable development goals and have societal impacts that can make a real and lasting difference.

Youth Perspective

Guillermo Ortuño-Crespo, Ph.D. student of Marine Science and Conservation at Duke University Marine Geospatial Ecology Lab and Fellow, Nippon Foundation Nereus Program, addressed the meeting as a representative of the next generation of ocean scientists who will take up the baton of marine scientific research and sustainable development in the decades to come. He thanked the organizing body for making this an inter-generational conversation from the very beginning. The intervention highlighted that, for young scientists, the Decade of Ocean Science represents an opportunity of a lifetime, an opportunity to establish knowledge bridges across ocean basins, disciplines, ecosystems and forms of knowledge. This generation and those that will follow will hugely benefit from an ambitious Decade that prioritizes interdisciplinary research, multi-stakeholder engagement, training opportunities, innovation, the development and deployment of new technologies, and the exchange of marine knowledge. In this day and age, given the new and emerging means of communication available to us, there is no justification for young marine scientists not to be equipped with the latest tools and knowledge, that may help them in their path towards understanding and sustainably managing marine ecosystems – wherever they are in the world. The need for increased investment and national research expenditures, opportunities for cross-disciplinary and cross-sectoral collaborations, as well as access to harmonized ocean data and analyses was highlighted as critical to form the backbone of this international endeavour. Regional and global networks and partnerships between ocean communities, research groups, governments, industries, academia and other members of civil society are crucial to facilitate this.

To gather perspectives from young scientists, the IOC reached out through its global network to produce a 3-minute video of interviews of young scientists from around the world to ask why the Decade is important and what it could achieve. This video was played for the participants.

The participants warmly thanked Mr. Ortuño-Crespo for his message, and agreed that the Decade is a critical opportunity for youth, early-career scientists and young ocean professionals from all stakeholder groups to participate in a global, interdisciplinary effort. In turn, these people and their knowledge and networks are a critical workforce to deliver on the transformative changes that are expected under the Decade.

Panel Discussions

Panel 1: A clean ocean whereby sources of pollution are identified, quantified and reduced and pollutants removed from the ocean.

This panel focused on new ideas for integrated research to assess the human and environmental risks of ongoing and future types of ocean pollution and to generate innovative approaches to reduce the ocean pressures by promoting recycling, pollution reduction measures and incentives.

Panel co-chairs were Suzan Kholeif, President of the Egypt National Institute of Oceanography and Fisheries and Peter Kershaw, Chair of UN Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP).

The session was opened Suzan Kholeif, who noted that, while we all depend on the ocean for well-being, humanity uses the ocean as a dumping ground for waste. The Decade offers a once-in-a-generation opportunity to work to protect the ocean and our own future. She reminded the participants that this panel is charged with generating research and development priorities to meet the SDGs and emphasized the importance of a regional approach to pollution problems.

Peter Kershaw noted that these three days provide an opportunity to brainstorm about how can we maximize potential opportunities of the Decade. *It is difficult to define what is meant by a clean ocean, recognizing that the ocean will never be pristine. How do we define what is “clean enough”, what are our aspirations, how can science address these, and what are our priorities? Pollution comes in many forms, including plastics, chemicals, sewage, nutrient run-off from land, acidification, hydrocarbons, and underwater noise. Pollution cannot be dealt with from a purely ocean perspective since many sources of pollution come from the land and the atmosphere. Social science is important for understanding what actions and behaviour modifications would lead to desired outcomes. Science has to engage with government frameworks and civil society to determine how we can exploit ocean resources in a sustainable way.*

Monika Stankiewicz, Executive Secretary of the Baltic Marine Environment Protection Commission, Helsinki Commission (HELCOM), described the 18 Regional Sea Conventions and Action Plans around the world, including the Baltic Marine Environment Protection Commission (HELCOM), united under the UNEP Regional Seas Programme. *The Regional Sea Conventions serve as an effective policy-science interface and cooperation platforms for a clean ocean. Cumulative impacts and pressures have recently been assessed by HELCOM in the “State of the Baltic Sea” report. Most of the identified impacts in the Baltic Sea are attributed to nutrient concentrations, followed by hazardous substances, non-indigenous species, and the extraction of fish. Eutrophication is the biggest environmental problem in the Baltic Seas, which has been addressed since HELCOM was created over four decades ago. In the 1980s, HELCOM set a 50% reduction target for nutrients and hazardous substances. Since then, the annual input of phosphorous has been reduced by 40,000 tonnes, thanks to the measures taken by the coastal countries. In 2007, a HELCOM nutrient reduction scheme was adopted by the Baltic Sea countries. The scheme consist of common eutrophication indicators with quantitative threshold values representing a boundary between good and poor status of the marine environment, Maximum Allowable Inputs of nutrients to each sub-basin of the sea, and country-wise nutrient reduction targets. This innovative approach to managing pollution has been possible thanks to advances in science and cooperation between HELCOM and the scientific community. Recovery of the marine environment is slow and estimated to take decades, partly due to phosphorus that has accumulated in the sea bottom sediments. Still, the HELCOM countries remain committed to reaching the nutrient reduction targets and the work continues. Recently, environmental economists have been engaged in HELCOM to support a regional scale social and economic analysis to show the importance of the Baltic Sea marine environment to society. For instance, it is estimated that combatting eutrophication will result in annual economic benefit in the order of 4 billion Euros. However, the impacts of climate change are putting the implementation of the existing anti-pollution policies at risk. Reaching the nutrient reduction targets will mitigate impacts of climate change to a certain degree, but even more ambitious levels of reduction of pollution will likely be needed to achieve the regional goal of a sea unaffected by eutrophication. The Decade is an opportunity to emphasize and elaborate on the role of the ocean in climate change mitigation and adaptation, and importantly, offer science-based solutions to adequately address pollution in light of the climate change and empower for actions across the entire society.*

Marc Simon, Innovation Director, Suez Environment, explained how the private sector can offer solutions to ocean pollution problems. *Implementing solutions is often not limited by new data but is limited by lack of consideration in strategic decisions. “Where there is a will, there is a way”. The Ganges River Basin strategy, for example, is a \$3-billion investment in waste water collection and treatment facilities designed to clean the Ganges river, which demonstrates the principle that with strategic leadership, tangible programmes can be implemented. However, clean oceans will be based on locally-designed solutions and not by global companies, where solutions must be developed by partnering with local organisations, NGOs, small companies, local partnerships and initiatives. There is a movement within the private sector to eliminate packaging that uses materials that cannot be recycled.*

Education for businesses is critical. Many businesses' bottom lines will be hit by pollution in areas of fisheries, tourism, and transport. The private sector collects a large amount of ocean data and encouraged partnerships to make best use of these resources.

Tosca Ballerini, Scientific Officer of Expedition MED, described this French NGO that is active in citizen science projects, specifically focusing on the example of plastic pollution. *While beach clean-ups are successful, they are not a solution to the problem but rather a symptom of a lack of a solution. NGOs and civil society play a key role in keeping pollution issues visible with the general public and also on the political agenda, and these sectors are key for literacy and influencing behaviour modification needed to inform individual choice and environmental responsibility. An estimated 25% of plastic pollution in the ocean comes from rivers in Asia and Africa and any attempts to stem global ocean pollution must deal with these regional land-based problems. There is often a perception that citizen science is not good enough for research purposes, and the MED programme has addressed these issues by partnering citizen science programmes with the research community to develop protocols and use technology that allow citizens to participate as valued partners in ocean observations.*

Daoji Li, Professor, East China Normal University, addressed the issue of the need to set priorities for dealing with pollutants, stating that while all are important, not all are urgent. *Transportation and sinks are complex, with many ocean pollutants having land-based sources. Standard guidelines must be established and toxicity understood for setting priorities, and setting priorities is urgent and requires consultation with all stakeholders at a global level. There must be an emphasis on controlling sources of pollution rather than cleaning. The development of regional agreements and initiatives on sources, sinks, and types of wastes in all countries must be a priority.*

Panel 2. A healthy and resilient ocean whereby marine ecosystems are mapped and protected, multiple impacts, including climate change, are measured and reduced, and provision of ocean ecosystem services is maintained.

This panel addressed generating knowledge of the ocean system, its role in the Earth and climate systems including the human component, its biodiversity and the seabed, with an emphasis on interdisciplinary research aimed at understanding impacts of cumulative stressors on the ocean ecosystems and the science necessary for sustainable ocean management.

This Panel was led by co-chairs Youn-Ho Lee, Korea Institute of Ocean Science and Technology, and Linwood Pendleton, Global Ocean Lead Scientist, World Wildlife Fund for Nature (WWF) and International Chair of Excellence at the European Institute for Marine Studies, Brest, France.

Youn-Ho Lee introduced this session, noting that science is needed by policymakers, industry, governments and private citizens to achieve a healthy ocean. He emphasized the importance of the relationship between natural and social science to define the scientific mission of the Decade.

Linwood Pendleton stressed that the focus of the Decade should be on the science needed to ensure a healthy and resilient ocean. He introduced the speakers and invited them to share their views and suggestions on how to achieve a healthy and resilient ocean.

Jane Lubchenco, Professor, Oregon State University, opened this panel discussion by highlighting the importance of developing a new social contract for ocean science, one in which science serves society and is embedded in society. *The vision for the future is a world where citizens and policy makers embrace science and know how to use it to make decisions, and where there is enhanced enthusiastic support for science because the direct value of it is evident. To achieve this vision there is a need to change the narrative we have for the ocean, since narratives frame our thinking and influence our values. The dominant ocean narrative says that the ocean is so vast that it cannot be impacted significantly by human impacts, that it is too big to fail. Another narrative centers around a doom and gloom scenario where the ocean is already so damaged that it is impossible to fix, where vested interests and limited options make efforts meaningless. At a time when we need more, not less, from the oceans, this pervasive narrative that the ocean is impossibly broken represents a real hindrance to action. We need to develop and promote a new narrative that acknowledges that challenges are unprecedented and complex but not insurmountable, and that new science carried out through new partnerships and taking advantage of advances in technology and innovation will be able to address these challenges. We need to highlight those successful science-based efforts at restoration that give us hope that we can heal the ocean and solve multiple other problems at the same time such as food security, climate impact change, and equity. The ocean is big – too big to ignore – and is central to addressing sustainable development goals. This new narrative won't change the status quo, but if it is widely adopted it will change people's perception about what's possible; what could be, not what is. Achieving the goals of the Decade will require a conscious adoption and promotion of this new narrative; not just doing the science but changing the perceptions of the public, industry, and policy makers about what is possible.*

Simon Walmsley, Chief Marine Advisor, WWF-UK, stated that marine science must adapt to new challenges, specifically issues like biological diversity beyond national jurisdiction (BBNJ) where significant knowledge gaps exist and changes in biodiversity are faster than expected. *We need a classification system and Marine Protected Areas with vertical as well as horizontal spatial integration. Migrating species need to be protected throughout their range, and we need data on sentinels and fit-for-purpose measures. We need to determine if MPAs and networks of MPAs are effective at doing what they were established to do, and to carry out marine spatial planning exercises on the use of ocean space, regional assessments and planning. We need more national contributions to the Paris Agreement and to establish linkages between ocean climate and blue carbon, and we need more data on the fate and behaviour of plastics in the ocean to develop regulations. Even if the implications are not fully understood, the precautionary approach must be applied. Finally, we need increased awareness about ocean issues and the value of the ocean through programmes of ocean literacy, visualization tools and a "digital aquarium".*

Paul Snelgrove, University Research Professor, Memorial University of Newfoundland, felt that the most important knowledge gap deals with understanding the drivers and sustainers of ecosystem function. *Biology is essential, but biogeochemistry and physics also play a determining role. A second priority issue is habitat provision, creating a baseline knowledge of who lives in different environments. Existing baselines describing our knowledge of habitats are very different between developed and developing nations. There is also the issue of continuity in environments, where what happens upstream can be as important as what happens in situ, so land effects have impacts on ocean systems. We need to be able to predict distributions and patterns, and how to do sampling and mapping to achieve this. We have some sense of the response value of perturbation and vulnerability, but there are still many unanswered questions. Technology development will be key, including sensor development across all disciplines but particularly for biology where technology lags. Humans are also sensors, and citizen science and indigenous knowledge is important for filling critical gaps. We need more autonomous sensors and satellites for biological variables, and wider use of e-DNA techniques. Innovations in imaging technology and advances in*

computational modelling are leading to rapid and spectacular advances in the biological sciences. An important question is how to use these advances to enable capacity development, which may include training students in developing countries in new technology, bringing technology and training to local scientists on research ships in coastal waters, or transferring new technologies to institutes in developed countries, which is the most challenging because of the need to maintain these instruments over time.

Nicholas Bax, CSIRO, University of Tasmania and Co-chair, Biology and Ecosystems Panel of GOOS, joined the meeting via video conference and discussed the biology and ecosystems panel of GOOS, highlighting new technologies, remote sensing techniques, autonomous instruments, and e-DNA techniques. *There is an urgent need to recognize the value of data and our responsibility to collect it in such a way that it can be shared with other scientists through international collaborations. The Biology and Ecosystem Panel of GOOS has developed Essential Variables that help us collect and share data, and collaborative frameworks like Future Earth help to ensure that data are used and re-used for many years. The Census of Marine Life galvanized collaborations and left a legacy of new programmes that were created, but many areas of research and data collection simply stopped after the programme ended. The Decade must last beyond the Decade and change the way we work together to provide observations and data for decision-making. We must shift our culture towards collaboration, data collection and metadata sharing, and need a quantum leap in capacity development so that all countries can manage their own resources and participate in science and conservation efforts in areas beyond national jurisdiction. This is especially important for SIDS and LDCs. These capacity development activities must be sustained, sustainable, and not end when project ends. It is obvious that you can't manage what you don't measure. Sustained observations are essential to underpin effective management actions such as restoration of ecosystems, deep sea mining, and the designation of marine protected areas. We have successes in assessing status, improving management and restoring some habitats, and can work together to determine best practices and approaches for particular situations. To meet the SDGs, we need to improve indicators and sustained observations at the global level.*

Yoshitaka Ota, School of Marine and Environmental Affairs, University of Washington and Policy Director of the Nippon Foundation Nereus Program, discussed the relevance of ocean SDGs to human well being, citing the most pressing issues of hunger and poverty, where climate change and global environmental changes will lead to greater disparity in the near future in access to ocean resources. *There is currently a lack of coordination among disciplines in addressing many ocean issues, and these academic silos must be broken down if we are to address the challenges of sustainable development. This gap exists not only at the level of research but also at the programmatic level. Gaps in training and knowledge about how to use data for decision making are large but these linkages will be critical to the success of the Decade. The Decade must reflect our values and relationship with the ocean through equity, inclusiveness, diversity, and responsibility, and the Decade must include sciences as well as the humanities and other forms of world views in planning for the ocean future we want.*

Panel co-chair Lindwood Pendleton suggested that science should operate in a way that serves society and invited participants to continue the discussions during the breakout group dedicated to a healthy and resilient ocean scheduled on Day 2.

PANEL 3. A predicted ocean whereby society has the capacity to understand current and future ocean conditions, forecast their change and impact on human well-being and livelihoods.

This Panel addressed enhancing ocean observing networks, data systems and other infrastructure including their supporting cooperation and partnerships so that society has the capacity to understand current and future ocean conditions, forecast their change and impact on human well-being and livelihoods.

Co-chairs for this Panel were Fangli Qiao, Secretary General and Deputy-Director General, First Institute of Oceanography, China's Ministry of Natural Resources and Craig McLean, Assistant Administrator, U.S. National Oceanic and Atmospheric Administration.

Graham Allen, Acting Director of The Nippon Foundation GEBCO Seabed 2030 Project, described his work with Seabed 2030 Project and how it will link to the Decade. *The Seabed 2030 project is an international collaborative effort being carried out by a community of ocean mappers to complete the map of the world's ocean by 2030 and to make the data fully available. The project will work with the Decade to mobilize the mapping work in several ways: 1) Data sharing. The project does not currently have all existing data that is out there. There are many data sets sitting in laboratory computers and not being shared. An important first step must be to share data that already exist. 2) Sharing and coordinating regional mapping initiatives. Many projects are already on-going, and the generated regional maps must be shared. The project cannot afford to replicate work. 3) Optimize and maximize. Many working vessels that ply the ocean have instruments capable of bathymetric mapping that are not switched on during transits between research stations. An effort must be made to convince these ships to collect data en-route. We must also carry out research to determine where we do have data, where we have gaps, and optimize ship tracks so that we do not repeat tracks already covered to make the best use of resources. We also need to use citizen science and mobilize crowd sources. Innovation is needed to develop new autonomous technologies. The private sector also has an important role to play in developing the innovation needed, and the vision of the Decade should serve as a call to stimulate the discoveries needed.*

Kentaro Ando, Director International Research in the Western Pacific Region, Research Institute for Global Change, Japan Agency for Marine and Earth Science and Technology, discussed the Tropical Pacific Observing System TPOS2020 project and contributions and lessons for the Decade. *The TPOS2020 Project is evaluating and revising the elements that contribute to the TPOS to provide data, science, and prediction capability required to promote sustainability. The TPOS2020 embraces integration of diverse sampling technologies, including making full use of new and emerging technologies and integration of biogeochemical and biological sampling into the TPOS design and implementation. The TPOS also facilitates experiments, process studies, and modelling to guide improvements in climate prediction and associated applications. An increased importance is placed in the areas of biogeochemistry, ecology and fisheries, and developing a system of indicators to meet the SDGs in the Decade.*

Lisa A. Levin, Professor of Biological Oceanography, Scripps Institution of Oceanography and founder and co-lead of the Deep-Ocean Stewardship Initiative (DOSI), emphasizing that there has not been enough attention to the deep sea, which is an integral part of climate system, covering 50% of the planet. *The deep ocean contributes to heat uptake and climate regulation, is a repository of unique biodiversity, and is key to our planet's ability to adapt to changing climate. We use the deep ocean for extraction of resources, fish, energy, oil and gas, minerals, and genetic resources. The deep sea is a major repository of debris and contaminants, for carbon dioxide, and is considered in many geoengineering schemes even though we do not have sufficient knowledge about the deep ocean. We know the important role the deep ocean plays in heat and fresh water budgets of planet, its energy balance, sea level rise, overturning circulation, and geothermal heating, but there are still questions about budgets that we need to observe and measure to answer. Natural and anthropogenically-driven climate variations affect temperature, carbon, and oxygen. The ocean is losing oxygen. How do system changes affect carbon and organic matter, and what does this mean for pelagic and benthic ecosystems? How is life in the deep ocean*

responding to climate change, and what is the tolerance threshold to adapting? We have so few answers to offer about the deep sea. We need to know what lives there, about diversity, how interactions are connected in the deep but also to surface waters and coastal areas. Structure translates to function in ecosystem services and how they affect people. How do deep ocean systems adapt to human disturbances such as fishing, energy extraction, and climate? How likely are our activities to make things go extinct? We need to expand our idea of what it means to map the sea floor. We need to map diversity and services, not just physics and chemistry. The scientific community will be called on to start this process. We need new synergies to use existing platforms and new techniques; we need to use innovative mapping and visualisation tools to locate observing system platforms (ships, Argo floats, mammals with sensors, etc.). We need to develop new networks of observing system stakeholders; for example, the exploration community can be re-purposed for observation help in the deep ocean. The deep ocean should be mainstreamed into discussions across all of the societal benefit areas, not just A Predicted Ocean.

Steffen M Olsen, Danish Meteorological Institute, discussed the European Blue-Action project that is establishing new partnerships to look at the Arctic's impact on weather and climate, which will be part of the emerging science of Decade. *The Atlantic ocean, with its overturning circulation and changes in ice and snow cover drive key climate processes, such as heat anomalies, fresh water budgets, and deep mixing. These processes need to be observed adequately to improve annual to decadal predictions of heat content and sea ice anomalies. The prediction systems for the Atlantic are the most developed of any part of the globe, but there are still surprises. The year 2015 was the hottest year on record, with the exception of one region in the North Atlantic where record cold anomalies were observed. The Blue Action project targets science to policy-relevant needs, and recognizes that partnerships with social science and the economic sector are needed to develop the capacity to respond to climate change.*

Pierre Bahurel, Director-General, Mercator Ocean International, addressed the frontiers in technology for satellite and in situ measurements and forecasts that the Decade should focus on. *Mercator Ocean International is an operational marine service with hundreds of partners in Europe with over 100,000 users, where 50% of the subscribers are from research (and attesting to the high quality of the data), 20% private and business, and the rest from private sector and NGOs. Today we are able to monitor the global ocean in real time using satellite and in situ measurements combined with models, and with results simplified and packaged to produce something users need (for example, temperature or current forecasts). Mercator has enthusiasm for improving and enlarging the system, stating that it can provide information about heat content, sea level, and ocean acidity, and provide this information as an ocean state report that can be used for sustainable development decision making. One of the challenges of the Decade would be to think about align observing capacity and modelling capacity. We need to keep in mind the importance of pooling observations and that there are not enough ocean biology and ecosystem data being collected to meet SDG goals. There is a great need for increased communication, data and information sharing, and reaching out to citizens and policy makers.*

Essam Yassin Mohammed, Head of Inclusive Blue Economy, International Institute for Environment and Development, emphasized the human dimension of ocean science and the relevance of science for making a difference in the lives of the millions of people who use the ocean. *There is a surging youth population in Africa that is expected to double rapidly, putting increased pressure on ocean systems. With a huge work force coming into action, how can we make sure they can have the opportunity of employment and the capacity to be productive? Marine resources, and the fishing sector in particular, represent an opportunity for many in developing world. We need to appraise the value of ocean resources in economic terms and bring this information to finance ministers in order to make a business argument for investment and innovation in the marine sector. Economists also need ocean data to calculate risk and changes in ocean services due climate change. How much*

do we know about the extent to which climate change may impact resources, livelihoods, hunger, poverty, jobs, or equality? All these issues are key to meeting the SDGs. We must inform policy makers using arguments they can use, and make sure that ocean and climate issues are at the core of all debates about these human issues. We also cannot ignore that 50% of the planet is in areas beyond national jurisdiction. We have started the negotiation process for management of the high-seas areas beyond national jurisdiction but the deal we strike has to be informed by science, not individual legal arguments of individual nations protecting their interests. This will be a huge issue in next few years, and the science must be in place to inform these high seas negotiations.

PANEL 4. A safe ocean whereby human communities are protected from ocean hazards and where the safety of operations at sea and on the coast is ensured.

This Panel discussed saving lives, ensuring safety at sea, seafood safety, and reducing risks from extreme events and ocean hazards through accelerated programmes of research and development of integrated multi-hazard early warning systems accompanied by improved community preparedness and awareness.

This Panel was co-chaired by Thorkild Aarup, Head of Tsunami Unit at UNESCO/IOC and Jens Krüger, Manager, Ocean Affairs, Pacific Community, Fiji.

Thorkild Aarup discussed the protection of human communities from hazards and ensuring safety of maritime operations. *Natural hazards and disasters have economic and social consequences for 600 million people living in low coastal zones, a number projected to grow exponentially in the coming years. The costs of hazards and expanding development require new efforts to assess risks. It is the fundamental role of sovereign states to protect their citizens from threats, including threats from natural hazards and disasters. All nations do this to some extent but many countries have limited resources. Preparedness, observations, science and technology, and operational institutions at the national level are needed to ensure safe marine operations, monitoring and mitigation of risks. Some countries have established national institutions that provide routine services and contribute with applied research and development. For the Decade there are several issues for ensuring a safe ocean. Nations have a responsibility to build national resilience, but there is an enormous benefit in working together, particularly for warning systems that have to collaborate with research and operational networks at the national and international level. Most financing is national and governmental, but are there alternative ways of financing these systems? How can existing national institutions contribute to hazard monitoring? For early warning systems, where a perfect warning system is ineffective if people don't know what to do when a warning is issued or if that advice is not adapted to their society and capabilities, we must link the science and technology to socio-economics, education, and decision-making.*

Jens Krüger introduced the Panel members.

Michael D. Angove, NOAA/National Weather Service Tsunami Program Manager, pointed out that a safe ocean is not one where there are no tsunamis. *A warning system can only eliminate the element of surprise. The 2004 Indian Ocean tsunami, for example, propagated to Africa and caused deaths nine hours later. If an effective warning system had been in place, much of the destruction could be avoided. The system is improving all the time, but is still far from being what it needs to be. We have real world examples now of situations in which a warning was issued, people knew what to do, the local authorities were coordinated, instructions were followed, and damage and death were limited. The Indian Ocean tsunami was a wake-up call and we will probably never see that level of destruction again because of the global reaction and development of the warning system. However,*

there are still populations that are vulnerable to the element of surprise in areas affected by tsunamis where agencies and services are not in place. Many areas are under-sensed and under-served. The necessary technology exists, but systems are simply not implemented in all places. The Decade can help with this. You cannot have appropriate forecast and warning systems based on data from land-based seismometers alone. If you are going to be serious about a tsunami warning system, you have to go look for triggers where they occur, and that's at the bottom of the ocean. That's a real technical challenge and one that takes considerable political will and financing. The Decade can help to mobilize the deployment of instruments for the deep ocean and to make use of the fiber optic cables already in place that could be used for earthquake detection without new instrumentation. New partnerships with the private sector should be a priority.

Ofa Fa'anunu, Director of the Tonga Meteorological Service, discussed the Pacific context of early warning systems and the capacity development needed for SIDS and other territories in tackling early warning issues. *The Pacific is the world's largest ocean but less than 10% of the monitoring buoys are in these areas due to limited resources and the geographic spread of islands, making monitoring and maintenance of existing infrastructure challenging. Forecasting and early warning systems suffer from the lack of baseline data and information. It is an extremely difficult exercise to collect data in these remote areas. Waves and storms affect Pacific islands differently than the continent. Large scale models have good accuracy at sea but are insufficient to tell us about inundation near shore. We have to develop data assessments and forecast systems for regional islands. Tsunamis are a real threat to all Pacific countries on the 'Rim of Fire' with some countries located next to active volcanoes and trenches. Warning systems here represent a very complex service. At present, only the tsunami warning system is sufficient in some regions; the system still cannot track submarine landslides, for example. Many islands still have no tsunami warning system at all. Staff competence in national warning systems is often poor, and tsunami watch-keeping services are needed. The Pacific Island Strategy, a regional programme with the IOC and WMO, is working to develop a multi-hazard warning system and associated marine services that also helps to mobilize funds in our priority areas. A Marine and Ocean Services Panel has been set up to provide expert advice to develop a system for a protected coast, with impact-based forecasting on the horizon. Some countries have already started this, focusing on forecasting impacts rather than ocean state. There is also a need to identify and use indigenous knowledge to fill gaps between indicators and impacts that we don't monitor or forecast. The Decade should inspire an increase in R&D methodologies for rapid detection of storm surges and tsunamis, strengthen partnerships, develop competence for national warning systems, enhance those systems with new smart technologies, and improve partnerships in SIDS and LDCs.*

Bengt Karlson, Senior Researcher, Swedish Meteorological and Hydrological Institute, discussed new tools to observe and predict harmful algal blooms. *New automated in situ microscopes can take measurements every 20 minutes, satellites can be used to observe large biomass blooms, and mobile molecular methods are making it possible to detect small-scale harmful algae and biotoxins as never before. Many new tools exist but are still very expensive. We have learned that some harmful algae are not toxic all the time, but only when zooplankton are around, making it clear that we must adopt a whole system approach to monitoring. Climate change means we have new types of algae in new places related to changes in temperature. Increases in aquaculture, fisheries, urbanization and eutrophication are changing the coastal ecosystem and leading to increases in harmful algal blooms. Improving observing systems means getting into the details: nutrient inputs from land, land-use along the coasts, sustaining monitoring programmes in key areas and starting them in other parts of the world where we still don't fully understand how the blooms are operating.*

Chip Cunliffe, Director, Sustainable Development, AXA XL Insurance, presented an overview of the needs of the insurance industry for ocean data and knowledge, and the role they could play in the Decade. *Ocean literacy is*

important for youth but also for the business sector. At the end of the Decade in 2030, today's young kids will be in university, and now is the time to begin ocean education. In terms of ocean risks important for insurance companies, hazards are changing, with an increase in intensity of storms, harmful algal blooms, wave heights that affect shipping, sea ice loss and the opening up of new shipping routes while other routes are closing down. Risk exposure is also increasing. An estimated 800 million people will be susceptible by 2080 to increased storm surges, especially SIDS and LDCs. Vulnerability has also increased owing to lack of planning, lack of knowledge, and insufficient infrastructure. The Insurance sector can work to find solutions to reduce and manage risk but we need data, and specifically, data that we can use in our models. We need to work together with ocean scientists to coordinate the data we need with what is available or possible. We need to produce an ocean risk index for various areas to look at the financial impact of storm surges, at mangrove and reef loss, and multiple impacts from coastal flooding. The Decade must encourage private sector and local communities to work together in an ocean resilience risk partnership.

Pavel Kabat, Chief Scientist and Director of Research, World Meteorological Organization, described how climate is ocean-driven on decadal to centennial timescales. *To improve forecasting, WMO's priority is the deep ocean. We need to focus on the deep ocean for heat content and carbon uptake in a whole-system approach. Models need more biological and ecosystems functions to be integrated. For ocean impacts on human welfare, such as salt-water intrusion into freshwater aquifers from coastal subsidence and offshore extraction, social scientists will be needed to help natural scientists and decision makers understand problems and develop appropriate and effective actions. Hurricane Katrina offered a good example of the need to integrate social science into the design of action plans when it was realized that one of the reasons there were so many people who refused to evacuate was owing to the fact that they could not take their pets to the shelters with them. Social scientists will be needed to find out why our science and action plans don't work and should be fully integrated in the design stages of research. WMO will engage in the Decade through the support of GOOS and providing services required for meeting the SDGs.*

Nicolas Gruber, Environmental Physics Group, ETH Zürich, began by stating that while science has made substantial advances in the recent decades there are still substantial gaps even at the very fundamental science level, especially with respect to the definition of the key hazards. *Sea level rise, for example, is one of the biggest threats from the ocean but we are still deliberating about how much sea-level change there will be from melting ice sheets. Even though this is essentially just a question of basic physics, the associated uncertainties have major implications for how we can and will deal with climate change in the decades and centuries to come. This question was intensively deliberated by the scientists involved in the production of the IPCC Special Report on the Ocean and Cryosphere that will be published in October, and the outcomes will be important for the planning exercise conducted here. A second major gap is the connection between hazards and impacts, especially associated with the triple threat of warming, acidification, and loss of oxygen. This is particularly crucial when considering the role of extremes in these marine stressors. For example, ocean heat waves cause bleaching in coral reefs, and if these extreme events become more frequent, reefs will be unable to recuperate or adapt, making the impacts more severe. These impacts affect not only marine life but also human well-being. Thus, we need to connect hazards and impacts in ways that haven't been considered yet, and it is very interesting to be having this discussion in partnership with the insurance sector. The challenges are indeed big, but we shouldn't despair; i.e., never underestimate human ingenuity. The ocean is not so big that our ingenuity can't solve these problems. To tackle these issues, we need to do three things: 1) enhance observations, the importance of which cannot be overstressed; 2) leave room in our science plans for creativity and discovery and avoid over-planning to leave space for development and learning; and 3) increase trans-disciplinary approaches and working with multiple stakeholders.*

PANEL 5. A sustainably harvested and productive ocean ensuring the provision of food supply and ocean resources.

This panel discussed the uses of the ocean and its resources that drive many sectors of the world's economy, and providing the scientific underpinning for sustainable use requires a more holistic understanding of the interactions and inter-dependencies of environmental conditions and processes. Defining science-based thresholds for safe and sustainable operations in the ocean will help policy makers and stakeholders to implement a truly sustainable blue economy and ensure food security.

This Panel was co-chaired by Ricardo Serrão Santos, Member of the European Parliament, Portugal, and Atmanand Malayath, Director, National Institute of Ocean Technology, India.

Ricardo Serrão Santos opened this discussion by stating that countries must take SDG 14 seriously since climate change impacts create instability and risk. *The UN Secretary General recognizes that the political will to reverse climate change is weakening and impacts are getting worse. Poor fisheries management and over-exploitation has led to losses of 35% of the food from the ocean, which is a critical issue for other SDGs. The future of food security relies on science, observations and data. But how can we predict sustainability in a changing ocean? After decades of exploitation of fish stocks, we do see some recovery where science was used in policy-making to manage and control. There are huge inequalities among nations to meet SDG goals, however. In the African, Caribbean and Pacific (ACP) countries, fisheries is not only about fishers and fish, but about livelihoods and economic development. Fisheries science has to be holistic, not just focusing on fish stock assessments but also on the environment and economic markets. Fisheries science also needs to go beyond traditional models to consider changes in other Blue Economy sectors and environmental issues, such as offshore mining, energy, minerals extraction, acidification, sea level rise, and heat waves. We also must keep in mind how this complex interplay between science, policy, and socio-economic development must be better understood and used for sustainable development as well as social justice.*

Atmanand Malayath, Director, National Institute of Ocean Technology, India, introduced the Panel members.

Manuel Barange, Director, Fisheries and Aquaculture Policy and Resources Division, FAO, began by pointing out that in a world overwhelmed by information, clarity is power. *The first message is that we need to make sure that the Decade isn't just a source of data without context. We can't just throw data up into the sky and hope someone will get the science and knowledge they need. Data must be contextualized based on what it's for and how it's used. Ocean data is for the many, not simply a product created by white males from rich countries. Simply opening up and sharing data does not mobilize knowledge. The Decade must think about what data is going to be used for and design science and observations appropriately. For example, in the Nansen program of FAO, which provides assistance to coastal developing countries to sample, assess and manage fisheries, data is only openly available if the government agrees to release it. One challenge for the Decade is to find a new vision for oceans in 21st century. What does society expect? What is the Future we want? Whose future? Whose ocean? For this, we need many communities to participate. What can the Decade do for sustainable development? Sustainability is a process that requires always making adaptations and revising strategies, with ecological, social, and economic considerations. Something that is not socially sustainable is not sustainable. In fisheries, there is a dichotomy: the developed world has more and improved resources and sustainability, but in the developing world, lack of progress is not from a lack of data but lack of political will, conflicts, and politics. In these areas, more*

data will not improve sustainability. For sustainable development to happen, we have to reduce conflict and acknowledge the needs of each country. In particular, one major concern is how climate change will impact marine resources. Living resources have no boundaries and can move across national frontiers. The Decade can provide invaluable assistance in these issues that have to be dealt with together.

Anne Christine Brusendorff, General Secretary of ICES, described how multiple sectors benefit and interact with the ocean, from ecosystem-based approaches to management to legal instruments of policy-making. *Science has the opportunity to inform across the government system spectrum, and we will have to do better at cooperation and integration of sciences, not just the ecological system but also social and economic sciences. We need to address a range of complex issues, like functioning and productivity of ecosystems, human impacts on ecosystem services, human effects on sea food production, how to sustain sufficient production from wild fisheries and aquaculture, how to synthesize the science for use by a variety of stakeholders. What is also important is the way we work, engaging with stakeholders and policy makers, being inclusive, working with different communities, and involving early career scientists. We must be transparent in the way we work, from the data we use in models to the process of developing the evidence base to provide to policy makers. If we manage to work across disciplines and develop a process of how we produce the science evidence, opportunities to engage and collaborate with a larger range of stakeholders and management bodies will lead to a better understanding of these complex issues. We must be aware that this will be an iterative process, and that we will learn by doing. Perceptions will be different among different participants. The ICES strategic plan, which uses an ecosystem-based approach to fisheries health and stressors, provides regional scientific advice on 220 stocks, covering 90% of all catch in the Atlantic, amounting to 7 million tonnes of catch both inside and outside national jurisdiction. The programme is working to improve assessments and increase species under study, focusing on stocks that are economically important and those in danger, but also other species important for understanding ecosystem considerations. Fish stocks are recovering, and we are keen to share our expertise in linking science, information products, and use of science by decision makers. This approach is good for both food production and the ecosystem.*

Rashid Sumaila, Director, Fisheries Economics Research Unit, University of British Columbia, participated in this Panel discussion via video link, with the message that the Decade must work to level the playing field in research power, pointing out that there is not enough research capacity in the south to meet the SDGs. *We must study the whole ocean, not just the northern hemisphere. For the Blue Economy, we have to think of the ocean as a whole as well as the people around the globe and how they interact. Policy actions can have negative or positive feedback, and science is needed to identify these feedback mechanisms. For example, we need to study how management policies and subsidies in different nations impact people, the economy, and ecology. Poor countries in particular need a regional system of science and management where they can pool resources, both financial and human. Science is needed to look into the future, make predictions, and have a vision of a sustainable ocean. This is very ambitious. We must share the science, not just the data. Working together, we can also influence the political agendas in favour of ocean sustainable development by increasing ocean literacy and effectively communicating and campaigning at the grass roots level to get ocean issues on the agendas of politicians. We saw a good example of this in the last elections in Canada, where the election campaigns included many issues about ocean sustainability. We need ocean issues to be moved up on the agendas of all nations, and in particular in Asia and Africa. Without Africa managing its own oceans, all oceans are in trouble. We are all in trouble if one region is in trouble. The Decade must build this inter-dependency concept into its programme and recognize the critical importance of this.*

Katherine Richardson, University of Copenhagen, highlighted three areas that the Decade should focus on. *We will have to feed 10 billion people without increasing land use, and the ocean will increasingly be used for food*

and biomass harvest. We need sustainable development for this. The world's health organizations and scientists say we should all eat more fish. In agriculture, we saw a green revolution. Now we need a blue one, but one that is on different terms, one that recognizes that our resources are ultimately limited and that humans have an impact at the global level. The green revolution had no focus on maximizing nutritional calories and minimizing impacts. If it had, we would all be eating very differently than we do today. We will have to maximize the nutritional calories we bring out of ocean with minimum impact. All sustainability is a compromise between well-being, wealth, and use of the global commons. We will need to focus not just on what people will buy but the impacts of these choices. Research will be needed to understand ecosystem impacts of using and harvesting wild organisms that we aren't used to eating. For example, Denmark has begun converting starfish, considered a nuisance, into animal feed, which at first seemed like a win-win situation but is in fact one that has significant consequences for the ecosystem. Research is needed to support good decision making. The seafood industry has begun looking to research to include climate considerations into resource management. A basic research question is how climate change affects fish, and for this, we need to look at how climate change influences the structure of food webs, how much energy we're using to produce the fish, and the functionality of the system. Another important issue is the ability of the ocean's biological pump to sequester atmospheric carbon. This is an issue that is not just about climate change and fish, but about climate change and functionality, and how fishing influences the ecosystem structure and the ocean's ability to take up carbon.

Cristina Tirado-Von der Pahlen, Center for Climate Resilience, Loyola Marymount University, addressed how we have to transform food systems to meet dietary needs of a growing population. *The global sustainable food system must operate for human health as well as the planet's health, and must focus on the ocean-climate-health connections for food production. In countries that need it the most, fish is an important food source where more than 3.1 billion people rely on food from the ocean for 20% of their nutrients. Some countries, on the other hand, eat too much fish. To move towards a sustainable system, we will have to change the way we think about our diets. This will require a planetary diet that is completely different from what we have now, based on human and planet health. Many of these ideas about linking nutritional targets with environmental sustainability have been published recently in a Lancet article entitled 'Food and the Anthropocene: the EAT-Lancet Commission on Healthy Diets for Sustainable Food Systems'. We have many food safety challenges, where pollution of food sources from plastics or sewage has direct impacts on human health. We need to develop an early warning system to manage risks to food sources. Can we sustainably harvest the ocean? Doing so will be driven by consumption and consumer choices, dietary guidelines, labelling, and education.*

Peter Heffernan, Chief Executive, Ireland Marine Institute, reminded participants that the Decade is not for ocean scientists but for sustainable development and warned that it is crucial to resist attempts to change this focus. *The programme must serve society by listening to stakeholders and integrating diversity. The big issues we need to deal with are well known. Observations and open access to data and knowledge are critical. Building trust and alliances and gaining momentum are very important for the Decade, enabling all to make the biggest impact in the shortest time. The U.S. politician Tip O'Neill famously said, "All politics is local". Our approach to ocean sustainability has to be in that sphere. Are we really getting the voice of youth that we need for impact and future change? We have to avoid focusing on the problems of bureaucracy and dwelling on why solutions will be difficult. This is a once in a lifetime opportunity. We must be scared – that is the only way we will address the Decade appropriately. We need many actors who say what can I do to achieve this vision and make it happen, from all strata of society. All sectors and ordinary people have to find their way into this strategy. We need hearts as well as minds. Momentum, momentum, momentum!*

PANEL 6. A transparent and accessible ocean whereby all nations, stakeholders and citizens have access to ocean data and information, technologies, and have the capacities to inform their decisions.

This Panel discussed the role of the Decade in transforming the scientific and technical capacity of ocean stakeholders, especially SIDS and LDCs, through greater access to and more informed use of scientific knowledge and accelerated transfer of marine technology, training, education, and increased ocean literacy. The integration of traditional knowledge was also discussed.

This Panel was co-chaired by Margaret Leinen, Director, Scripps Institution of Oceanography, and John Gunn, Integrated Marine Observing System Governing Board.

John Gunn opened the Panel discussion with an overview of the major issues and challenges. *Our grand challenge is that of ensuring that oceans are healthy, continue to provide essential ecosystem services and play their critical roles within the earth system, while contributing to economic development. This requires informed decision making across all levels society. Individuals, local communities, companies, governments and international bodies need to understand the implications of development and how risks can be managed if they are to make wise decisions. A key role for science is to provide this information and understanding in a form that each of these stakeholder groups can understand and use. It is no longer sufficient to hand over our data and publish our scientific papers. We must engage with stakeholders in partnerships where the two-way exchange of information, ideas and concerns allow inclusive decision making. For the purposes of the Global Planning Meeting we refer to a 'transparent ocean' as not only one that can be explored, described and understood because new technologies are encouraged and developed, but one for which open data allows everyone to benefit, receive knowledge, be involved in the decisions to ensure sustainable development. For both of these to be the case, we also need to develop the capacity for exploration, understanding and use of information concerning the ocean. Our session today brings together Panellists with a broad range of backgrounds and our shared aim is to set the scene for a discussion on:*

- *How technology development can help us observe and understand the oceans,*
- *How we might increase access to scientific information and understanding to all ocean stakeholders regardless of where they live, and in so doing ensure that decision making is a shared and inclusive process,*
- *What our priorities for capacity development might be, and*
- *Very importantly, what we can learn from the coastal and maritime peoples who have been living with and studying the seas for thousands, and in some cases tens of thousands of years.*

From the Slido audience interaction application : Which is the most important element of the 'transparent' ocean to you?

- Equal access to data: 28%
- Capacity development to participate in ocean exploration, observation, understanding and use of data: 59%
- Development of new technology for observation: 7%
- Incorporating indigenous knowledge: 6%

Margaret Leinen introduced the speakers for this Panel.

Donna Kocak, Immediate-Past-President, Marine Technology Society, addressed the question “Which of the ocean science technology development frontiers are you most excited about? And how will these ensure that we have the knowledge required to promote and support sustainable development?” *There are many lines of promising new technology, and the Marine Technology Society Journal of October 2018 reviewed the top 30 technologies that will change the way we do things. Some of these include artificial intelligence for automated measurement systems, pollution cleaning technologies, cellular-based seafood production that replicates fish (sushi) on scaffolding, numerous advances in unmanned vehicles, e-DNA techniques, ocean mapping techniques, using fiber optic cables for tsunami detection, in situ sensors, and remote sensing from small satellite constellations. These new technologies will change the way we do things in marine science, and the marine technology sector has much to offer the Decade.*

Tony Long, CEO, Global Fishing Watch, addressed the question “What are the impediments to ensuring that data and information from all of the amazing technologies that are coming on line to observe and study the oceans are freely available to all ocean stakeholders, and how can we help to remove these?” *It is possible to change people’s attitudes over data, and sharing can be done, the benefits can be seen, and this encourages others to participate. We have to start by asking ourselves “what can we do together that we can’t do separately?” When we do this, we can consciously reform our perceptions of what is possible. The technology around us is changing exponentially but we also need to reframe the way we look at technology, including rethinking proprietary attitudes, costs and business models of data, and the way data is accessed. In the Global Fishing Watch programme, we promote ocean sustainability through greater transparency using cutting-edge technology to visualise, track and share data about global fishing activities in near-real time and for free. Our programme has a strong focus on shifting attitudes, by highlighting fishing activity around the world and encouraging transparency to change behaviour and compliance. Can we put vessel monitoring systems (VMS) on fishing boats to contribute to data collection? Most of this information is proprietary, and very often, fishermen don’t want their position to be known. However, new technologies that can identify fishing activities even without the fishermen’s participation is now encouraging fishermen to be more compliant, and once a few countries adopted the practice of making data and information available, others joined more readily. But even scientists don’t traditionally share data very well. There is significant cost involved. Data are expensive. Dealing with this will be a challenge. We need to develop a sort of Google map of ocean activity, to see activity in way it can be accessed, visualized and understood, and to provide this information in a way that people can access and use easily. The Decade should unite stakeholders from multiple sectors to join forces to make a common access point for data and information that supports visualization of data and aids in understanding the data without generating hundreds of different systems.*

Colin Devey, Scientific Committee on Ocean Research, discussed how to get science into the public realm and noted that the International Council for Science and its ocean body SCOR are eager to work with the Decade on this issue. *The world’s ocean science community is a powerful resource as we strive to ensure that development is sustainable and, in many places, to remediate and restore systems that have been affected by unsustainable development practices of the past. How can we harness this resource to maximum benefit and ensure that we have critical mass in tackling the biggest challenges? The International Science Council can help in the dialogue with social scientists and in kicking off big-scale science projects. It is critical to ensure that the Decade educates the next generation about the ocean. One of the biggest problems is that the general public doesn’t like doom and destruction messages. It’s simply not the right message for this audience. Politicians are aware of the global environmental problems and consequences of poor decision making. One example of this is the continued subsidies for oil and gas versus investments in renewables. Policy makers are fully aware of the science that should underpin their decisions but there is a problem of political will to act. Changing this will take education and*

mobilisation of the general public at the grass roots level, starting with young people to create an Ocean Generation. The fascination with our planet is what leads people to watch documentaries about the ocean, not gloom and doom scenarios. We also have to put a priority on capacity development, especially in SIDS, and we need to listen and learn from traditional knowledge sources about how to live in harmony with the marine environment.

Ann-Katrien Lescrauwaet, Director of International Relations, Flanders Marine Institute, addressed the question “Developing capacity across the spectrum from skills, to infrastructure, partnerships and governance approaches is recognized across the global science community as a top priority and is acknowledged as a huge challenge. What do you think the Decade should focus on in capacity development given its particular focus on sustainable development?” *Technology can only be transferred if the capacity is in place, and we need training programmes so that learning how to use and maintain technology is faster. We must focus on the mechanisms needed to achieve capacity development. We have many programmes at many levels with international and intergovernmental agreements on technology transfer. Capacity development is a cross-cutting issue for sustainable development, an enabling mechanism for more equitable resource management. The IOC is starting the development of a clearing house mechanism for the transfer of marine technology (CHM/TMT). Capacity development must be needs-driven, must acknowledge regional diversity, and we have to match offers with demands. The clearing house mechanism to meet these needs has much support within SIDS and LDCs, especially with programmes that work through regional nodes. We have to improve how this system is managed and need new tools to promote access to the platform for users to register their needs and offers. Based on experience with these types of international programmes, our advice for the Decade is 1) that seeing is believing, so highlight success stories, 2) First walk then run, and 3) think beyond marine science. It is important to carry out pilot exercises and document lessons learned that can be applied to other projects in other regions. Lastly is the question of equity and the need for sustained finance mechanisms.*

Alfonso Ascencio Herrera, Deputy Secretary-General, International Seabed Authority, addressed the question “The development of successful management plans for sustainable development of ocean resources invariably involves consideration of potentially competing objectives among stakeholders. What is required of science and scientists if we are to reduce the potential for conflict and promote effective and timely development of sustainable development plans? How can the Decade support this pathway?” *The International Seabed Authority (ISA) gets its mandate from the UN Convention on the Law of the Sea and the ISA can play a major role in Decade, particularly in areas beyond national jurisdiction. Working with the IOC and other UN partners, we can join forces to achieve objectives such as improving mapping of the deep-sea bed, including not just physical data but also biological and ecosystem data, exchanging those data via the OBIS system, standardizing methodologies and carrying out intercalibration and intercomparison experiments. The ISA supports the Seabed 2030 mapping programme, especially in developing the data base in a collaboration between contractors and science that is accessible to a wide range of users and purposes. One problem is the lack of deep sea taxonomy, and we need to establish a taxonomic atlas. The ISA has 30 years of deep ocean exploration experience and ISA programmes must all include capacity development funding for education and training to enhance local and regional science and management capacity. We have provided training for 259 people in the last 10 years through partnerships with contractors, internships and funding for scientific research. The ISA is eager to partner with other sectors in the Decade to continue these efforts.*

Somkiat Khokiattiwong, Senior Researcher, Phuket Marine Biological Centre, was asked, “The Western Pacific, with its range of coastal states and SIDS, is a maritime zone full of precious coastal and open-ocean resources, and presents a significant number of sustainable development challenges. You’ve been at the forefront of

bringing ocean sciences to the region for many years. What do you think the priorities of the Decade should be to assist the region with these challenges?” *Capacity development is vital as we need more people around the globe to both collect and use the data. Capacity Development is different in each region, with some limited by equipment and others by higher education and training, so no one-size plan will work to meet needs. Development is not just about improving access to data, but teaching local scientists to collect high-quality data that can contribute to the Decade as well as local and regional management. We also need Capacity Development for the general public, including educating people and communicating what the Decade is and what it can do. For technology transfer, some countries are able to learn and spin up programmes rapidly themselves and need targeted partnerships to make the most of these opportunities. The Decade should use partnerships with NGOs, foundations and universities to achieve these goals.*

This Panel session finished with some comments from the floor. The issue of sharing data from EEZs was raised, noting that this appears to be more difficult for developing nations because they may not think they receive benefit from the data. The importance of working together with nations and their governments to serve global-level needs was stressed. The value of the knowledge from indigenous people was also emphasized.

Wrap-Up of Day 1

EPG members Elva Escobar and Ana Joborn led a wrap-up session to provide an overview of the discussions and main messages from this first day.

Ms. Escobar thanked the Panellists who have inspired the participants and who have highlighted the most important aspects to be considered in the design of the Decade. She provided an overview of the key messages from the day and began with a quote from Jesse Ausubel (Director, Census of Marine Life) who once said, “Everything has been said, but not everyone has had a chance to say it.” Ms. Escobar noted that, to be more inclusive, the Decade needs the voices of women, of young scientists, of people from different cultures and different regions, of all members of society from different generations including children and the elderly. She reminded Participants that we need to listen to how different cultures perceive the oceans, to understand how changes are viewed regionally, to understand their needs and limitations, and as mentioned by Ofa Fa’anunu, to recognize their vulnerabilities and to include everyone in this adventure.

Ms. Escobar called the Decade a unique opportunity to create a bridge that links science and society, as Essam Mohamed mentioned, where science means not just the natural sciences, but includes social sciences, economics, and the humanities. SDG 14 is about life below the water. To conserve and sustainably use oceans and marine resources for sustainable development, ocean science knowledge needs to be appropriated by society, by decision makers, and by the businesses to find better economic opportunities for nations to contribute to sustainable development. It will be necessary to build a strong bridge between knowledge and decision-making, with knowledge supported by an Ocean Best Practices System that will have a strong and positive impact on ocean transparency and capacity development.

Ms. Escobar noted that the Panellists in the morning session recognized that the Decade is a once in a life-time opportunity to deliver a step change in ocean science, stating that it needs to be inspiring and should influence how countries invest, utilize, and participate in science and innovation. She recalled how Margaret Leinen offered a guiding principle for the development of the Decade when she encouraged participants to focus on ‘what we can do together that we can’t do separately’. Ms. Escobar further recalled the intervention of Jane Lubchenco who reminded participants that it is a big ocean that requires a new narrative to set expectations, a new model

where knowledge is used to make decisions. The marine industry and private sector gave examples of ways in which existing activities in different sectors can contribute to the Decade, including voluntary environmental certification programs, marine insurance programs that value biodiversity, and data and monitoring from exploration and extraction activities. She concluded by reminding the participants that the Decade is an opportunity to embrace societal goals and align research investment to contribute to these common goals, and that the task now is to design the ocean science we want to achieve the SDGs. A large number of the Panellists have reiterated that the end of the Decade should see a more ocean-literate society, where communities and decision makers care for the oceans and the life in the oceans, where people understand the importance of the oceans and use knowledge to make better informed decisions based on robust predictive models to diminish hunger and poverty.

Anna Joborn described the sense of passion for the Decade expressed in the Panel discussions today, noting in particular the inspiring examples of the Solomon islands perspective provided by Lysa Wini and the Pacific island nations provided by Ofa Fa'anunu that implore us to consider the design of the Decade and its priorities from multiple view points. Ms. Joborn reminded participants that there is an important human dimension to ocean science that should not be underestimated. The Slido audience interaction application poll shows that 60% of the public and meeting participants thought that capacity development was the key to success for the Decade. Ms. Joborn stated that the ocean science community needs to change the science culture to a collaborative culture, further stating that it is not sufficient to wait until the science is done to link with the social sciences. She concluded by reminding participants that the insurance sector has highlighted the need for ocean literacy and risk management, and as explained by Jane Lubchenko, ocean science needs a new narrative and the Decade represents a unique opportunity to develop this.

Salvatore Arico (Head, IOC Ocean Science Sector) provided an overview from the Decade's High-Level Science Panel working to design the implementation plan. The strategic objectives for the Decade are given in the Decade Roadmap, where the first 3 strategic objectives are scientific ones: 1) understanding effects of cumulative stressors on ocean systems and related impacts, including socio-economic dimensions, 2) developing the science base and capacities for ecosystem-based management, and 3) research and development to mitigate ocean-related risks and hazards. These overarching objectives will be complemented by bottom-up interests from a wide range of stakeholders through global and regional consultations. Mr. Arico explained that, for societal objectives, scientists see themselves as one of many stakeholders, and there is a clear call for multi-stakeholder dialogue and co-design of the ocean science plan in the context of the Decade and the SDGs. He reminded participants that this is not a Decade for Ocean Science but rather Ocean Science for Sustainable Development, and co-design with multiple stakeholders is critical to meet these objectives.

Side-Event: The Global Ocean Observing System Contribution to the Decade

Our ocean, seas and coastal regions are critical to life on Earth, and a rapidly expanding 'Blue Economy' estimated to be worth \$3–6 trillion per year. The cumulative impacts of climate change, development, pollution and over-fishing are placing considerable stress on our marine environment. We now know that the trajectory of change, increased pressure, and damage threatens the future of our planet and all those who live on it.

The global community, through the 2030 Agenda for Sustainable Development, the United Nations Framework Convention for Climate Change, and many other international, regional and national initiatives, has committed to ensuring that future development is sustainable. Achieving sustainability at global, regional and local scales

will require a comprehensive understanding of the current and projected state of our ocean, seas and coasts. It will also require monitoring the impact of our policies and management actions.

Improving early warnings of floods, droughts, and severe storms – all predicted to increase in warming world – will require expanded ocean observations. The sustainable development of the Blue Economy, underpinned by ocean information, is a future source of jobs and economic growth.

While we have made significant improvements in our ability to observe and understand the oceans over the past three decades, our current efforts fall well short of what will be required. This side event presented the Global Ocean Observing System 2030 Strategy which provides a vision for a truly global ocean observing system that delivers the essential information needed for our sustainable development, safety, well-being and prosperity.

The 2030 strategy for GOOS has 11 Strategic Objectives at its core, which focus on deepening engagement and partnership from observations to end-users, delivering an integrated, fit-for-purpose observing system, and building for the future. In the coming decade, the observing system will rely on new, lower-cost technologies and autonomous adaptive technologies to enhance our capability to observe the oceans. Industry partners and the public will become part of the observing system by providing data from industry platforms and citizen science programmes. Capacity development and technology transfer programmes will increase the number of observations in under-sampled parts of the world's oceans. The observing system will extend systematic observations to understand human impacts on the ocean, and to be responsive to the needs of multiple stakeholders, providing information essential for understanding climate, operational needs, marine ecosystem health and human impacts, seasonal weather forecasts, improved planning for farming, construction, insurance, public health, and water, ecosystem and wildlife management. Representatives of the US, South Africa, China, and the European Marine Board spoke in support of the Strategy in a panel discussion.

Working Group Discussions

On Day 2 of the meeting, parallel working group sessions were held to provide opportunities for in-depth discussion on each Societal Outcome, building on the Panel discussions of Day 1. Morning sessions considered Societal Outcomes I-III and afternoon sessions considered Societal Outcomes IV-VI. A Task-Group on Communication also met in the afternoon session. The key objectives of the working groups were to:

- identify the knowledge gaps and key science questions and R&D priorities that should be addressed through the Decade to achieve the Societal Outcomes
- develop an understanding of existing scientific initiatives relevant to addressing the science questions
- discuss the role of cross-cutting themes in addressing the science questions, and
- identify additions/modifications to R&D priority areas for inclusion in the Decade implementation plan.

Working Group 1: A Clean Ocean

This Working Group was co-chaired by Ms. Suzan Kholeif, President of Egypt National Institute of Oceanography and Fisheries, and Mr. Peter Kershaw, Chair, GESAMP. Rapporteurs were Somkiat Khokiattiwong, Department of Marine and Coastal Resources, Thailand, Simon Jennings, ICES, Chair of Science Committee, and Monika Stankiewicz, HELCOM Executive Secretary.

What are the knowledge gaps and what are the key science questions relating to the R&D priority areas identified in the Decade roadmap that should be addressed through the Decade in order to achieve a 'Clean Ocean'?

Defining a 'Clean Ocean'

There was broad agreement on the range of positive consequences of a clean ocean but differing perspectives on whether 'clean' should be interpreted as 'no impact' or 'natural'; i.e., a visionary view or whether there should be a focus on clean as reflecting an ocean in which the impacts of pollutants and contaminants are reduced so that ecosystem health is adequate and sustainable. Aspirational aims and visions, while important to be expressed, often refer to a situation that is not possible to achieve or revert to, such as an ocean free of pollution in pristine condition. A compromise definition would be: 'A clean ocean is an ocean where inputs of all contaminants and pollutants are minimised and do not have adverse effects on physical, chemical and biological processes, ecosystem functions and ecosystem services.' To refer to the definition of a clean ocean from the Decade, *"A clean ocean whereby sources of pollution are identified, quantified and reduced and pollutants removed from the ocean."*

Knowledge gaps overview

The broad knowledge gaps were identified, although specifics were brought forward as well, especially related to shipping, marine litter and plastic, underwater sound, the Arctic, cultural heritage, and the deep sea. Several participants highlighted overall knowledge gaps on the state of the ocean and how the current state impacts natural resources. Major knowledge gaps include effects of contaminants on ecology, ecological processes and ecosystem services, including cumulative impacts, impacts of climate change and impacts of legacy pollution. Understanding and managing the effects of cumulative stressors is included in one of the objectives defining the scientific basis for the Ocean We Need in the Decade Roadmap.

Participants raised the flag on the issue of climate change, where a number of knowledge gaps were identified related to predicting the ocean in a changing climate, including predicting sea-level rise and acidification and the consequences of these.

It is important to know the acceptable level of pollution, set threshold values, define ecological boundaries and tolerance levels for an ocean that is 'clean enough.' This will help us to measure progress towards a clean ocean. Knowing impacts and setting threshold values are not enough to address pollution. One needs to know where pollutants come from. There are knowledge gaps regarding sources, transport, fate and distribution of contaminants and pollutants. In many cases, the major sources of pollutants are from land. The Roadmap already establishes the link to land-based sources, which could be further strengthened to form a strategic approach to science for a clean ocean.

Many participants highlighted necessary measures on a general level, such as the need to establish best practice management guidelines to minimise releases of pollutants and contaminants into the environment. This requires understanding the role of regulation and social and economic incentives (social and economic science). Another interesting question was raised about what might be learned about pollutants and ecosystems from the past; the 'historical' evidence of pollution.

Specific knowledge gaps

Overall: Open-ocean processes and contamination; Deep-sea features and ecosystems; Half-life of pollutants in the marine environment; Rates of ocean bio-degradation; Norms of observations and modelling that would enable management and decision-making; Not enough information in some areas to understand the state of the ocean and its impacts on natural resources; Measurements of pollutants; Cultural diversity and pollution links; Ethical considerations needed to design innovative solutions.

Impacts: Accurate long-time impact of pollutants on ecosystems; Effects of pollutants on seagrass/ecosystems; Cumulative impacts of contaminants (all types) on the biology; Quantifying impacts; Impacts of nano-plastics on the food chain; Effects and implications of underwater noise and its effects on reproduction and healthy ecosystems; Effects of deep sea mining on the ocean health; Effects of plastic pollution on coastal communities globally; Overall population effects/mortality of marine fauna from plastic ingestion and entanglement; Effects of plastics through the ecosystem and impacts on health of communities; How cultural heritage is impacted by different forms of pollution.

Thresholds: Lack of baselines; Lack of targets (measurable); Setting threshold values; Define ecological boundaries; The levels of pollutants that would limit optimal functioning of the ecosystems.

Climate Change: Prediction of new forms of pollution as a consequence of sea-level rise; How rising sea level and acidification will change ocean chemistry; How climate change will impact the toxicity or degradation of pollutants.

Legacy Pollution: Legacy pollutants (from wrecks); Legacy pollution that affects species and populations (orcas, for example).

Pathways: Pathways of pollution; Identify primary sources and develop ways of eliminating.

Management and Measures: Ecosystem management; Compound pollution effects/stress; Social and political willingness and ability to define issues and react; Demonstrate measurable impacts; Sustainable solutions to reduce climate change impact on oceans; Cleaning solutions; Take significant steps to remove plastic pollution from the ocean (what levels are safe?); How to make the legislation stronger for plastic producers and plastic consumers in all countries; Cost-benefits of reducing pollution; Cost-effectiveness of measures; Waste/wastewater infrastructure, programmes/investments; How to achieve effective ways of fighting /reducing ocean contamination taking into account cultural diversity.

Awareness: What education and awareness programmes are in place to reduce plastic waste and ocean effects in global communities and developing countries? How to develop a targeted awareness programme to reduce human practices that harm the ocean (plastics/pesticides) that all conservation professionals incorporate into their community outreach process regardless of their primary focus.

Communication: More communication for citizens to make them understand what is at stake and act for the oceans; How the marine community can better communicate to influence policy-making processes.

Traditional and Local Knowledge: Who are the complementary knowledge holders (local and indigenous) and local ocean users who can help advance research?

What are the existing initiatives and mechanisms that the Decade can build on to deliver outputs (e.g. partnerships, programmes)?

Two sub-groups responded to this question.

Group A

The group indicated several existing initiatives and mechanisms that are in operation from the global to regional level, including programmes or projects such as GOOS, CBD, Large Marine Ecosystem (fund by GEF), and related Fisheries programmes or projects (PICES, ICES, European Marine time Fisheries Fund, Regional Sea Program and etc.). All of these programmes are in operation and many parts of their programmes are related to the clean ocean activities to serve fisheries management. One of the FAO programmes is the Nansen Project supported by the Norwegian government to carry out fisheries surveys, ecological studies, pollution assessments and management advice, which include measurements of nutrients and chemical parameters in the Indian Ocean. These activities could support and benefit the Decade. To ensure a strong connection and coordination with those organizations that support the work of the Decade, the establishment of coordinating body is necessary.

Group B

There are many on-going initiatives and these should be carefully mapped, including their geographic specificity and how they can contribute. Broadly, the initiatives identified were classed into NGO and foundation initiatives, initiatives driven by legislation and conventions, projects (funded research and management actions), industry initiatives and coordination actions by intergovernmental organisations. The working group suggested that a full matrix-based approach was needed to look systematically at existing initiatives in these (and potentially other) categories and to define their regional and societal remit.

What are the roles of the following cross-cutting themes to address the science questions?

Capacity development and technology transfer

Group A

Capacity development extends from the global to regional and to national levels. However, the regional level activities could play an important role to harmonize capacity development across a region. The UN global programmes were recognized to play a role in capacity development at all levels, such as FAO, IOC, and UNEP since capacity development is an important part of their mandates. The group recommended including Best Practices as part of capacity development to ensure the high quality of the training courses. Some limiting factors must also be recognized in the capacity development activities related to biochemical studies in some areas, such as the difficulty in transporting samples and biological material using chemical preservation where it might not be possible to ensure the integrity of the samples.

Group B

The group came up with many specific suggestions, but three broad themes related to capacity development were:

1. Training, education, scholarships, visiting programmes and supporting scientist mobility.
2. Vessel and technology sharing and technology transfer.
3. Activities based on a clear and systematic analysis of demand for capacity development by regions.

Partnerships and financing

Group A

This group recommended for the Decade to establish a partnership with programmes at all levels (global, regional and national level). The establishment of partnerships among the organizations with interests in issues related to the Decade is highly recommended. Private partners were also recognized to play an important role.

Group B

Much of the discussion on partnerships focused on the process as much as who to engage. In relation to 'who', the overwhelming emphasis was on developing and building on existing relationships with business and civil society, but also emphasized those with intergovernmental organizations, NGOs, Development Banks, and regional funding mechanisms and Conventions. In terms of process, the working group wanted to encourage more, more accessible, and more visible ocean champions, new meeting fora (more welcoming for participants outside the existing 'core') and using the understanding of the circular economy as a mechanism by which to help bring different sectors together and to collaborate.

Access to information, data and knowledge

Group A

Using the internet and social media to disseminate information and activities of Decade was recommended. The open access of data and information, best practices and a clearing house mechanism were recognized to be important to support the Decade.

Group B

There were two clear focus areas in relation to this question; providing data and making data accessible.

Providing data: Develop a global portal and database, perhaps linked to a living atlas, to provide data on contaminants and pollutants, as well as a code repository to support coordination and knowledge transfer of data processing. This is a related point to Group A from the morning session, which made a concrete suggestion for one of the R&D priority area to create a global contaminants database, containing information on essential pollution elements including on threshold values (of help to SIDS) building on experience and achievements of GOOS.

Making data accessible: Improve understanding and simplicity of ways to submit and access data, increase policy-maker awareness of the benefits of open access to data and code, improve global standardisation of methods of collection and data submission.

No strong third focus emerged, but other topics included facilitating dialogue across platforms, providing clear focal points for data globally (a collaborating network), increasing availability of and methods to use indigenous knowledge and a greater role for citizen science. This was a related point from Group A's morning session, where it was suggested to learn how to integrate and use different knowledge systems, including traditional and indigenous knowledge, and local expertise (e.g. of local fishermen).

Communication and awareness-raising

Group A

Communication is a very important component of the Decade. It should therefore use professional science communicators, and a suggestion is that all scientists involved in Decade activities contribute a minimum of 10% of their time committed to communication about their work. NGOs such as WWF could be valuable partners for communication since they have great efficiency in disseminating information to audiences. Communication with other partners and stakeholders is important, but it is also important to establish joint messages and campaigns within the Decade with regular communications with all participating programmes.

Group B

Three clear proposed areas emerged:

1. Development of an ocean Olympics and other ‘competitive’ activities to raise engagement with the ocean, such as international prizes, hackathons, links to ocean sporting events, etc.
2. Science communication and diplomacy, science ambassadors, communication through ocean stories and art.
3. Ocean-related content and teaching for engagement of youth and schools

Comments from the floor

A participant suggested that the Decade should do a ‘horizon scan’ of possible future pollutants from Blue Economy growth in the coming years. What might be expected and what are the interacting, combined pressures from increased activities that might affect the ocean and, in particular, the coastal zone?

A Slido audience interaction poll response raised the issue of the need to establish stronger science-based links between ocean pollution and human health, particularly dealing with unknowns of plastics.

A participant informed the meeting that, at the current trend, an additional 1 billion tonnes of plastic will be dumped into the seas during the Decade, and suggested that the Decade should set a very ambitious goal to combat this trend. One concrete milestone could be to develop a programme in which 50 cities of more than 1 million people commit to reduce their pollution stream to the ocean by 50%.

A participant noted the importance of convincing Blue Economy sectors and the general public that protecting the oceans is good for business. Public health, fisheries, tourism, global brands, local startups, etc., will all benefit from cleaner oceans and their visible actions to support sustainable development.

Working Group 2: A Healthy Ocean

The three framing questions, (i) key science questions, (ii) existing initiatives, and (iii) enabling measures were presented on several axes, with science connecting in a two-directional way with policy, business, and public awareness in order to make the Decade truly transformative, address what people care about, and help choose paths that lead to sustainable pathways for a healthy and resilient ocean. But the connections are much more fluid even than a multi-box and arrow diagram can illustrate, and new platforms and tools are needed to assist these interactions. A caveat was not to lose sight that the outcome of the Decade is for sustainable development and societal outcomes are key.

Co-Creation of Science

Engage Stakeholders and the Public from the Start

Participants emphasized that all stakeholders must be involved in the design process to successfully articulate what a healthy and resilient ocean—*the ocean we want*—actually is. It is not sufficient to apply science. A dialogue between decision makers, stakeholders, citizen, and scientists is required. This should shape how science questions are determined and how science is done. Science must be co-created with people beyond scientists, involving diverse stakeholders in an inclusive, iterative process, not just conveying information. This is not just pushing science to society, but using different forms of knowledge and co-creating research from the outset.

Science, policy, and management interactions should be iterative and multi-directional: policy informs science, science informs policy, policy and management affect ecosystems. The science must be central to decision making, but often decision making is not well designed for science take-up, so institutions need to be strengthened and decision making changed at all levels. It is also important to understand when enough data is enough, and make clear what is known. Existing governmental processes and national priorities will be important in connecting research questions to what people care about.

Take a Holistic, Systems Approach to Understand What Data are Needed to Achieve a Healthy and Resilient Ocean

Science should be set in the context of a systems approach to thinking about what science is needed to achieve healthy and resilient oceans.

Education and Ocean Literacy is Needed to Promote the Use of Science in Ocean Conservation and Management

A key element required for people to use science in decision making is to improve ocean education and literacy across a range of venues. Working group participants mentioned business and public policy programs as an example.

Ecological Knowledge, Indicators, and Observations

Measure Ocean Health and Ecological Resilience

Ocean health and resilience hinge on ecological knowledge, and well-developed and comprehensive observation could address many of the objectives. Past successes in ocean observations offer a good foundation and existing initiatives should be used more effectively. Essential ocean variables that measure progress to ecosystem outcomes for societal outcomes must be identified, but it is also important to provide capacity – human, physical, financial – to set standards for them.

Long-term, sustained observations must be reinforced so that they do not rely on research funding or evaluation. Perhaps a certification model with defined standards for data and observations could help for public awareness.

Use Science to be Explicit about Desired Ecological Outcomes: Restoration

Participants asked whether restoration is possible, and what both ecological and cultural change mean for local and regional marine ecosystems. This revealed that people do not share common understandings or definitions of ‘ocean health’, ‘resilience’, or ‘ecological restoration’. Restoration gives a sense of turning back, but only systems and functions can be restored, and restoration to some past state may not be possible in the face of climate and other global environmental change. A scientific understanding of the future ocean we want is needed.

Leverage Different Forms of Knowledge, Develop Capacity, and Ensure Fairness in Social-Ecological Data Sharing

Open data is important, but open data is not democratization of knowledge. An asymmetry of access and ability to use and understand data can make the powerful more powerful. Data sharing must build on the FAIR principles (*Findable, Accessible, Interoperable, Re-usable*). Also, an expanded understanding of data and information must include traditional ecological knowledge (TEK) and citizen science and other ways of knowledge generation like storytelling. Indigenous peoples should not be seen only as sources of data; the data collector needs to benefit from data collection for it to be sustainable. Data sharing must be mutually beneficial. Additional capacity development is needed to collect a broad variety of data at global scales and with local resolution. Data collection could be improved by bringing young people to the table and by building trust in science and data. Cultural data needs to be taken into account including the use of data on historical ecological and human conditions; for example, there is millennia of historical data on how people have caused and adapted to ocean change.

How We Organize and Conduct Science

Create More inter-disciplinary and trans-disciplinary interactions

Trans-disciplinary and multi-disciplinary interactions are needed to articulate questions, not just to inform existing research. Ocean science must include social sciences (plural), humanities, arts, and other disciplines, such as engineering. For the use of social science and wider knowledge, including local and traditional ecological knowledge, NGOs can help.

Barriers to Scientific Collaboration Must be Overcome

Scientific competition is a barrier. Preconceived ideas in all sectors must be avoided, including research. Too many initiatives are never finished; need ‘finishitives’. There are problems of engagement – how do people engage in science if they aren’t scientists, or in policy if they aren’t policymakers? And if there are too many overlapping entities that require engagement, it can push developing countries out because of financial and capacity constraints. Behavior change is a key area to understand.

Understanding and Modeling Complexity and Interdependence

It is essential to collect data and conduct analyses specifically to understand and model the interdependence among ecosystems, particularly the connecting role of meso-pelagic zone, deep sea, and the open ocean. There is also a need for a breakthrough in the science of ocean social-ecological complexity.

Modeling Abrupt Changes and Phase Shifts

A major question is how to measure and model abrupt changes in ecosystem state, both systems and forcings (e.g., harmful algal blooms)? What science is needed to avoid horrible or unpredictable surprises?

Finding Better Ways to Integrate Social-Ecological Data and Disciplines

Improvements are needed in integrative thinking and integrative design, and coordination, including getting scientists out of the discipline-specific meeting culture. There is a need for a mechanism that can better leverage the results of scientific experiments, like a medical register of drug trials, which would be an interesting concept to pursue. Better technology could help. There are also models and ideas using innovative technology to improve data sharing. The goal should be to strive for global ocean information rather than just a data system. The data must be rendered into useful forms by making them accessible for interdisciplinary applications. Data governance is needed, and could use tools like block chains to be able to trace data flows and trace back to providers.

Modeling the Impacts of Unknown Stresses on Ecosystems

There are also many new pressures that ocean ecosystems will face, including several for which scientists have no experience or the full science required to address them, such as rapid global change, the Blue Economy and avoiding a “blue gold rush,” or geoengineering. Transformative science is required to understand the new and cumulative impacts that could be associated with these emerging pressures.

Monitoring Policy Effectiveness

Scientific approaches must guide the collection of data needed to evaluate the ecological outcomes of policy actions and human processes. Evaluation must be more systematic in its analyses. It is important to document and learn from failures with regard to policy actions taken to improve ocean health. This includes taking a scientific approach to recognizing when existing types of ocean data are not policy relevant. Holistic approaches are needed to understand the ecological trade-offs associated with different policy actions and sustainable development pathways, the impact of poor decisions, and behavior changes.

Creating a Movement to Transform Ocean Science for a Healthier Ocean

Keep the Momentum Going

There is currently a fantastic level of momentum in interest about the ocean, but how linked is this interest to science and services? Social sciences are required to better understand how to keep the momentum going and to create a movement in which data about ocean health is as common and useful as weather data. Research priorities based on user needs should be mapped.

Communications

Evidence-based approaches are critical to understanding when communications are effective. Better presentation skills can help, as well as designing different ways to talk to different audiences, including communicating effects and pathways to politicians.

Partnerships and Research Mobilization

Partnerships are a *sine qua non* for the Decade. A priority is to leverage, enhance, and create value among existing partnerships, and coordinating among partnerships could be effective. A network analysis and database of ongoing activities would be tremendously useful. Information resources exist, but synthesis and systematic review of the existing information and curation of information is needed, along with navigable data and literature searches. New creative venues and partners for outreach and communication should be sought.

Identify existing initiatives

Nippon Foundation Nereus Programme, World Fish Centre, Seabed 2030, Atlantos, iAtlantic. GeoHAB, Circum-Pacific Council, Ocean Frontier Institute, One Ocean Hub, GOBI projects, ATLAS, International Climate Initiative (IKI) projects, CBD Ecologically or Biologically Significant Marine Area (EBSA) Programmes).

Working Group 3: A Predicted Ocean

General Comments

The Decade science implementation plan should focus on the science that can inform policy or decision-making, with attention to the interface with users. A more structured interface with those users is needed, by application area, in order to engage them on which predicted ocean knowledge and forecasts are most important for them (for sustainable development and operational applications) and therefore on priorities for development of forecasts, models, data systems, and observations. This includes policy users, business users, for development, hazard mitigation, climate adaptation, and long-term planning. There is currently no platform or programme to connect users to an ocean prediction system, to identify how ocean predictions can help problems they face. "Who are we doing this for and what do they want to know?"

Traditional knowledge should be embraced in order to facilitate observing and prediction programmes, and boost local engagement in management and ocean literacy. There is a related challenge for science to provide quick answers when political attention is suddenly focused on a problem (i.e. Sargassum in the Caribbean).

This group also emphasized that 'predicted' also encompasses 'understood'.

Capacity Development

There is a need to understand and identify how success should be measured (the Global Ocean Science Report provides one baseline) and foster partnerships in a joint way to ensure that data and forecasts can be used locally, as well as contributing to a global system, with a focus on increasing the capacity to monitor coastal waters for local benefit.

Ocean science fellowships should be promoted in the Decade to encourage opportunities for developing-country oceanographers. Capacity development should focus on both scientists and technicians, be gender-sensitive, and pay special attention to SIDS and Africa. We need a clearing house mechanism to facilitate the brokering of technology transfer and capacity development. We need technology development specifically for coastal observations (see Technology Development, below).

Communications / advocacy / ocean literacy / education

It is essential to encourage and support efforts at the national level to get all relevant agencies around the table and identify a national ocean science plan encompassing research, observations, and modeling. We need to ramp up efforts to communicate on the benefits, by audience, as well as to listen to their needs; e.g., politicians emphasizing economic benefit from services, and scenarios of risk and loss, and businesses, listening to their needs, focused on managing risk, and the added value to them with materials that speak to a broad audience.

The Decade should strive to spark fascination about the ocean by supplying teachers with materials, in many languages, for many age groups, with attention to empowering girls and young women.

Data sharing and management

We need to change the paradigm on data sharing and advocate for non-disclosure agreements or licenses with time limits, so that data are eventually available. Access to fisheries data is an important contribution, where "every fishing trip is a scientific survey." We should publicize ways to contribute data with the science community and industry, as a way to rapidly increase what is available.

Findable, Accessible, Interoperable, and Reusable (FAIR) data principles are key for the Decade: we need to implement access, sharing, and use guidelines for Decade activities.

Technology development

The Decade offers a great opportunity for innovation for observations in multiple areas, such as new technologies for measuring biological and ecological variables, new autonomous platforms to increase upper ocean observations for operational purposes as well as bathymetric data, low-cost easy-to-deploy technology for coastal observations and technology transfer for use in capacity development, economies of scale in sensors, housings, and platforms, to reduce the cost of observations.

Thematic by R&D priorities

The Decade offers opportunities to optimize bathymetric mapping in transit, and to obtain data from new sources including crowdsourcing. "Every transit is a mapping opportunity." Mapping is about bathymetry, but also more broadly about mapping habitats and species, on the bottom and in the water column, and all the key physical, chemical, biological, geological, archaeological, and human impact variables. Basic mapping should support development of more complex products: mapping of risks, of habitat loss, of hotspots, of scenarios. While much emphasis has been put on the bottom of the deep ocean, it is in the coasts that humans have the greatest utility of and impact on the ocean.

Ocean observing of ecosystem health: There are particular gaps in the Southern Hemisphere, Arctic, and for mid-and-deep water ecological processes. There are also many deep ocean knowledge gaps, including its role in climate, climate variations impacts on carbon cycling and organic matter fates, deep ocean responses to cumulative human impact, and ecosystem function and services, and adaptive capacity. New technology and process studies will help build ecosystem understanding about tipping points and regime shifts, and about cumulative human impact from multiple stressors. Increasing the use of ocean observations to extend time horizons of weather and climate forecasts will drive requirements for higher resolution observations in upper

ocean, better understanding of diurnal variability, air-sea fluxes, and atmosphere-thermocline feedbacks. This, in turn, will drive observing and communications technological development. The Decade is an opportunity to facilitate observations in waters under national jurisdiction. We need compatibility with observations of human activity and impacts in order to feed future ocean scenarios under different pathways. We must build on existing efforts: GOOS, POGO, OceanObs'19, Global Ocean Observing System 2030 Strategy, and create a platform to build partnerships to ensure that the observing system is responsive and fit for purpose, is improving delivery, supporting technological innovation in observations, and observing human impacts. Observing systems and forecast systems should improve engagement around improving the delivery to end users and feeding back to observing system priorities and design.

There is a need to focus on developing coupled models; e.g., wave, tide, circulation, coupling with the atmosphere, and coupling physical and biological models. These should be seamless but with a focus on particular timescales, including short timescales for hazard warning and operational services, and seasonal to decadal-to-centennial. We can build on existing efforts like OceanPredict, but need a focused effort on ocean model development, which is presently scattered. Engagement with users is necessary to identify priority information from models, and therefore observing priorities, co-designing operational and climate services with industry and organizations. We need to move beyond the technical outputs of our models to quantities and indicators of clear societal value; i.e., habitat loss, fisheries yields, and other societally-relevant indicators to inform policy. Developing scenarios could be a major effort that combines observations of physics, chemistry, biology and humans, models, and truly serves sustainable development challenges. This can engage The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and the World Ocean Assessment, and be inspired by the work in Coupled Model Intercomparison Project (CMIP) of the Intergovernmental Panel on Climate Change. We are ready for a first large-scale model intercomparison project (building on FishMIP and other efforts) to improve our predictive ability, and the development of model ensembles.

Working Group 4: A Safe Ocean

Thorkild Aarup provided an introduction for this group, highlighting the context for the Decade societal outcome IV –“A Safe Ocean” as framed in the Roadmap document. He also highlighted broader perspectives from the introduction to the high level Panel IV discussions from Day 1:

- Collaboration and sharing observation and R&D
- Hazard community is primarily rooted in public good model. But is it time to explore other financing models to channel resources to strengthen hazard detection and mitigation?
- What role for the national mandated operational and resource management institutions who will continue their work – Decade or not?
- Warning Systems are about people, not technology. A perfect warning is useless if people do not know how to react, touching on the socio-economic-political dimension and education actions.

Jens Krüger outlined the practical arrangements for the deliberations of WG4. Three sub-groups were formed and each discussed the three questions on a rotational basis:

- What are the knowledge gaps and what are the key science questions relating to the R&D priority areas identified in the Decade roadmap that should be addressed through the Decade in order to achieve a safe ocean?
- What are the existing initiatives and mechanisms that the Decade can build on to deliver outputs (e.g. partnerships, programs)? What would milestones look like toward the achievement of this outcome?

- What are the roles of following cross-cutting themes to address the science questions:
- Capacity building and technology transfer
- Partnerships and financing
- Access to information, data and knowledge
- Communication and awareness raising

Michael Angove, Sarah Grimes and Bengt Karlson acted, respectively, as rapporteurs for one of the three questions listed above. Each of the questions were discussed in the framework of: (i) What has worked well? (ii) What needs improving? (iii) What are some new ideas? and (iv) What are some actions?. Sam Harper served as chief rapporteur and presented a consolidated report to the plenary of the GPM on Day 3.

Question 1: What are the knowledge gaps and what are the key science questions relating to the R&D priority areas identified in the Decade roadmap that should be addressed through the Decade in order to achieve a Safe Ocean?

Worked Well

- Global Numerical Weather Prediction
- Tropical Cyclone track forecasts (gold standard)
- Ocean hazard notifications, e.g., “Notice to Mariners”
- Global Tsunami Warning System
- Research-to-Operations where resources permit
- Leveraging of bathymetric collections by ocean hazard community to the extent avail through IHO
- Marine life census/baseline
- HAB Awareness
- UNESCO / IOC Taxonomic Reference List of Harmful Micro Algae
- IPCC-led awareness
- Plastics Hazard Awareness
- Multi-disciplinary ocean hazard training efforts (e.g., WMO, IOC, etc.)

Needs Improving

- Data availability to support accurate, real-time ocean hazard detection, forecast, warning and responses
- Mapping baseline (scope and scaled to match hazard)
- Real-time dynamics (temperature, pressure, chemistry, etc.)
- Understanding technical feasibility and industry risks of adding scientific instrumentation
- Ability to leverage proprietary industry data for ocean hazard detection and forecast purposes
- Public Trust in Warnings—“belief” in the forecast
- Linkage between awareness, preparedness, and actions
- Tropical Cyclone-related hazards (intensity and storm surge) forecasts
- Establish relationship between human health and ocean health
- Implementation of IPCC findings and recommendations
- Ensure all populations receive equal hazard consideration, not based on geo-political influence
- Marine life census updates and changes over time; historical archive
- HAB time and space database and repository
- Development of automated in situ observing systems for HAB (imaging systems, molecular tools etc.)

- Including HAB observations in existing coastal GOOS
- Development of HAB prediction and warning is needed. A combination of observations and modelling the advection of HAB is one way forward
- Implementation of IPHAB/GlobalHAB findings and recommendations
- Updated bathymetry as seafloor elements change
- Consideration of CO₂ emissions before and after major disasters

New Ideas

- Institutional strengthening through partnerships: Industry; Research/Academic
- “Mandated” applied research aimed at end users
- Reconsider chemical applications and use in ocean—Industry must demonstrate safety
- Prioritize ocean data collection and observations by highest impact to life and property
- Ensure hazard warnings include traditional as well as modern components in order to build trust and confidence
- Leverage single-purpose sensors for other hazards to the extent possible (e.g., met sensors on DART buoys, HAB sensors on coastal buoys and ships of opportunity)
- Establish and/or leverage off-shore, in-situ ocean observing networks to support ocean hazard identification and forecasts
- Fully leverage industry data collections or opportunities: Oil/gas, Fibre optic cables, Commercial shipping, Wind mill parks, Aquaculture sites
- Crowd sourced bathymetry

Actions Proposed

- Engages and/or leverage industry for ocean observations that support hazard identification and forecasting: appeal to “greater good”; seek mandates and/or legislative requirements
- Revise international chemical standards framework: Recognition that there is a continually increasing number of POPs being used that potentially can harm the marine environment; Strengthen international legislation in this area with a view to reverse the burden of proof to industry and also require industry to contribute resources towards the monitoring; Strengthened international legislation and guidelines could also have positive influence on national legislation.

Question 2: What are the existing initiatives and mechanisms that the Decade can build on to deliver outputs (e.g. partnerships, programs)?

Worked Well

International Frameworks – SIDS Accelerated Modalities of Action (SAMOA) Pathway Programme, UN Disaster Risk Reduction Sendai Framework, Multi-Hazard Emergency Warning Systems (MHEWS) conference series, UN Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER), International Panel on Climate Change (IPCC), International Ocean Drilling Programme (Drilling Program), Green Climate Fund, Global Level Of the Sea Surface (GLOSS), IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB), Tsunami program IOC, GEBCO Seabed Bathymetric mapping, Stockholm Convention (chemical disasters), SOLAS and related safety of life at sea platforms, Satellite Data, World Ocean Council Smart Ocean/Smart Industries

Regional Frameworks – Framework for Regional Development in the Pacific – Climate Dev. & DRR together; Subduction zone observation Programme in Mediterranean; Integrated Coastal Zone Management programmes.

National Frameworks – Operational and routine services & management of national resources tied to international mechanisms (eg. WMO/IOC Regional clusters); Evacuation training and alert systems in Japan (especially using apps for alerts); Insurance companies risk management programs – useful to reduce claims to insurance; MHEWS.

Needs Improving

- Submarine landslides –Emergency Warning System.
- Integrated coastal zone management in developing countries
- Air pressure impact on waves, OBS & EWS
- Rogue waves
- Capacity Development and lessons learned on Disaster Risk Reduction (how to do it well)
- Alert systems for evacuation in SIDS (Software instruments)
- Resilience of coastal communities – infrastructure needs
- Set up of tidal gauges and infrastructure
- GOOS – Essential Ocean Variables: develop the work on coastal HAB (especially early warnings of HAB for aquaculture, fisheries (e.g. ciguatera), desalination plants and tourism)
- HAB – integrated global system
- GlobalHAB (more funding needed)
- Regional GOOS, e.g. EuroGOOS: adding HAB observations; establish a global HAB observation and prediction system subdivided into regional systems
- HAB information to the public and to the aquaculture industry (good examples include the Irish HAB bulletin, the Norwegian Algae Info system, the HAB observing system in California)
- Remote sensing of ocean colour for detecting high biomass HAB - work with ESA, NASA and others to develop combined remote sensing/ in situ observations
- Multi-Hazard Early Warning System (MHEWS) – fill the gaps
- Enhanced machine computational abilities for MHEWS.
- Ocean data to improve models for tropical cyclone & hurricanes and all extreme weather events – artificial intelligence
- Improved forecasts to ships at sea
- Loss of life from non-extreme events at sea: Statistics for Pacific Island Countries (e.g., more lives are lost at sea in maritime weather events that are *not* extreme, compared to extreme weather events and/or lives lost due to coastal hazards)
- Focus on increased hazards in Polar regions where ice is melting fast
- Improving awareness of forecasts (for public) and improving capacity to deliver forecasts (for met services in developing regions)
- Stockholm Convention – keeping up with the chemicals and hazardous materials is challenging: ocean focus is needed.

New Ideas

- Mobile technology for alert systems
- Resilience
- Adapting infrastructure and strengthening national capacity in response to sea level rise

- Capacity Development for National Meteorological and Hydrological Services (NMHS) in country – minimum needs are required
- Encourage collaboration within national governments, and with neighbouring national governments
- Technology transfer for simple measurements
- Work closely with insurance industry for aquaculture regarding HAB (e.g., fish mortalities)
- Use wind turbines and other fixed structures in the seas for automated observations of HAB
- Teach consumers about HAB and algal toxins
- Private company (e.g., Ports) and liaison with National Governments, e.g., NMHS.
- Improve savings from insurance (less claims, safer ocean) - funding to make risk management applications
- International subduction zone: international management plan
- Artificial Intelligence to predict storm surge (e.g., images of) ocean surface – predicted ocean.
- Legislation and codifying some of these ideas in conjunction with a massive education effort
- Helping indigenous people in Arctic – climate is changing rapidly and they need new methods to adapt
- Better understanding of toxic food sources, e.g., Indigenous hunting of cetaceans that are contaminated with heavy metal (e.g., Faroe Islands).
- Clean ships (e.g., Cleaning of old contaminating)
- Monitoring, Control & Surveillance

Actions Proposed

- Technology transfer – automated in situ HAB observations
- Mechanisms to encourage investments and liaisons between the private sector and national agencies
- Use of Marine Spatial Plans
- Legislation Guiding Principles / Charters
- Integrated Coastal Zone Management that increases cost recovery (eg. Pays for coastal erosion)
- Create data-pool of ship owners with insurance companies / be involved in safe ocean: ongoing.
- GLOSS – big data analysis & AI technology (predictive)
- Engagement of Finance & Security Industries (e.g., World Bank Pro Blue) linked to prosperity, safe ocean and poverty reduction
- Link “Safe Ocean” with developing countries – UN support to strengthen this
- Benchmark capacity development awareness and SOLAS (publication awareness and forecasts) including traditional knowledge
- Awareness and education, generally
- Social research is needed to help deliver methods with the most useful benefit to society
- Research the developments in Arctic Environment to come up with strategies to adapt – Arctic Council (plus other regions)
- Adaptation to physical circumstances, food habits (ciguatera fish toxins, heavy metals, POPs)
- Regional awareness of hazards – new approaches?
- Including awareness-raising directly in the school curriculum – this has significant impacts on social development in developing countries

Question 3: What are the roles of following cross-cutting themes to address the science questions: Capacity building and technology transfer, Partnerships and financing, Access to information, data and knowledge, Communication and awareness raising?

Hazards to (also) be mindful of in scoping text of Decade Roadmap associated with societal Theme IV – A Safe Ocean include Geo hazards (Tsunami sea surge, ice, landslides, volcanoes, chemicals), Pollutants (Oil pollutants and contamination of sea food), Biological hazards (Harmful Algae Pathogens, Invasive species, Jellyfish, Acute and/or chronic infection from thalassogenic diseases).

Worked Well

Geo hazards : Tsunami Sea surge, offshore network Japan – Pacific NW – New Zealand

Pollutants – oil – micro plastics initiatives from young people

Biological hazards:

- Regional Training and Research Centre
- IOC Harmful Algae list
- Weekly HAB observations in Norway
- The Irish HAB bulletin
- Emerging California HAB observing system
- Cyanobacteria observations in the Baltic Sea Data availability & sharing

Needs Improving

Data availability & sharing

Building competence in warning centres

Capacity development

Teaching the public

Geo hazards: Tsunami Sea surge

- Seismic data – needs improved sharing
- Multi-sensor data
- Geographical expansion
- Open access data/governance
- What polluting chemicals are in the ocean and what are the human health/environment implications?
- Toxicological implications of micro/nano plastics in seafood?

Pollutants – oil – micro plastics

- Satellite data for small island states, (e.g. Sentinel 2 is not available while Sentinel 3 data is)
- Hazards from ship wrecks – data loggers connected to sensors (ADCP, temperature, salinity, ...)

Biological hazards

- Combine data from many different platforms with the (tsunami) warning community
- Modelling of advection, behaviour
- Technology transfer - “Automated microscopy”
- Data in near real time
- Open access data
- In situ data is needed

New Ideas

Geo hazards: Tsunami Sea surge

- Mandatory funding of technology transfer + ocean monitoring for resource explorers
- Installation of observing systems on oil platforms, wind mills, ocean mining
- Effects of tsunamis on ecosystems, CO₂, etc.

Pollutants

- Shipping – ballast water
- Reduction of nutrients: regeneration; seaweed + biovalve cultured together
- Reversal of burden of proof of chemicals for industry Re: environment/health impacts

Biological hazards

- A global HAB observations and prediction system subdivided into regional systems
- Combine oil/HAB forecasts of advection
- Education module at multi-level – Teaching consumers is essential

Actions Proposed

Geo hazards: Tsunami Sea surge

- Multi-level & Multi-stakeholder capacity-building (not just new scientists collecting data)
- Customize the message to the specific culture
- Museums and ocean aquariums can be used for communication
- Public awareness

Biological hazards

- Coastal ocean observing system should include HAB
- Introduce automated imaging flow cytometry

Financing & Partnerships (including advocacy)

- Aquaculture industry + Insurance companies
- Tourism industry
- Green Climate Fund
- Insurance industry - Protect coastline from erosion and extreme events
- Oil industry
- Plastic manufacturers

Summary

Overarching Observations

Mitigation or elimination of risk – We have to collect the data, do the science, develop the technology and build the partnerships that allow us to mitigate the consequences of hazards and events (both anthropogenic and natural in origin).

Scope – A safe ocean relates to those living and working at sea as well as coastal communities.

Focus of solutions and interventions – Recognition that work is required at the local, national, regional and international levels in order to secure change.

Gaps – Where is work needed?

- Baseline data – Aggregation, Quality, Access, Completeness, Resolution and Collection.
- Capacity development and knowledge transfer – Institutional and individual level with a focus on public trust.
- Collaboration – Need to develop partnerships that span different sectors and regions.
- Access to financing – Recognizing the challenges faced by traditional funding models.

Ideas and Innovations

- Establishing subsea observation networks – Potential to use existing infrastructure and platforms.
- Capacity development and knowledge transfer – A focus on cross-generational and cross-sectoral approaches.
- Crowd sourcing and citizen science – building on existing programmes and involving new platforms.
- Engage the development, finance, and insurance communities – Make the link between a safe ocean and poverty reduction or reduced risk.

New Approaches

- Legislation and standards – Clarification of the expectations around sharing data, utilization of subsea infrastructure, etc.
- Monitoring and enforcement – Ensuring compliance with licensing requirements.
- Communication – Engage the social sciences to better communicate key messages and generate public trust.
- Embrace new technology – e.g., Ensure full benefits of Big Data Analytics, AI, data science and machine learning are realised.

Working Group 5: A Sustainably Harvested Ocean

Context

The term ‘harvesting’ needs to encompass the wider Blue Economy beyond fisheries to include activities such as mining, oil and gas, and genetic resources. For placing a value on the ocean, we need to communicate that challenges to the ocean mean challenges for the ocean economy. Societal, environmental and economic considerations must be balanced.

Knowledge Gaps

- Understanding tourism in the marine sphere – impacts of tourism on the environment and impacts of adverse environmental impacts on tourism.
- Linking oceans and human health – tourism, blue space use, psychological health.
- Climate change impacts – stock assessments lack basic information; life history is a knowledge gap.
- What is sustainable harvesting at the ecosystem level rather than at the species level? Fill knowledge gaps on ecosystem function.
- The meso-pelagic zone.
- Challenging biases – geographic bias (where data is collected, gaps in global south), taxonomic bias (e.g. Regional Fisheries Management Organizations that only conduct stock assessment for a limited number of species) and need for monitoring schemes across taxa.
- Comprehensive information for marine spatial planning.
- Social license – trans-disciplinary approaches for community cohesion, governance and commons theory to reduce pressure and transfer of burden to global south.
- Political science – governance and law – international cooperation between countries.

- Food production from the ocean – Human impacts, equity and social justice, improving affordable production of algae and oil as replacement for fish.
- Equity – gender equity and indigenous fishers issues. Informal rights and different impacts of harvesting on different communities.
- Taxonomy skills gaps.
- Translating science to policy.
- Food security – protecting themselves.
- Impacts on the seabed – mineral extraction, fisheries, etc.
- Role of private sector in sharing data.
- Communications – Awareness campaign, tell public about the sustainability of seafood.
- Sustainable consumption.
- What social structures need to change to enable societal change, governance change?
- Trade-offs between different uses – where are the conflicts and synergies between ocean uses in near-shore?
- Incentives for data sharing.
- Scientific knowledge gaps – trophic gaps, not just who is there but how they relate to each other.
- Continuous monitoring of data

Existing Initiatives

- The EAF-Nansen Programme, supporting the application of the ecosystem approach to fisheries management considering climate and pollution impacts.
- Permanent Commission for the South Pacific (CPPS) is the maritime organization that coordinates regional maritime policies in order to adopt concerted positions of its Member States (Chile, Colombia, Ecuador and Peru) in international negotiations, development of the Law of the Sea, International Environmental Law and other multilateral initiatives.
- Regional Fisheries Management Organisations or Arrangements (RFMO/As); many have a mandate over waters under national jurisdiction, some have competence areas that extend to the areas beyond national jurisdiction. Need to be involved to articulate the message.
- Agencies for cooperation
- Community-based fisheries
- Ocean twilight zone program
- UNEP Regional seas programme
- FAO Hidden Harvests Project – voluntary guidelines for securing sustainable small-scale fisheries
- Environmental Impact Assessments for large scale projects
- Small fisheries – too big to ignore
- Large Marine Ecosystems
- Global Environment Facility Programmes
- Coral triangle initiative
- NSF long-term ecological research

Milestones

- Compliance, with maximum sustainable yield being threshold.
- Targets for what proportion of fisheries in a given region are acceptably sustainable.

- What does sustainability at the ecosystem level mean (beyond MSY).
- List of SDG targets? No subsidies.
- Spatial data on activities in ocean.
- Impact of trade-offs.
- Global scale level of literature summary on how species distribution will change with climate change.
- Reversing declining trends.
- Connectivity.
- Identify best practice approaches and adopt best practice approaches in access to data.
- Clarify what is needed in term of data.

Cross-cutting

- Transparency is the cross-cutting theme of cross-cutting themes: i) science data ii) activity data iii) decision making data; requires interdisciplinary approach.
- Capacity Development through leveraging knowledge synthesis.
- Research business model innovation for ocean observations.
- Business model innovation.
- Coordination and endorsement from IOC for good practice.
- 10 steps for a citizen to take.
- What is needed for food and nutrition – what are the needs. Needs driven. What do we need and pathways for decision-making.
- Radical change in financing – business as usual will not work!
- Training people, ensuring data access matched by skills

Working Group 6: A Transparent Ocean

The Co-chairs for this working group were Margaret Leinen and Martin Visbeck, with rapporteurs Emma Heslop, John Gunn, and Peter Pissierssens.

The Slido audience interaction application used during the Day 1 Panel sessions showed that the majority of people felt that the most important topic for the Decade was the ‘transparent’ ocean issue. Thus, Working Group 6 on Day 2 focused on equal access to data and capacity development. The breakout was divided into two parts: an initial plenary session covering both topics and then two breakouts focussing on one topic each.

Plenary Session

There was good participation across the breakout, with many good ideas brought forward. The suggestion from Day 1 (Lubchenco) that we need to look at changing the narrative found resonance in the discussions. The participants were from a wide range of backgrounds but all shared a passion and fascination for the ocean that they thought could and should be shared, and in fact felt that this was vital to achieving the aims of the Decade. A number of ideas were focused around communication, as well as capacity development and data access.

The cross-cutting nature of the session was noted at the outset, as was the vital importance of working on capacity development within the Decade. Margaret Leinen challenged the group to think about what the Decade can do or make possible that would not happen without the Decade, noting that we have heard about capacity

development in many ways, and access to data is a part of this, but out of the hundreds of things we could do, what can we collectively leverage or leap frog over?

Breakout Group on Access to Data

An early discussion centred around the definition of accessibility in the Transparent Ocean theme, noting that access could be thought about in terms of access to information, but also in terms of physical access to the ocean. Some people do not have physical access to the ocean, including those who live far from the coast, the disabled, or simply those who do not know how to swim. It was noted that many people in small island nations are not able to swim. One early suggestion is that the Decade could aim to ensure that all can swim, through partnerships with organisations focused in this area. In the US, for example, approximately 50% of the population cannot swim. An ambitious but possible goal is for every child under 10 to learn to swim. Drowning is the second leading cause of accidental death for children. The Decade could partner with national organizations or schools. For small island nations, the swimming issue also addresses issues of ocean literacy and gender equality.

Igniting people with passion for the ocean

This idea was picked up in several discussions, through a map of ocean information, a list of projects already underway, showing the gaps, and discussing oceans in curriculums. However the biggest theme was connecting more people with the passion and fascination for the oceans first, then the other narratives, also also help people see the oceans as a major part of the planet. Some ideas from participants include:

- Importance of showing a map of the whole planet and the part of the planet that is the ocean. It is important for people to know what is out there. Many people do not even know what is being destroying.
- Seek to change the narrative by capturing people's fascination with the ocean; a video or documentary to transmit the excitement and passion for the ocean, rather than working through curriculum.
- Using underwater world heritage sites as a communication outlet.
- Include ocean science as a part of integrated curriculums, integrated as part of earth system science and not isolated.
- Provide access to the ocean and ocean knowledge through curriculum in all nations. Let the scope of ocean literacy expand through the Decade so that we can talk about how we all work sustainably with the ocean.
- Work with artists to create an ocean generation for next decade.
- Change the political scene in countries that do not embrace sustainable development by having people informed, focused and involved in grass roots movements and campaigns.
- Incorporate cultural heritage as part of the ocean advocacy campaigns.
- Build the concept of human well-being into the value of the ocean.

Developing (younger) scientists

- Provide training in how to engage policy and decision makers.
- Get more young people involved in the Decade so they can see how the strategy is developed.
- Set up mentorship programmes for young scientists to make them better equipped for the Decade to come. The role of scientists in society is evolving and we need to create new ways of educating marine scientists able to communicate, seeking out unconventional partnerships, etc.
- Establish an early career researcher programme.

Issues and opportunities to connect inventory of data and capacity

- There is a real opportunity to connect the data that is out there already. There is no tool to see the existing data; we all see only small pieces of the puzzle.
- A clearing house mechanism for sharing of expertise, technology, and infrastructure has been developed as a pilot within IODE.
- The methodology of SDG 14 transfer of ocean science capacity development is an opportunity to provide feedback on the type of data that should be in this to report on ocean capacity.

Data use, value and access

- A fundamental challenge is that much data is poorly used or unused. By the end of the Decade a goal should be 'no ocean datum left behind'. The research community cannot continue to spend resources and not fully use the data collected. Providing visibility is not sufficient. Data should be used, and it is necessary that all data that is funded is made available.
- Emphasize open data, making all the data accessible as a goal. Make a resolution in the UN to contribute and collect all already-taken data.
- Pass a transparency resolution at the national level where it is agreed that if public money is used to gather data, those data must be returned for science, capacity development and knowledge.
- Harness technology to enable new visualisations of data and models, like gaming technology, to break down barriers to access data, enable people to visualise data or move through it in new ways.
- The Observing system is expensive and it is important to state openly the cost of acquiring data; the value of the data need to be communicated to show the return on the investment.
- Strengthen the Global Ocean Observing System.
- It is difficult to communicate the value of data to policy makers. Environmental economics is starting to examine the value of ocean science, and this should be pursued further. The value of legacy activities and cultural values should be considered.

Bringing data and knowledge access down to the local level and connecting local/regional activities, particularly in small island and other developing nations

- There are several key areas to consider in terms of access and capacity. It is important to ensure that people in the coastal area are aware of what is happening in their region. If communities are involved in taking samples, then they already have some understanding of the limitations of the oceans and why it is necessary to take action when decisions are made. It is important to communicate the value of ocean work – it is not cheap and needs to be well justified. International projects taking measurements within national waters need to make the data (easily) available to regional users.
- There is a great need to better coordinate between agencies, particularly in developing countries, across NGOs, UN, projects, etc. and to share data and support efficiency. Could the Decade do something to better connect those taking these data?
- Providing access to information beyond the scientific community will mean working with communities more closely to understand their needs. It was suggested that NGOs could be a good partner as they work with many stakeholders. In addition, knowledge brokers can be important, working across disciplines, conducting

participatory research, which also helps with capacity development. The Decade could help design partnership and knowledge needs, with a bottom up approach.

- Within small island nations there are large data gaps, and there is a reliance on regional expertise and on community-based knowledge. The governments have some useful data, but need more. Citizen science is one approach, as well as partnership with more developed areas.
- Need more ways of providing access to data. Dialogue with many communities, ensure some information on activities in each area so that people can take decisions.
- Optimise and look to different sources and access. In our “global” assessments, many countries do not have resources to harness data. There is much information in reports done by local governments, so it is not always necessary to start from scratch with another assessment.

Ocean information as a public good

What if ocean information was understood as public good? This could be a transformative change. The observing system and ocean modeling systems are often discussed. Could there be an ocean information system that would increase engagement, sharing, visualization, and assessment of information against the societal agenda? In other fields of science, such as space programmes, there is shared access to a facility since few countries can put people into space. The space station is one example. Accelerators are another. What would be the equivalent for ocean observing and data platforms?

Equity

- Activities under the Decade should have responsibility to promote equity in research and innovation (ethics, gender, stakeholder involvement, governance).
- Indigenous communities should be at the table; indigenous scholars.
- Keeping connected and evolving throughout the Decade.
- Must adopt a continuous think-tank approach. The Census of Marine Life spent money on getting people together throughout the project and this had value.

Breakout Group on Capacity Development

Capacity development is a key theme with broad implications about changing the narrative, using ways outside of education to ignite passion, fascination, and increase understanding in people. Harnessing other communications techniques (e.g., the arts) was also discussed.

Visualisation and a transparent ocean

- Visualisation is vital for understanding the value of ocean knowledge. Make the ocean visible through images to show what is happening under the surface in a science-supported way. For example, if CO₂ increases, can the impacts be made visible and understandable?
- Many fields of training, such as law and medicine, are highly visible. Building the recognition of scientists and bringing more knowledge about marine environmental issues through highlighting scientists and their work is key (local “hero scientists”).
- The Decade should produce a film about ocean sustainable development issues featuring scientists from all over the world dealing with the range of SDG issues.

- Work with those already engaged with the ocean, e.g., the sailing community, where people are asking how they can contribute. The Decade should be prepared to answer this for many communities.
- Have a UN Ambassador for the Decade.
- Develop a toolbox of good practices and communications materials and projects that have produced some results. A collection of case studies can be a really good product. Instead of assuming data needs to be bite sized, develop the capacity of people to understand information in a different way.
- Develop a massive outreach event, like a Live Aid concert, to focus on global ocean issues. Use the revenue for capacity development.
- Develop a real map of the ocean, not just the map of land and ocean presented in most school textbooks, which would help to meet a practical objective in changing the way people view the world.

Capacity development and communicating at the policy interface

- Develop a real map of the ocean, not just the map of land and ocean presented in most school textbooks, which would help to meet a practical objective in changing the way people view the world. Need people to translate the scientific advances, people who understand the policy process.
- COP21 event bringing a lot of relevant stakeholders together with a new vision and a receptive community (climate); introduce the ocean in the vision. Need to develop a voice that is a trusted source, with robust methodology and work experience at the policy interface in providing answers and developing trust in those answers.
- Need a sort of IPCC for the ocean to provide trusted advice and strong methodologies; how do we go about pulling together the information and provide the trusted advice that people would go to? The climate community and biodiversity community has done this successfully. For example, with plastics we don't really know enough to produce a consensus report; it is an area in which we could do a lot better.
- Particularly for local and indigenous communities, need a forum on science policy; work with them and have a meeting where 50% of the discussions focus on the oceans. Indigenous groups must be represented at the meeting.
- UN should develop a platform for local communities and indigenous communities.
- The capacity development/knowledge needs to flow both ways, including from indigenous and local communities to science. We need to be prepared to change way of thinking.
- Communicating science to policy makers and economists is a priority for capacity development.
- How the common resource allocation has been made and does it stand up to the science for accountability and responsibility.

Sharing capacity and training, reaching beyond typical routes and partners

- Collaborative program to make use of spare capacity. How to link initiatives done by different countries. Have masters courses in different countries, combine the work of different countries and institutes, network post-graduate training courses. The Decade can look at masters and then move through from masters to support fellowships and move with people through their careers, equipping them perhaps in the ways that have been mentioned.
- IMO seafarers training – maybe we should revisit this and look at what we could bring into this. An example would be that of the national parks, when fishermen were giving permits with the requirement that they had to train with scientists first.

- Aquariums are looking at the next 50 years, at the role they play in civic space or leadership in ocean conservation. Can this be leveraged as an opportunity for training and outreach? Aquariums are useful for distributing information, tools for census of diversity, science projects using simple sensors that can involve people in measurement programmes.

Work at the UN level

1. Clarity in nations for the science-policy interface. One of the biggest concerns is the policy disconnect and inability of nations to deal with ocean-related policy issues because of a lack of clarity. Few countries have a minister of oceans, and in many countries there are many ministries dealing with different ocean-related issues. This fragmentation is a systemic failure and policy failure in addressing ocean issues. This is where the Decade could make a difference at the UN level.

2. Coordinating between agencies. Could the Decade call on UN Oceans to act as one and get all the regional centres set up as one coordinated entity? This would be a transformative change for regional actions that would eliminate duplication and make best use of financial and human resources.

Work on finding data that exists and making it visible

In developing the Caribbean marine atlas, for example, one of the problems was getting the data. Once we began to find where the data were being taken, we realized there the coverage was sufficient, but it was very difficult to collect. Scientists were keeping it in their research institutions, or the a community was taking data but with no systematic way of managing it. The catholic churches in the Caribbean also had long historical records of ocean-related data – more than 200 years – that was useful for analysis. To encourage data sharing, it is important to show the authorship of the data

We need to develop an Ocean Information system thinking, where all data holders bring in what they have and their contribution is seen and can be accessed by all. Many ocean project results do not really get used. Can we integrate an economic concept – equilibrium in demand and supply – to join up people who need data and those who collect it?

Data Access Breakout Group

What should be done

- Concern about lack of open sharing, controlling access, inappropriate use, and ethical conduct. For data and information inventories, scales of inventories are needed.
- For the Decade to make a real difference, data and information inventories must be inter-sectoral and inter-agency.
- Data portal needed.
- Data control issues addressed (Nations serving their own data instead of through global systems).
- Private corporation data linked.
- Best practices for use: inter-operability, QZ/QC, management plans, metadata, coding, archival and preservation, curation, best practices to be used for citizen science.
- Computation needs: develop Platform as a Service (PaaS).
- New kinds of data identified, linked.

- Implications of new paradigms for data use: implications for developing nations.
- Fostering partnerships for mutual data use.
- Data to information.
- Regional opportunities.
- FAIR principles – findable, accessible, inter-operable, reusable.
- Semantics, ontologies.
- Incorporating citizen science data: cultural challenges where the Decade can introduce the concept of “trusted data” and/or traceability of data and information.
- Crowd analysis opportunities.
- Indigenous knowledge and how to access and use.
- Ethical compact for the decade in general.
- Data and information as a public good.

Big Themes

- Data and information as a public good
- We have responsibilities/ public trust/ amount of investment
- Formulation of a broadly-accepted ocean data policy (UN wide)
 - Creative commons?
 - Driven by societal benefits – preservation of life and property
 - Importance of public trust
 - Driven by other decade ambitions
 - Facilitates other entities/programmes (regional seas, etc.)
- Data curation: archival and preservation responsibility: heritage!

Services Related To Data

- Mechanism to test and verify if services meet societal needs? How to engage society? How do large efforts generating data ensure that they are addressing user needs? Use of data to create virtual experiences for inspiration, education, etc.
- Problem now: the ocean observing system was designed, the service was set up, and only then went to look for users. This needs to be reversed, but without transforming all science into application-driven science.
- Ocean data and services community has not been good in PR (compare to weather forecasting)
- The data system mentioned in the roadmap still needs to be developed. Will probably be distributed system but it should still be mentioned as a deliverable.
- Need services but also data products.
- Couple of compelling demos

Task Group on Communication

The Communications Task Group was a model of how the Decade should be collaborating: it included a mix of ages, was gender balanced, interactive and participatory. Communications need to be strategic: who is the audience? There are so many potential audiences that it is important to be strategic about who the audience is and when to engage to create a sustainable movement. The communications strategy should have a very strong focus on digital media, both mass media and social media.

Jonathan Clay, director of the BBC documentary series *Our Planet*, informed participants about how they have used both mass media and social media to get the ocean on the table for the Beijing 2022 Winter Olympics.

Social media is not monolithic. There are different audiences, different formats, different content. The Decade's communications need to match the media. The Panel even discussed the possibility creating a "matchmaking" social media site (working with scientific publishers) to connect ocean scientists with each other and with decision makers.

The strategy needs to focus on a concrete, realistic goal. Movements need to create critical mass to become sustaining. What's the critical mass for the Decade? How many people need to think they are part of the Ocean Science Enterprise?

Jonathan Clay asked *"How can we get to a world where being green is just the normality? How do we get people to think ocean science is just as mainstream as weather data?"* People need to get to the point of understanding that we need it.

Many of the communications ideas included 'incentives' for people to act and incentives to encourage participation (e.g., a passport with stamps aligned to attaining SDGs, or scientific journals that ask people to indicate SDGs like they would keywords or data impact factors aligned to SDGs).

Brands

- Imagine the ocean, #ImageOcean, to make people think about what the ocean could be.
- Generation of Ocean Science – create an emotional connection using the idea that, wherever you are, you are connected to the ocean and your actions have impacts; #oceangeneration
- #Oceanisus
- #PlanetOcean, We are all ocean citizens; global referendum to change the name of Planet Earth to Planet Ocean.

Challenges

- What exactly is the UN Decade of Ocean Science for Sustainable Development? How does it differ from ocean conservation, ocean solutions, ocean action?
- There is still a tendency to drift from the Ocean Decade to Ocean Management and Conservation.
- There is a struggle with differentiating between making people care about the ocean and making them care about the Decade.
- Digital communications will help a lot with scaling up, but it won't provide the global coverage that is need. Think beyond digital.

Cross-Cutting Theme Reports

Capacity Development and Technology Transfer

This group addressed the global and regional priorities where the Decade can support and foster cooperation for the effective delivery of targeted and sustained capacity development programmes (people and institutions), including through the exchange of marine technologies.

Panel Chair Elva Escobar opened this cross-cutting session by noting that the promotion of economic, social, cultural and other rights are at the heart of UNESCO's work, and that to enjoy the benefits of scientific progress and its applications is one of these human rights. This Panel explored global and regional priorities where the Decade can support and foster cooperation for the effective delivery of targeted and sustained capacity development programmes (people and institutions), including through the exchange of marine technologies. She introduced the Panellist for this session.

Francesca Santoro, UNESCO/IOC Ocean Literacy and Ocean Science Communication Programmes, informed the participants that the Decade must be developed in keeping with the ideals of UNESCO and human rights by developing knowledge for all and promoting international cooperation and sharing. Participants have emphasized that the Decade will have to generate knowledge that is not only relevant for the scientific community but also for the society at large. Ocean Literacy as part of the Decade Capacity Development efforts should develop international collaboration to promote the exchange of good practices and the creation of partnerships on ocean knowledge that is fully leveraged to advance ocean sustainability. The success of this effort will depend, on the one hand, on our capacity to enhance the science-society-policy interface, and, on the other hand, on empowering a wide range of stakeholders; i.e., communities and networks of business, universities, research centres, and civic groups to share responsibility in addressing urgent threats that are causing a decline in ocean health.

Juliette Babb-Riley, Permanent Mission of Barbados to the United Nations, provided information about the World Ocean Assessment that was first published in 2015 by a Group of Experts comprised of 25 experts from 5 regional groups of the UN, assisted by pool of experts of 600 scientists around global. The WOA was the first comprehensive report on state of the world's ocean. The 2nd WOA will be published in 2020. The key objectives of the Decade can inform decision making and the work of the assessment. The processes is ambitious: to generate knowledge of the ocean system and the human component for sustainable development of ocean resources, highlighting cooperation and synergies. The global reporting and assessment will focus on the integrated view of drivers, pressures, paths and associated impacts on human well-being and contribute to sustainable management. The IOC contributes to the assessment with technical and scientific support, logistic and financial support, and assisting with the second cycle of experts nominations. The trends and gaps that will be highlighted in the second report could inform the development and design of the Decade. As the process evolves after 2020, we need to coordinate closely with the Decade.

Jaqueline Uku, Kenya Marine Fisheries and Research Institute and President, Western Indian Ocean Marine Science Association (WIOMSA), gave a brief overview of some of the key capacity development needs for the Decade, specifically in the region from Somalia to South Africa. She pointed out that when you walk around fish markets in this region of the world, you see the importance of fish for people's well being, and thus, for the Decade. The Decade must work to establish capacity for its projects to be successful. In many capacity development programmes, good scientists get trained abroad but then come home to nothing, to no infrastructure and no support. Many areas now have people with a high-level of skills but no equipment. These people and institutes need to be connected to the global process. Regional assessments of the state of the coasts are needed, and should be linked to the World Ocean Assessment. Marine Protected Area baselines are also needed, including threshold information and models. These are critical habitats and institutes in the region are working on a range of research issues, but they need equipment and some training. The Decade needs to align objectives with national agendas.

Ariel Triosi, Vice-Chair, IOC, and Chair of the IOC Capacity Building Panel, reminded participants that talk about capacity development often only focuses on human development, but capacity development also includes development of physical infrastructure and institutions. The Decade needs to assist in finding and mobilizing financial support, transferring research and science capacity for policy making to meet the SDGs, and educating through ocean science communication and ocean literacy. Technology Transfer is very broad, and it needs to match needs with offers of help through a bottom-up, not top-down, process.

Sophie Seeyave (Director, Partnership for Observations of the Global Ocean) described the different types of capacity development that all serve useful but different purposes. POGO, in partnership with other organisations like SCOR and the Nippon Foundation, has developed a portfolio of training programmes over the last 20 years, including fellowships (which involve sending young scientists from developing countries to receive training in a developed country) and professorships, which work the other way around by sending a professor to teach in a developing country. POGO also has a network of alumni that fund joint research projects, and more recently launched a project to develop low-cost instrumentation for coastal monitoring in developing countries. She stressed the importance of different organisations working in capacity development to network and combine their efforts and resources, and that work along these lines had already been started through a GEO Blue Planet Working Group, through joint publications between POGO, SCOR and GOOS, and under the umbrella of the EU projects AtlantOS and AaANCHOR.

Katy Croff-Bell, Director, Open Ocean Initiative, Massachusetts Institute of Technology (MIT) Media Lab, highlighted some of the challenges with the tools used today for deep ocean research. Deep submergence technology is expensive and large and technical, and there are data challenges as well with how to access and use the data. Only a few countries have access to deep sea waters, and leveraging economies of scale (e.g., mass production) is needed to decrease costs. Today, most people have a supercomputer in their pockets (smart phones), which is more sophisticated than the technology used to put men on moon. Increased investment in standards and systems is needed, such as artificial intelligence driven tracking of underwater environments. There are also advances in other industries that can be applied to oceans. The project “My Deep Sea, My Backyard” helps locals to explore their own deep sea areas. This is a long-term scientific and technical programme for deep sea waters. The programmes are locally-led deep sea explorations happening now. The technology must be easy to use, cheap, and easy to fix. The programmes are co-designed with the local communities, and the training is culturally relevant, with long-term investment, not just a single workshop. It takes time and it is very challenging. The programme is planning to expand to train people around the world to explore their own backyard areas. The 2018 Ocean Exploration Forum developed some innovative partnerships that enhanced diversity and equity by investing in travel funding for scientists from LDCs because representation matters. It brought in big organizations for communications from sectors beyond the typical ocean science realm, such as Disney, Lego, surfing organizations, etc. These programmes require trust and respect and shared values, with participatory design principles. The programme envisages developing advanced low-cost tools that can be used around the world by local people.

Elva Escobar closed this session by noting that ocean observations and the role of marine biodiversity are central elements to the Decade, and that these are linked to issues of human health and the global economy. Capacity development and technology transfer support the science community to develop indicators to track life in the sea and human health, and improve the economy. She asked each of the Panellists for a one-word closing remark:

- Pool resources and find more funding for Capacity Development
- Partnerships
- Full dimensions of Capacity Development and Technology Transfer has to be needs-driven

- Many developing country scientists only publish in what is considered “grey literature”. Need access and help to get their stories into mainstream visibility.
- We need to get out of our comfort zone to embrace new approaches being used in other sectors.

One comment from the Slido audience interaction application asked the Decade developers to consider the problem of open access publications, which are internet-based, asking how do people who have no internet access this information? It is a big challenge for the LDCs.

Partnerships and Financing

This session addressed how the Decade can help leverage and align national and international investments in ocean science that will require cooperation, coordination, and communication amongst stakeholders, including the private sector and philanthropy. Mechanisms for Innovative partnerships and financing models to support the Decade enterprise were discussed.

This session was opened by Chair Anna Joborn, who noted that we need to act as matchmakers to link the activities of the Decade with stakeholders who will fund and implement them. She introduced the Panellists.

Janaina Bumbeer, Science and Conservation, Boticario Group Foundation, Brazil, provided an overview of some lessons in developing needs-based capacity development and technology transfer activities, stating that donors need to think about monitoring and long-term planning. She also highlighted the importance of building connections with the local public to explain why science is important for sustainable development, and that it is not something that is always harmful or restrictive to livelihoods as is often the perception (particularly among fishermen, for example).

David Millar, Fugro and the Maritime Alliance, discussed how corporate responsibility was increasingly important to employees, shareholders, and clients. It makes sense to do sustainable development in Blue Economy industries, and they are looking for visibility and opportunities for sustainable development. Public-private partnerships with existing fleets of fishing, shipping, cruising, and exploration sectors can help with technology, observations and big data. Fugro is involved in the Seabed 2030 project. There is some hesitation to share data, but this can work by offering lower resolution data or delayed sharing. Other ideas include turning on side-beam sonar systems even when ships are just cruising from one spot to the next, which can collect data that doesn't exist through any other means. The same principles should apply to other data streams and multi-beam systems. While it is important to keep in mind that the clients own the data, it is also the case that ships collecting bathymetric data can also collect oceanographic data. He stated that successful engagement of society in the Decade will lead to society putting pressure on companies and industries to comply with responsible sustainable development practices.

Mikkel Klougart, Senior Advisor, the Velux Foundations, discussed philanthropy and private foundations. The Velux Foundations are one of the largest private philanthropic foundations in Denmark, started by the Velux founder through his passion for science and environment. The Foundation provides \$7.5 million per year for restoration of coastal areas and reefs, grasses, awareness campaigns, and local low-impact fisheries. It also supports research projects. For investments to have high impact and maximum return, the Foundation focuses on climate change, companies invested in must adhere to the Paris Agreement and show responsible sustainable development behaviour. The Foundation is proud to have established a partnership agreement with the UNESCO

/ IOC for the development of the Decade and to support initiatives which can help Decade understand how to engage private foundations. The Velux Foundations will be co-hosting with the UNESCO / IOC an engagement conference for private foundations for the Decade in October 2019 in Copenhagen.

Paul Holthus, President and CEO, World Ocean Council, discussed the role of ocean industry and the existing partnership agreement with the IOC, WMO and IHO, to engage the ocean business community. He mentioned there are 90,000 merchant ships, 3-4 million fishing boats, 9000 operating oil and gas platforms, 1 million kilometres of submarine cables, and numerous wind farms and aquaculture farms, all representing infrastructure that can be used to gather data. The role of the WOC is to help to engage this diverse community across sectors. He discussed the Smart Oceans, Smart Energies program and an ocean investment platform. From 20-22 November the WOC will host a Sustainable Ocean Summit in Paris where the theme is “Investing in Ocean Futures: Finance and Innovation for the Blue Economy.” He stated that key to success is partnerships based on an aspirational vision and practical expectations of what is possible, dialogue and relationship building. Partnerships must be based on reality as well as possibilities.

Torsten Thiele, Founder, Global Ocean Trust, stated that healing the ocean is part of human well being. The health sector economy is much greater than the blue economy, and yet, healing the ocean will require action on a much larger scale. We must bring different aspects of the problem together to identify ways to turn this challenge into an investable proposition. There are several components to consider: 1) economics and the benefits of investment, which requires an ocean equity and debt proposition and how does science fit into this? He gave the example of a large financial institution that developed ocean expectations and expected companies to report on ocean impact accordingly. Ocean science can help provide a framework for this sort of accountability, and can help investors make the right financial decisions and decide where financial flows need to go. This type of decision making needs ocean science information, including impacts on the global ecosystem and human domain, not just the ocean. The Decade should communicate ocean knowledge and expertise to financial groups. He further suggested the establishment of a natural capital financing committee, where all projects must follow the framework of science-based ocean sustainability. The ocean is our pension fund, and necessary for next generation. The world is now committed to the SDGs and ocean science is the tool needed for this transition.

Anna Joborn provided a summary of the session:

The private sector can and should play a key role in Decade.

Philanthropy can inform and contribute:

- Importance of communication plan and ways to monitor results and measure success for philanthropic engagement
- Incentives innovative models and tech solutions
- Scale-up roles of local businesses to contribute to SDG14
- Example: innovation labs including civil society, decision makers, scientists and private sector; need mentoring processes and a pipeline of projects to keep things going
- Lack of understanding of why science is important to our lives

Business and industry can contribute

- Hundreds of companies look for business opportunities to contribute to sustainable development – Decade perfect opportunity

- Examples of companies in: fishing, shipping, exploration, construction, survey, technology companies, sensor development, data manage distribution and big data, AI

Industry can provide equipment and deploy equipment

- Coordination collaboration and partnering needs to be used – take advantage of planned movements of vessels to plug the gaps
- Use of industry fixed and mobile infrastructure such as ships; e.g., there are 90000 ships in merchant fleet and 3-4 million fishing boats in fishing fleet; 9000 oil and gas platforms; 1 million square km of submarine cables.
 - E.g. crowd source bathymetry program Fugro
 - Increase efficiency – vessels collecting bathymetry could be collecting oceanographic data for water column and seabed too

Share data

- Digital philanthropy – businesses

Engagement – engage early

- Public private partnerships for engagement

Innovative financing mechanisms

- Turn the challenge into an investable proposition: equity and debt
- Understand ocean equity (natural capital stock) deliver ecosystem
- Debt proposition – how to create investable finance infrastructure to deliver finance at much lower costs
- Investment banks, for example, have an interest in impact of companies – ocean science needed to understand this
- Need an ocean finance architecture supported through an ocean sustainability bank to deliver ocean solutions at global scale – based on science
- The ocean is our pension fund and our fund for the next generation's livelihoods

Data and Information Sharing and Knowledge Exchange

The collection and management of ocean data often remains siloed with physical, biological, and human data collected and managed in ways that make it difficult to conduct large-scale science, analysis, and modeling and support decision making.

The Panel addressed how the Decade can stimulate data access and integration aiming at delivering knowledge, products and services more effectively to end users.

QUESTION 1: Do we know what data are available from UN agencies and other partners and organizations, including national entities?

Comments from Sky Bristol, Chief of Science Information Services, United States Geological Surveys

For many reasons, data producers are doing an increasingly better job at getting data into reasonably usable formats and putting them online for use and re-use. There is still a problem of needing to be 'in the know' in order to find them and figure out what are often highly customized and complicated user interfaces. This is partly

due to a pervasive ‘not invented here’ problem where organizations with enough money feel like they need to build their own unique tool set.

Comments from Lutgarde Coppens, Head of the SDG and Environment Statistics Unit, Big Data Branch, Science Division, UN Environment

In the context of the SDGs, UN Environment recently launched a publication entitled *Measuring Progress: Towards achieving the environmental dimension of the SDGs*. This publication provides an overview of the availability of statistical and spatial data for the environment-related SDGs and progress towards achieving the SDGs. Across the SDGs, 68% of environment-related SDG indicators do not have enough data to assess progress. For goal 14 on oceans, only 2 of the 9 indicators have data which can be used to measure global progress. There is a need to scale up support for better monitoring across the SDGs and particularly on oceans. This is particularly true as 4 of 9 oceans indicators are still Tier III, which means no global methodology is agreed. For SDG 14.1.1 on coastal eutrophication and marine litter and 14.2.1 on ecosystem-based management of marine areas, we have some data, but much of the information is old, is not updated often enough to provide information on trends and not granular enough to result in policy-relevant information for countries. We still have major knowledge gaps in terms of understanding both nutrient and plastic concentrations (for nitrogen, phosphate, metals and other pollutants, for floating debris, debris in the sea column, for debris on the seabed floor, for microplastics, for ingested plastics and for other aspects of ocean health). Additionally, in order to develop policy, we need to not only understand the current state of these indicators, but also the attribution of pollution (where is it coming from?) and there are also knowledge gaps in this area.

Comments from Nadia Pinardi, Professor of Oceanography, University of Bologna and JCOMM Co-President

In order to know what data are available it is necessary to have the data sets discoverable and accessible, and this is still not true for a large number of data sets from the research sector. From the private sector we also are missing data sets but it will be difficult to obtain these since they are economically important for the companies and they trade on this. What really cannot be accepted any more is that the publicly-funded research does not deliver catalogues and data in due time. In a recent survey at European level, the EMODnet Checkpoints, it was clear that data accountability was low at European level; i.e., catalogues were not present and not representing well the content of the datasets across the European Seas. An exception is the Copernicus and EMODnet programs in Europe or the NOAA databases in the U.S., but much more is needed.

Comments from Alex Rogers, Science Director, REV Ocean

Data available include: (i) Physical and chemical data: for example: World Ocean Atlas; GOOS; GEBCO; (ii) Biodiversity data: for example: OBIS; UNEP WCMC’s Ocean+ Library (habitat data); Fishbase; (iii) Human impact: Global Fishing Watch AIS data; ocean acidification; ship traffic density; coral bleaching; coral disease; coastal population density; (iv) Ecosystem services data: Fish catches (FAO); natural hazard mitigation. A project of REV Ocean identified 97 billion data points from 59 data layers originating from 16 open data sources. What is missing are the full range of data relating to human impacts on the ocean (e.g., plastics, pollution, etc.). Much more should be done on this. Industry data are largely absent, although they have been engaged in developing their own data sharing and management platforms such as DNV GL’s Veracity platform.

Comments from Anna Milena Zivian, Senior Research Fellow, Ocean Conservancy and Co-chair, Ocean Knowledge-Action Network Development Team

Many people who use and need ocean data, especially in the non-academic and non-governmental communities, do not know what data are available from UN agencies, national governments, and other organizations, nor how to access the data that are available. For example, a 2008 study by Moser and Ekstrom found that coastal managers were not aware of the latest research, science, and information that could help them plan to adapt to climate change, and also that what they really needed was learning opportunities to understand how to use that information. Yet a 2016 study by Gill et al. found that human capacity (including good access to good data) was one of the strongest predictors of conservation impact. The inverse is also true. Excellent science is being done outside traditional academic structures, notably in NGOs. This data is often over long time series, often integrates traditional or local knowledge, and is usually user focused to drive solutions to observed problems. Yet such data is often not published or diffused, lacks status or prestige, and is thus unavailable to a wide audience. So many of the people who would benefit from better information are not necessarily aware of it or accessing it. And even among scientific researchers, it is not clear to what extent the full range of data are known to different academic communities; for example, from different disciplines in both natural and social science. And for certain types of information, it's neither known nor accessible; in particular, military information is closely held, but it's often where huge stores of national information on the marine environment are held.

QUESTION 2: Are policies in place and sufficient to support free and open exchange of data under the Decade?

Comments from Sky Bristol

It is important to agree on what is meant by 'free' data. Data are an asset that require resources (both people and capital) to create and maintain. They are also currency in our modern economies. In many countries, taxpayers fund the data and copyright law prohibits managers from putting a license on these data. Therefore, they are donated into the public domain, free of any restrictions on use. This is not true everywhere, and this must be recognized and respected. An enterprise like ocean science must be operated within the context of the digital knowledge economy.

There is a growing movement among richer nations to enact and implement open data policies, and this is starting to have an impact. This needs to continue evolving into full implementation, with more of the full scholarly content released openly, better documentation for re-use, deeper thinking about what F.A.I.R. really means, etc. The Decade should focus on one area in particular that it is uniquely positioned to address: to foster an environment that supports indigenous communities and SIDS (big ocean states) competing fairly and equitably in the information and knowledge economies.

Comments from Lutgarde Coppens

The major challenge is not in terms of developing policy for sharing data, but for developing systems that allow the sharing of data.

- Data availability: Across the Regional Seas Programmes, 22 indicators – which align closely with the SDGs – were agreed for regular reporting and data collection. However, many of the Regional Seas do not have the capacity to collect information from their members and members do not have systems in place to share information. This is a major obstacle in terms of 14.2.1. In the case of 14.2.1, we know that countries have information on marine spatial planning and intercoastal zone management, but there is not an easy way to access and collate this information.

- Comparable data: definitions (waste), example of marine litter such as micro-plastics that include information about size.
- International standard methodologies
- Capacity development
- Publishing Metadata / methodologies
- Guidelines: At the request of the Statistical Commission, the Inter-Agency Expert Group on SDG indicators (IAEG-SDG) and the Committee for the Coordination of Statistical Activities (CCSA) worked together to develop a document on criteria for the implementation of the guidelines on data flows and global data reporting for the Sustainable Development Goals. The IAEG-SDGs also developed a background document on best practices on data flows and global data reporting.
- Country reporting platforms for the SDGs
- Statistical Data and Metadata Exchange (SDMX) is an ISO standard for the data and metadata exchange between organizations and between countries and the international agencies. SDMX is a standard to describe statistical data and metadata, normalize their exchange; and to improve their efficient sharing across statistical and similar organizations. It consists of technical standards (including the Information Model), statistical guidelines, and an IT architecture and tools. Development of a global Data Structure Definitions (characteristics of the data exchanged) is typically carried out by a Working Group composed of a number of international agencies and countries.
- Discovering Data: A linked-data approach enables the transition ‘from SDG data islands to a global SDG data space’ by: (i) Providing consistent identification of how data relates to the SDGs, so it can be easily discovered, used, and re-used; (ii) Allowing users to organically discover relevant and authoritative SDG data and information among the multitude of available sources on the web; (iii) Providing a coherent basis to support the development of applications that integrate authoritative data, concepts and definitions from a large number of distributed sources.

Comments from Nadia Pinardi

At the international research level, for example, there is no concerted action to require data from a research article to be perennially stored in a repository and adequately documented. This should be a Decade goal: to make data from published research articles available and using approved data management standards. This could be a global experiment between UNESCO and scientific publishing companies. Basic science is needed to know what data management must do: data collection is not the primary focus, data interpretation is. Furthermore there should be a request to make the data from the Decade available in near real time (with fixed time delay) as much as possible.

Comments from Alex Rogers

For academic and research purposes, ‘open exchange’ is working and there are a lot of data available. However for a wide range of users and for commercial applications, data are not as available. Governance of data use and mechanisms must be looked at to ensure that data producers are acknowledged, or some form of benefit from data use must be developed. Data must also be harmonized in terms of format and standards applied, but this is something that IODE has been involved in. This whole process needs to be accelerated and moved forward under the Decade. REV-Ocean is developing the Ocean Data Platform which is intended to create this data ecosystem and act as a gateway for ocean data. It will allow the development of applications or tools for specific users including policymakers and the public.

Comments from Anna Milena Zivian

Some key issues that remain to be addressed for free and open exchange processes are (1) ensuring that different countries are sharing non-proprietary data that they collect. New agreements on non-proprietary data collections inside individual nations' EEZs would greatly help coastal and ocean observing capacity; (2) designing, creating, and using decision-making processes that are inclusive, comprehensive, and consensus driven; and (3) balancing data ownership and open access in order to make as much data as possible available, especially so that developing countries can build capacity to assess and apply data for action, including management, policy, and environmental stewardship. Not all of these processes yet exist, and it would be useful for the Decade to focus on helping create better policies and processes.

Another topic that needs to be addressed is how to make sure that the processes and policies that are in place are open and accessible. There was a robust conversation going on earlier in the meeting about the overwhelming dominance of older, white males on the Panels. Perhaps we need to redefine what "high-level panels" are and who can participate on them; otherwise we exacerbate exclusion, given that past practices mean that people in executive positions tend to be overwhelmingly male and from the global north. Similarly, we need to build in ways of including people who communicate in different ways and in different languages from the start of information sharing processes, including workshops and conferences. Translation is expensive, but maybe it's worth providing, especially for spoken interactions, like conference presentations.

We also need to respect the different cultural attachments to data. In many developing countries there has been a long history of northern researchers coming in, doing the science, and leaving with the data; data that governments see as a valuable natural resource. While there is growing sensitivity on the part of researchers around this issue, many developing country governments remain cautious about being asked to freely share data or about giving free access to foreign research teams. This issue is not insurmountable but should inform dialogue with developing country governments.

QUESTION 3: Discussion point (to be addressed by all): What methods as well as partnerships should be used to maximize the impact of the Decade on society in terms of data and information? (e.g., citizen science and how to deal with their contributions of data and information, commercial publishing vs open science, how to better involve private sector and find a mutually beneficial partnership, etc.)

Comments from Sky Bristol

Projected future of research technology (these things are going to be the reality regardless of what the Ocean Decade promotes or does not promote):

- Downloading data will become a thing of the past. Data users will either be writing code on a computation platform co-located with data or tapping into a data stream to run an analysis rather than moving data from point A to point B, spending a bunch of time in preparation, and then working on them. Data that don't fit into this paradigm will be rarely used.
- Scientific programming will be the norm. Analytical software development will be a necessary skill of successful scientists, released with data and narratives as part of the scholarly record.
- Artificial intelligence, machine learning, and related technologies will be operationalized and a routine part of analysis, reaching out beyond the immediate set of information being analysed to identify remote

information streams that may be related. This will enable rapid development and testing of new models of the earth system that are responsive (or at least reactive) to new variables.

- Robotics will be where scientific programming is today in that the most rapidly productive science teams will already have this as an established part of their toolbox. Observation gaps will be filled by rapidly developed and relatively cheap sensor suites. Modelled ecosystems can be tested in the real world and iteratively improved through real time feedbacks.

What can the Ocean Decade do to help ride this wave?

- Avoid trying to resurrect dead technologies. The idea of the one-stop shop for data is dead; do not try to bring it back by investing in an 'Ocean Decade Data Portal' or 'Clearing house'. Rather, promote the implementation of principles and techniques that project good metadata from data repositories onto the web and use the web as it was intended to be used (linked data).
- Encourage a "don't build anything that you don't absolutely have to build" approach. Join other platforms and movements wherever possible, investing in them rather than risky start-ups that are not a core part of the business model. Build loosely-coupled architecture where any given component can be upgraded with something better at any time. This includes the syntactic part of data interoperability and re-usability, where the necessary standards already exist to be adopted.
- Highlight the importance of releasing the full scholarly record (narrative, data, software, and web/interactive) among ocean science communities, especially through applications to decision analysis support.

What unique contributions should the Ocean Decade promote?

- Develop, socialize, and follow an ethical compact that punishes any attempt at digital colonialism.
- Focus on building the unique knowledge of the ocean science community into ontologies (building on what's already been started by the British Oceanographic Data Centre, etc.) to aid in the semantic part of interoperability. Every time a group of ocean scientists gets together to work on problems, capture some aspect of the knowledge and churn it into the ontology base. Use the ontology base actively to discover places where people are using terms inappropriately or inaccurately.
- Foster synthesis working groups that bring science, business, policy, and civil society together in creative problem-solving spaces. Promote investment in synthesis centres that have the methodology and infrastructure working to support these ventures.

Comments from Lutgarde Coppens

Partnerships are about bringing together the strengths of each partner so that the outcome is more than the sum of each partner's contribution. For example, modelling, the use of big data including geospatial data, requires development of algorithms, machine learning, and vast computing power, where a partnership with the private sector may be needed. Some of the data collected by major players in this space, including citizen science, is not made public or is not shared in user-friendly format (i.e. without standard categories related to types of plastic, location, etc.) This creates a situation where the good will that is put into collecting this information is not maximized and users are not getting much of the information that exists. The community also needs to take into account the many languages used and ask "to what extent is content in different languages accessible and usable?" Research institutes and universities are crucial for organizing citizen science activities in scientifically rigorous ways using scientific protocols.

Comments from Nadia Pinardi

Citizen science has the potential to be a major paradigm shift in ocean observing during the Decade, partially solving the basic issue of unresolved time and space scales in the ocean ecosystem. Design of such systems should be done with data management concepts from the start. For the private sector, partnership and the use of new data from the Decade will foster innovation, i.e., producing a combination of data for solutions.

Comments from Alex Rogers

All data from Decade programmes should be made publicly available on a time horizon of 12-24 months, and in some cases should be shared in real-time. These data should be available for development of specific applications for use by society. This includes policy makers and ocean managers but also the public.

Comments from Anna Milena Zivian

Partnerships will be key to maximizing the impact and utility of the Decade for societal benefits. Open science is important for access, especially for non-academic users, or users in developing countries with more limited academic access. Data managers need to be working with communities who use ocean data and information from the outset via citizen science, co-production of knowledge, collaborative research design and implementation to both identify research questions and to identify from the beginning the forms in which data could most appropriately be provided to key audiences. This is critical to addressing societal needs. Local governments and NGOs can be key to this kind of action. Understanding the data needs of decision makers is important when designing research to address societal needs, as is understanding the political context for decision making. Boundary organizations like the Ocean Conservancy and the Ocean Knowledge Action Network (still in development stage, a ‘network of networks’ sponsored by IOC, Future Earth, WCRP, and SCOR) can help in connecting knowledge and information to action by linking different disciplines and sectors and connecting researchers to decision makers in business and at different scales of government. Knowledge brokers from different sectors can also connect disciplines, sectors, institutions, and communities.

Communicating the Decade

Communicating science to society and society’s priorities to the scientific community will be a priority for the Decade. This Panel highlighted the challenges and shared solutions to communicating about the Decade’s objectives, report on the brainstorming exercises carried out by the Task Group on Communication, and identify priorities for the Decade Communications Strategy.

Steve Menzies, Director, Flinch Marketing, opened this Panel by asking what successful ocean science looks like to the general public. What’s important for them? What do we want an audience to do? How can they be involved? The Census of Marine Life is the benchmark of success, and had a budget of \$650 million dollars with a large budget reserved for outreach. We have to accept that we must spend money on communications to be successful and it’s expensive.

Linwood Pendleton, World Wildlife Fund for Nature and International Chair of Excellence, European Institute for Marine Studies, Brest, France, began the Panel by reporting on the 20-person brainstorming session of the Task Group on Communications, saying that it was a model of how we should be collaborating – a mix of ages, gender balanced, interactive and participatory. (*see Report of the Task Group on Communications, above.*) He highlighted

the main discussions from the Task Group, beginning with the issue of knowing your audience. There are so many audiences to be reached but we need to be strategic with our messages. We have to start communicating to other audiences outside of our traditional ones with a concrete message and shorter timelines. We need to figure out how to get scientists from other disciplines involved (e.g., social and economic sciences) and learn how to communicate with them and understand their vocabularies. People from industry such as the insurance or finance sectors also talk differently and we need to be aware of their vocabularies. Partners are not just institutions, they are people, and we have to find ways to communicate with them. He brought up the issue of digital media, social and mass media, and how to combine these in a way that gets the ball rolling. Social media will be critical to connect people who will make Decade happen. We can use social media to create a marketplace of ideas and a “matchmaking” platform to connect ocean scientists with each other and with decision makers. Mr. Pendleton said that the Decade is a movement, not a thing, and we have to be concrete about what it takes to create a movement of science – it can’t end with the programme after 10 years. We need for everyone to think that they can be an ocean scientist. We need branding and great ideas. The UN Decade has some good possibilities: Planet Ocean (not Planet Earth), Ocean Citizen, etc. It is easier to talk about the oceans than to talk about ocean science, so we need to communicate in a way that doesn’t intimidate.

Carlie Weiner, Director of Marine Communications, Schmidt Ocean Institute, warned against sending dire messages, highlighting a recent report on extinctions and a New York Times opinion piece called “Surviving Despair in the Great Extinction”. There are so many challenges. How do we avoid losing faith? Polls show that the public has a dim view of scientists in the current political climate of some countries, where the perception is that scientists value knowledge over morality. We need to think about Jane Lubchenco’s call for a new narrative, and human faces have to communicate that narrative. Individual scientists and their passion can make a difference in that communication. We also need to know who our public is and how to effectively share this message. She described the Artists at Sea programme to create art that makes science approachable. Artists should be included as stakeholders and communicators in the design and implementation of the Decade.

Jonathan Clay, Silverback Films, asked how we develop a global media campaign that saves the world? He described his television series for the BBC, *Our Planet*, which has now partnered with Netflix, that tells stories about the restoration of biodiversity. This series engages a billion people using social media. The key to success is having your content shared, but how do you do this? What is it that makes people share? We need media experts to create the image we want to put out there. Your message will be shared among people who already agree with you and who want your message on their page, but the challenge is to be able to break out of that group. There are three groups of people to consider: 1) those who already engage with your message, 2) those who you will never persuade, and 3) the biggest group, those who are warm to your message but don’t think of themselves as being “green” and wanting to share “tree-hugger” stories. We have to create a shift to where being green is just normal. Humanity is on this journey towards sustainable development. We have to engage the passions of audience and ask, “who consumes information about this?” Some of the most popular topics in the media are food and travel. These need a light touch, and they do not try to be persuasive because they already assume that the world is changing. We should avoid being preachy, but should instead entertain with stories about food or travel linked to ocean sustainable development to shift perceptions. We must stay positive. Martin Luther King, Jr. did not begin his famous speech by saying, “I have a nightmare.”

Philippe Vallette, General Manager, Nausicaa Aquarium, noted that, after the conclusions of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) were published, the public has been able to take into consideration the urgency of preserving the Earth’s biodiversity. This is an additional reason, if needed, to highlight the role of the Decade on Ocean Science for Sustainable Development.

But without the commitment of the public, no massive change will occur. We must leave our laboratories and offices, we must go out and tell our stories to the public. No media is as strong as the communication forum offered by aquariums. Aquariums have more than 700 million visitors per year all over the world, and, according to a recent European survey, constitute the most credible source of information on ocean for the public. We offer to the public a direct experience with the sea, and we can make ocean science attractive. Aquariums show people the marvels of life in the ocean, but the job of the aquarium has changed a lot over these last 20 years. Many aquariums are now focusing on the impact of humans on the state of the ocean, and, furthermore, increasing numbers of aquariums are now focusing on how humans could use the ocean in a more sustainable way. Ocean Literacy is an absolute necessity, but it's not enough. We need to talk with the public, to interact with them and co-create and co-build a future, harvesting their advice and ideas. I'm not saying that everyone must become a scientist, but I mean we must find better ways to help them understand and use the results of science to be more informed and become actors of their future. The aquarium community, through the International Aquarium Network, and more widely, organizations like the World Ocean network, can help. The motto of the Ocean Decade is "The Science We Need for the Ocean We Want" and no one must be left behind. It's the ocean we want for all humans, living in harmony with nature. We organize an International Aquariums Congress every 3 years. The last one was held in Fukushima, Japan, in 2018; the next one, in 2021, will be held in Nausicaa, in France. At the last congress in Fukushima, we presented the Decade for the first time, and we started to discuss with our aquarium colleagues what we could do in the decade. The role of the aquariums is broad:

- Public education and exchange.
- Programmes to empower people in their everyday lives.
- Research in the facilities themselves and implementation of new techniques which can help in the wild.
- Conservation actions with partners.
- Most of us have created foundations to help conservation.
- Interface between the public and other groups – researchers, business people, managers, decision makers, etc.
- The aquariums can help inspire young people, and give them the love of science and the ocean.
- All the aquariums have their own national and regional networks.

To establish a long term link between the aquariums of the world and the Decade is a unique opportunity for both sides to communicate on ocean science with the public. Please think to invite them to your regional and thematic planning meetings. The aquariums can easily understand why it's important to promote ocean science. Many cooperation and projects can happen through aquariums. We need a blue revolution. The aquariums of the world can help.

Alejandro Laguna, Regional Communication Officer, Europe, Communications Division, UN Environment, presented the Regional Seas campaign as an example that made a big impact. He also discussed the importance of individuals telling their own stories to connect with an audience, providing an example of his own personal story about how his life changed because of plastic straws and his realization of how much single-use plastic the average person uses without even considering it. For a year, he collected and documented his own use of plastics and developed a short documentary from it. This approach reached people in a personal way that a scientific documentary never could, and many people told him that this story changed their lives and their behaviours. To be effective in communications, we need not only to get a story out but to change mindsets. He noted that the UN has advantages and disadvantages to consider for communications:

Advantages:

- Convening power – people listen to you.

- Scientific expertise (particularly if you combine the expertise of all the different agencies).

Disadvantages:

- Very (!) bureaucratic
- The UN remains an intergovernmental institution, so there are many things its Secretariat cannot say publicly (need to pass the messages through external partners)

Side-Event: Integrating Underwater Cultural Heritage Into the Decade

The meeting participants recognised that cultural heritage should be an important component of the Decade of Ocean Science for Sustainable Development, providing not only scientific links to the societal goals but also a unique way of engaging the public and making cultural and human connections. Cultural heritage will be included within the scope of specific R&D priorities, such as digital mapping, as well as providing a key strand in greater integration between the natural sciences, social sciences and humanities. This side event demonstrated that cultural heritage was not a narrow sectoral concern, but would contribute directly to each of the Decade's societal objectives:

Clean ocean	Cultural heritage can contribute to a clean ocean by enabling better understanding of the extent and risks of legacy pollution from shipwrecks, mining waste and land-based sources. A clean ocean is also important for the long-term conservation of underwater cultural heritage.
Healthy and resilient ocean	Culture heritage is fundamental to understanding how coastal and marine ecosystems achieved their present form, including the pressures upon them and the scope for maintenance and enhancement. Cultural heritage such as shipwrecks can form an important component of marine ecosystems.
Predicted ocean	Understanding 'Ocean Past' – the long history of human interaction with the historic environment – is essential to understanding our ocean present and to forecasting change and its implications for human well-being and livelihoods.
Safe ocean	Cultural heritage informs the understanding of coastal inhabitation and intervention in the past and present – including the impact of previous catastrophes – to identify risks, present examples of human adaptations, and to encourage resilience.
Sustainably harvested and productive ocean	Cultural heritage is a major contributor to the blue economy, especially through recreation and tourism. Increasing productivity should enhance – not damage – irreplaceable cultural heritage.
Transparent and accessible ocean	Information about cultural heritage is fascinating to the public and enables engagement with many topics of ocean literacy. Publicly-accessible information about cultural heritage helps communities to appreciate the past, present and future of humanity's relationship with the sea.

The side event also showcased existing cultural heritage projects that are contributing to cross-cutting themes such as capacity building, partnerships, access to knowledge, and awareness raising. Archaeologists working in North and South America, Africa, Europe, Asia and Oceania attended the Copenhagen meeting, providing the core for an Ocean Decade Heritage Network that will grow in coming years to help support planning and implementation of the Decade. Cultural heritage will be at the forefront of developing the new narratives that are necessary to deliver the ocean we want.

Way Forward and Closing Remarks

Peter Haugan, UNESCO / IOC Chair, opened this last session of the meeting, noting that the EPG would provide an overview of the meeting outputs and the way forward. He noted that one of the most important things coming out of this meeting is the agreement that scientists need to ask for stakeholder input and partnership at the beginning of the design process rather than carrying out the science and then hoping that the results are of use. The process must be collaborative and inclusive process. He reminded participants that while we speak of the UN Decade, we need to begin talking about 'after' the Decade, since this should mark the beginning of a transformation in the way ocean science is done and should not end with the close of the Decade. He asked participants to keep in mind the message expressed by IOC Executive Secretary Vladimir Ryabinin at the opening of the meeting where he hoped this meeting would generate a "snowball effect" that would build real enthusiasm and excitement for the Decade, and that participants would return to their institutions and organizations to communicate the objectives of the Decade. Mr. Haugan noted with humour that, while the spirit of this message is clear, some participants in this meeting may have never seen snow.

Luis Pinheiro, IOC National Committee from Portugal, told participants that the success of the Decade would be measured by results on actions that address human health and societal needs. He noted that meeting this goal will require the engagement of all stakeholders and needs global representation where all stakeholders feel they are key actors. He outlined some of the major achievements that the Decade should produce: an ocean-literate global community that recognizes the importance of protecting the oceans while exploiting its resources in a responsible and sustainable way; capacity development and technology transfer, especially providing technology to the most vulnerable areas without resources; the development of cheap technology; a 4-D model of how the ocean behaves that will allow for better forecasting of scenarios of development pathways; reversing degradation and pollution and improving human health and well-being; and launching a real movement with transformative powers for how we relate to the ocean. He read an announcement from the Portuguese Minister of the Sea, who recognizes that the ocean is at the centre of global challenges as well as at the centre of new economic and business initiatives, and that developing the means for ocean governance will be necessary for sustainable exploration and exploitation and must be based on solid science. He further recognized the need for more international cooperation through multi-lateral collaborations and the UN system, and announced that Portugal would be hosting the 2nd UN Ocean Conference in June 2020. The Minister announced that the government of Portugal offers to host the 2nd Decade Global Planning Meeting in Lisbon from 28-30 May in conjunction with the UN Oceans Conference, which would offer the Decade a forum where decision makers, scientists and major stakeholders will be present.

Alf Håkon Hoel, Ministry of Trade, Industry and Fisheries Norway, presented two initiatives of Norway of interest for the Decade: 1) the convening of a High-level Panel on Sustainable Ocean Economy, where heads of state from all over the world will work to produce recommendations on how to reconcile conservation and use of the oceans; and 2) Norway will host the sixth Our Ocean Conference in Oslo, Norway from 23-24 October, which will focus on marine science and promoting the sustainable future of the ocean and will work towards voluntary commitments for ocean actions and supporting the work of the Decade. He stated that this conference would be an excellent forum for communicating the Decade objectives and encouraging participation.

Martin Visbeck, GEOMAR, Germany, reminded participants that the Inaugural Conference for the Decade will be hosted in Berlin in the time-frame of February to April 2021 for 3 days. He noted that the conference should focus

on engagement and commitment by organizations, foundations, governments, and stakeholders from all sectors. The government of Germany and the EU will be engaged, and SIDS should be very visible in this conference. There are plans for a high-level (ministerial level) segment planned, with an anticipated 800 people attending the conference. The organizing committee is already hard at work confirming the venue, and planning is already underway.

Jennifer Hall, Communications Officer, The America's Cup / Prada Cup Yacht Races, provided an overview of the links between science and sporting events. She informed participants that the America's Cup is the oldest trophy in international sport with races going back to 1851, saying that science is at the heart of the America's Cup and innovation is in its DNA. The sailing world is one that sees first hand the impacts of climate change and wants to work with the Decade for a clean, healthy, and resilient ocean. She noted that the America's Cup can build a stage to amplify the message of the Decade and to engage citizens and the private sector in actions that support the work of the Decade. She noted that, while yacht racing is a niche sport, it is one with a strong connection to the ocean and one that can leverage business partnerships. Ms. Hall quoted Nelson Mandela, who said, "Sport has the power to change the world and it speaks to youth in a language they can understand." She informed participants that the next America's Cup Race will be in Auckland in 2021, but that there will also be many preliminary regattas around the world. She concluded by saying that the yacht racing community can serve as ambassadors for ocean science and the work of the Decade.

Alfredo Giron, University of California, represented young ocean professionals who will be beginning their careers as the Decade begins. He encouraged the designers of the Decade to include the perspectives of young professionals in planning the Decade and to use the enthusiasm of the young generation of scientists who will take forward the movement created by the Decade. He noted that capacity development must happen on a global scale and from the early career stage, where diversity would be critical for shaping objectives of the Decade. He informed participants that it is the young professionals of today that will be embarking on international collaborations and projects, and noted that these collaborations need to begin as soon as possible since it will take time for young professionals from different sectors to learn each other's professional languages in fields as diverse as policy, business, science, advocacy, communication, and many other areas. He proposed a partnership that would 1) include young professionals in the EPG to provide continuity and mentoring, 2) include, when possible, young professionals in meetings, with senior EPG members serving as mentors, so that the young professionals get a first-hand experience in how these processes work, and 3) build a platform to reach other young professionals and establish networks to take the Decade forward.

Closing Remarks by the EPG Representatives

Margaret Leinen noted that the oceans are having "a moment" unique in history. She reminded participants that, in 2014, governments decided that protecting the oceans was important not only for science or environment ministers, but for all ministers, and this concept developed into the Our Oceans Conference where politicians, scientists, business and civil leaders discussed how to most effectively protect our oceans. The G7 has called for support of ocean observations. After 22 years of Conferences of the Parties of the UN Framework Convention on Climate Change in which the ocean was never included in a negotiating document, the Intergovernmental Panel on Climate Change has called for report on The Ocean and Cryosphere in a Changing Climate to be presented at CoP 23, being referred to as the "Blue CoP", and now there is the UN Decade of Ocean Science for Sustainable Development. She stated that the concern is not that we do the right thing, but that we really use this opportunity so that young people never go through frustration of not having people understand the importance of the ocean. She encouraged participants to take up Jane Lubchenco's challenge to develop a new narrative

about the oceans; that the ocean is not too big to fail, but it is too important to ignore. She stated that participants should also listen to Jonathan Clay's advice in communicating about the oceans, where Decade designers should be saying "I have a dream", not "I have a nightmare". She noted that there is need for a change in the culture of scientists and the way ocean science is done; specifically, this conference has highlighted the importance of including social scientists in the design of the Decade, and the "data works" also highlighted the need for social science and called for an ethical framework for the Decade on data sharing. She stated that this would represent a real sea change in how the ocean science community does things. She concluded by saying that the Decade needs to think more about how to engage young professionals, social scientists, and the rest of world, and our next steps will be crucial.

Jens Kruger noted that, in the Pacific, they must respond to many challenges. This is a region with 10 million people, hundreds of languages, and is home to the world's largest ecosystem representing 20% of the world's ecosystem. He noted that ocean issues in the Pacific are not only about science but also about people and culture. He felt that the question "What can we do together that we can't do separately" was a good approach for designing the Decade and a question that is fundamental to the success of the Decade.

Suzan Kholeif noted that Egypt is a hot spot for biodiversity; not just natural but also human biodiversity. She stated that one of the biggest challenges facing many countries is pollution, and said that there is a lot of funding now available for research on different types of marine pollution. She noted, however, that ocean science students don't get exposure to other sectors that are critical to dealing with pollution issues, such as the private sector or technology sectors. She hoped the Decade would offer a platform to bring these diverse stakeholders together to address these interdisciplinary and trans-disciplinary issues that can offer real solutions.

Peter Haugan thanked the EPG members and reminded participants that while they have a common global cause, they need regional, cultural, and contextual implementation of programmes. He emphasized that there had been considerable talk about the importance of social science at this meeting, and that participants have to work together and use the right framework for the common cause.

Julian Barbière thanked the participants on behalf of the IOC Secretariat, noting that this conference was held to get convergence among different stakeholders about what we can collectively achieve through Decade. He hoped that participants will leave the meeting thinking about what we can deliver, and said that now is the time to better define the actions to be taken to develop the implementation plan for the Decade. A number of meetings and regional workshops will be held soon, starting with the first Decade regional workshop being held in the Pacific and focusing on SIDS (organized by Jens Kruger). A second regional workshop will be held in the North Pacific at the end of July in Tokyo. He noted that the secretariat is still working to develop regional workshops for the Mediterranean, the South Atlantic, the North Atlantic, the Caribbean, and the Southeast Pacific. He noted that, while there is a great deal of effort going into the planning of these meetings, it is not always possible for all relevant actors to attend meetings, and it is therefore important to allow people to self-organize and get their ideas into the planning process. He stated that the Decade needs to cultivate parallel tracks, where different stakeholder communities organize their own meetings about the Decade. The Decade designers need to follow this up through partnership with the private sector and philanthropic organizations. He noted that the Decade also needs more direct engagement by the science community. He further noted that the UN bodies and sister agencies need to communicate and coordinate better, which will be done in the coming months and in partnership with regional seas organizations. He stated that the communication group will begin doing its work in the coming months, developing strong strategies for outreach. He reminded participants that the secretariat is available to assist the community to move these plans along and to integrate stakeholder contributions into

this process. Mr. Barbière told participants that they must realize that the IOC is too small to implement the Decade, saying that the IOC can coordinate efforts, but reminded participants that it is the responsibility of the community to carry out the programmes and mirror the global activities at local, national, and regional levels with their own constituents. He informed participants that there is a Decade logo and that it is available for participating programmes to use, with of course some basic guidelines and criteria to be met. He explained that the use of the logo and approval of an activity as a contribution to the Decade allows the secretariat to keep track of partners and participating programmes get increased visibility. He concluded by saying that now is the time to show that the ocean science community is starting a movement and an engagement. Mr. Barbière thanked the participants for their enthusiasm and for taking ownership of the conference, and thanked the EPG for their hard work in planning and running the meeting. He particularly thanked the meeting sponsors, Carlsberg, Suez, Global Compact, the Government of Denmark, and the National Museum of Denmark and the museum staff who were so critical to running this meeting. He closed by thanking the IOC secretariat staff for their hard work.

Peter Haugan closed the meeting, reiterating that the Decade goes beyond the IOC and beyond the UN. He noted the critical importance of having staff and leadership to design and coordinate the Decade, and that the IOC had to carefully plan how to meet this challenge without over-burdening the small secretariat. He asked participants to recognize the importance of coordination and this requires financial support, saying that such support now will pay off in better Decade planning. He warmly thanked Julian Barbière for his leadership in developing the meeting and coordinated the work of the Decade at the IOC.

ANNEX I. AGENDA

Monday 13 May: The Science We Need for the Ocean We Want	
09:00 – 09:25	Opening remarks Rane Willerslev , Director, National Museum of Denmark Peter Haugan , Chair, IOC-UNESCO H.S.H. Prince Albert II of Monaco (via video) H.E. Tommy Ahlers , Minister of Research and Education of Denmark H.E. Carsten Staur , Permanent Delegation of the Kingdom of Denmark to UNESCO H.E. Peter Thomson , United Nations Secretary-General's Special Envoy for the Ocean
09:25 – 10:20	Setting a vision for the Decade Moderated by James Nikitine , Media Advisor for the UN Decade of Ocean Science Craig McLean , Assistant Administrator, U.S. National Oceanic and Atmospheric Administration (NOAA) Ed Hill , Executive Director, UK National Oceanography Centre Erik Giercksky , Head, Sustainable Ocean Business, UN Global Compact Sigi Gruber , Head of the Marine Resources Unit, DG Research and Innovation, European Commission Mathias Jonas , Secretary General, International Hydrographic Organization Erica Key , Executive Director, Belmont Forum Lysa Wini , Environment and Conservation Division, Ministry of Environment, Climate Change, Disaster Management and Meteorology of the Solomon Islands Ludgarde Coppens , Head of the SDG and Environment Statistics Unit, Big Data Branch, Science Division, UN Environment
10:20 – 10:35	Decade preparation: Introduction to the preparatory phase for the Decade, aims for the Global Planning Meeting Vladimir Ryabinin , Executive Secretary, IOC-UNESCO
11:00 – 11:10	Young scientists perspectives Guillermo Ortuño-Crespo , Ph.D. student, Duke University Marine Geospatial Ecology Lab and Fellow, Nippon Foundation Nereus Program Key messages from young scientists (video)
11:10 – 11:55	Panel 1: A Clean Ocean Co-Chairs: Suzan Kholeif , President, Egypt National Institute of Oceanography and Fisheries Peter Kershaw , Chair, GESAMP Panellists: Lorna Inniss , Coordinator, Caribbean Environmental Programme, UN Environment Mark Simon , Innovation Director, Suez Environment Monika Stankiewicz , Executive Secretary, Baltic Marine Environment Protection Commission (HELCOM) Tosca Ballerini , Scientific Officer, Expédition MED

	Daoji Li , Professor, State Key Laboratory of Estuarine and Coastal Research, East China Normal University
11:55 – 12:40	<p>Panel 2. A Healthy and Resilient Ocean</p> <p>Co-Chairs:</p> <p>Youn-Ho Lee, Professor/Principal Research Scientist, Korea Institute of Ocean Science and Technology</p> <p>Linwood Pendleton, Global Ocean Lead Scientist, World Wide Fund for Nature (WWF) and International Chair of Excellence, European Institute for Marine Studies</p> <p>Panellists:</p> <p>Paul Snelgrove, Network Director, NSERC Canadian Healthy Oceans Network II and Associate Scientific Director, Ocean Frontier Institute</p> <p>Simon Walmsley, Chief Marine Advisor, WWF UK</p> <p>Jane Lubchenco, Professor, Oregon State University</p> <p>Yoshitaka Ota, Research Assistant Professor, School of Marine and Environmental Affairs at the University of Washington and Director of Policy, Nippon Foundation Nereus Program</p> <p>Daniel Dunn, Assistant Research Professor, Nicholas School of the Environment at the Duke University, and Bio-eco Panel Co-chair, Global Ocean Observing System (GOOS) (remote participation)</p>
13:00 – 14:00	Side Event: GOOS contribution to the Decade – A call to action for ocean observations
14:00 – 14:45	<p>Panel 3. A Predicted Ocean</p> <p>Co-Chairs:</p> <p>Fangli Qiao, Secretary General and Deputy Director General, First Institute of Oceanography, China's Ministry of Natural Resources</p> <p>Craig McLean, Assistant Administrator, U.S. National Oceanic and Atmospheric Administration (NOAA)</p> <p>Panellists:</p> <p>Graham Allen, Interim Director, The Nippon Foundation GEBCO Seabed 2030</p> <p>Kentaro Ando, Group Leader of the Ocean-Atmosphere Interaction Research Group, JAMSTEC</p> <p>Lisa Levin, Professor of Biological Oceanography, Scripps Institution of Oceanography; Founder and co-lead, Deep Ocean Observing Strategy (DOSI)</p> <p>Steffen M Olsen, Research Scientist at the Center for Ocean and Ice, Danish Meteorological Institute</p> <p>P. N. Vinayachandran, Professor, Indian Institute of Science (IISc) and Co-chair of the Science team, GODAE Ocean View</p> <p>Essam Mohammed, Head of Blue Economy, International Institute for Environment and Development</p>
14:45 – 15:30	<p>Panel 4. A Safe Ocean</p> <p>Co-Chairs:</p> <p>Thorkild Aarup, Head of Tsunami Unit, IOC-UNESCO</p> <p>Jens Krüger, Manager of Ocean Affairs, Pacific Community</p> <p>Panellists:</p>

	<p>Michael Angove, Tsunami Program Manager, US National Oceanic and Atmospheric Administration (NOAA)</p> <p>Bengt Karlson, Senior Researcher, Swedish Meteorological and Hydrological Institute</p> <p>Pavel Kabat, Chief Scientist and Director Research, World Meteorological Organization (WMO-UN)</p> <p>Ofa Fa'anunu, Director of the National Meteorological Service of Tonga</p> <p>Chip Cunliffe, Director, Sustainable Development, AXA XL</p> <p>Nicolas Gruber, Chair of the Environmental Physics Group, Center for Climate Systems Modeling (C2SM) at the ETH Zürich</p>
16:00 – 16:45	<p>A Sustainably Harvested Ocean</p> <p>Co-Chairs:</p> <p>Ricardo Serrão Santos, Member of the European Parliament, Portugal</p> <p>Atmanand Malayath, Director, India National Institute of Ocean Technology and Chair, IOCINDIO (UNESCO)</p> <p>Panellists:</p> <p>Manuel Barange, Director, Fisheries and Aquaculture Policy and Resources Division, FAO</p> <p>Anne-Christine Brusendorff, General Secretary, ICES</p> <p>Rashid Sumaila, Director of the Fisheries Economics Research Unit, Institute for the Oceans and Fisheries at the University of British Columbia (remote participation)</p> <p>Katherine Richardson, Professor, Natural History Museum of Denmark</p> <p>Cristina Tirado-von der Pahlen, Director of the International Climate Initiative, Center for Climate Resilience at the Loyola Marymount University</p> <p>Peter Heffernan, Chief Executive, Ireland Marine Institute</p>
16:45 – 17:30	<p>A Transparent and Accessible Ocean</p> <p>Co-Chairs:</p> <p>Margaret Leinen, Director, Scripps Institution of Oceanography and Vice Chancellor, University of California-San Diego</p> <p>John Gunn, Chair, Integrated Marine Observing System (IMOS) Governing Board</p> <p>Panellists:</p> <p>Colin Devey, Scientific Committee on Ocean Research (SCOR) of International Science Council (ISC)</p> <p>Somkiat Khokiattiwong, Senior Researcher, Phuket Marine Biological Centre</p> <p>Ann-Katrien Lescrauwaet, International Liaison Officer, Flanders Marine Institute (VLIZ) and Member of IOC Group of Experts on Capacity Building</p> <p>Donna Kocak, Immediate-Past-President, Marine Technology Society</p> <p>Tony Long, CEO, Global Fishing Watch</p> <p>Alfonso Ascencio Herrera, Deputy Secretary General, International Seabed Authority (ISA)</p>
17:30 – 18:00	<p>Next Steps</p> <p>Guidance for working groups:</p> <p>Julian Barbière, Head of the Marine Policy and Regional Coordination Section, IOC-UNESCO</p> <p>Reflections from the Executive Planning Group</p>

	Presentation of survey on science priorities: Salvatore Aricò , Head of the Ocean Science Section, IOC-UNESCO
18:00	Welcome Reception The Welcome reception is offered by the United Nations Global Compact, a voluntary initiative based on CEO commitments to implement universal sustainability principles and to take steps to support UN goals. www.unglobalcompact.org
Tuesday, May 14: Co-designing research strategies to achieve the Decade societal outcomes	
09:00 – 12:30	Working Group 1: A Clean Ocean Working Group 2: A Healthy and Resilient Ocean Working Group 3: A Predicted Ocean
12:30 – 13:30	Side Event: Integrating Underwater Cultural Heritage into the Decade
13:30 – 17:30	Working Group 4: A Safe Ocean Working Group 5: A Sustainably Harvested and Productive Ocean Working Group 6: A Transparent and Accessible Ocean Task Group on Communication
Wednesday, May 15: Addressing cross-cutting issues to deliver a transformative and inclusive Decade	
09:00 – 10:30	Working Group Reports
11:00 – 11:40	Working Group Reports , continued
11:40 – 12:15	Capacity Building and Transfer of Marine Technology Chair: Elva Escobar , Research Scientist, Institute of Marine Sciences and Limnology at the Universidad Nacional Autónoma de Mexico (UNAM) Panellists: Juliette Babb-Riley , Co-chair, UN Regular Process (World Ocean Assessment) World Ocean Assessment Sophie Seeyave , Executive Director, POGO Katy Croff-Bell , Director, Open Ocean Initiative, MIT Media Lab Ariel Troisi , Chair, IOC Capacity Development Group Jacqueline Uku , Senior Research Officer and Research Coordinator, Kenya Marine and Fisheries Research Institute and President, Western Indian Ocean Marine Science Association (WIOMSA)
14:00 – 14:45	Data and Information Sharing and Knowledge Exchange Chair: Sergey Belov , Chair, International Oceanographic Data and Information Exchange (IODE) Panellists: Sky Bristol , Chief of Science Information Services, United States Geological Surveys Anna Milena Zivian , Senior Research Fellow, Ocean Conservancy and Co-chair, Ocean Knowledge-Action Network Development Team Alex Rogers , Science Director, Rev Ocean

	<p>Ludgarde Coppens, Head of the SDG and Environment Statistics Unit, Big Data Branch, Science Division, UN Environment</p> <p>Nadia Pinardi, Professor of Oceanography, University of Bologna</p>
14:45 – 15:30	<p>Communicating the Decade</p> <p>Chair:</p> <p>Steve Menzies, Director, Flinch Marketing</p> <p>Panellists:</p> <p>Alejandro Laguna, Regional Communication Officer, Europe, Communications Division, UN Environment</p> <p>Carlie Wiener, Communications Director, Schmidt Ocean Institute</p> <p>Phillippe Vallette, Director General, Nausicaá and President elect, IAC</p> <p>Linwood Pendleton, Global Ocean Lead Scientist, World Wide Fund for Nature (WWF) and International Chair of Excellence, European Institute for Marine Studies</p>
16:00 – 17:00	<p>Moving the Decade Forward</p> <p>Chair:</p> <p>Peter Haugan, Chair, IOC-UNESCO</p> <p>Panellists: The View From Stakeholders</p> <p>Luis Pinheiro, IOC Portuguese National Committee</p> <p>Alf Håkon Hoel, Ministry of Trade, Industry and Fisheries Norway</p> <p>Martin Visbeck, GEOMAR, Germany</p> <p>Jennifer Hall, America's cup / Prada Cup</p> <p>Alfredo Giron, University of California</p> <p>Panellists: The EPG Perspective</p> <p>Margaret Leinen, Director, Scripps Institution of Oceanography and Vice Chancellor, University of California-San Diego</p> <p>Jens Kruger, Manager of Ocean Affairs, Pacific Community</p> <p>Susan Kholeif, President, Egypt National Institute of Oceanography and Fisheries</p>

Annex II. List of Participants

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Annex III. List of Acronyms used in this Report

AaANCHOR	All Atlantic Cooperation for Ocean Research and Innovation
AtlantOS	Atlantic Observing System
ATLAS	A Trans-Atlantic Assessment and Deep-Water Ecosystem-Based Spatial Management Plan for Europe
BBNJ	Biological diversity beyond national jurisdiction
CBD	Convention on Biological Diversity
CHM / TMT	Clearing house mechanism for the transfer of marine technology
CMIP	Coupled Model Intercomparison Project
COP	Conference of the Parties of the UN Framework Convention on Climate Change
CPPS	Permanent Commission for the South Pacific
DOSI	Deep-Ocean Stewardship Initiative
DRR	Disaster Risk Reduction
EBSA	CBD Ecologically or Biologically Significant Marine Area
EC	European Commission
EEZ	Exclusive Economic Zone
EPG	Executive Planning Group
EMODnet	European Marine Observation and Data Network
FAIR	Findable, Accessible, Interoperable, and Reusable
FAO	Food and Agriculture Organization
GEBCO	General Bathymetric Chart of the Oceans
GEF	Global Environment Facility
GESAMP	UN Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GLOSS	Global Level Of the Sea Surface
GOBI	Global Ocean Biodiversity Initiative
GOOS	Global Ocean Observing System
GPM	Global Planning Meeting of the UN Decade of Ocean Science for Sustainable Development
HAB	Harmful Algal Bloom
HELCOM	Helsinki Commission / Baltic Marine Environment Protection Commission

IAEG-SDG	Inter-Agency Expert Group on SDG indicators
iAtlantic	Integrated Assessment of Atlantic Marine Ecosystems in Space and Time
ICES	International Council for Exploration of the Seas
ICP	UN Informal Consultative Process (ICP) on Ocean Affairs and Law of the Sea
IGY	International Geophysical Year
IHO	International Hydrographic Organization
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
ISA	International Seabed Authority
LDC	Least Developed Countries
LME	Large Marine Ecosystems
MHEWS	Multi-Hazard Early Warning Systems
MPA	Marine Protected Areas
MSY	Maximum sustainable yield
NGO	Non-governmental organization
NMHS	National Meteorological and Hydrological Services
NOAA	U.S. National Oceanic and Atmospheric Administration
OBIS	Ocean Biogeographic Information System
PICES	North Pacific Marine Science Organization
POGO	Partnership for Observations of the Global Ocean
POP	Persistent Organic Pollutants
RFMO/As	Regional Fisheries Management Organisations or Arrangements
R&D	Research and Development
SAMOA	SIDS Accelerated Modalities of Action Pathway Programme
SCOR	Scientific Committee on Oceanic Research
SD	Sustainable Development
SDGs	Sustainable Development Goals
SDMX	Statistical Data and Metadata Exchange

SIDS	Small Island Developing States
SOLAS	Safety of Life at Sea
TEK	Traditional ecological knowledge
TPOS	Tropical Pacific Observing System
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UN-SPIDER	UN Platform for Space-based Information for Disaster Management and Emergency Response
VMS	Vessel monitoring systems
WCRP	World Climate Research Program
WIOMSA	Western Indian Ocean Marine Science Association
WMO	World Meteorological Organization
WOA	World Ocean Assessment
WWF	World Wildlife Fund for Nature