Global Ocean Science Education Workshop

November 13-15, 2019

Workshop Report

Gail Scowcroft (1), Tina Bishop (2), Peter Tuddenham (2), and Andrea Gingras (1)
(1) Inner Space Center, University of Rhode Island
(2) College of Exploration
Acknowledgements

Thank you to all the delegates and presenters who travelled from around the world to freely and openly contribute knowledge, time, and energy to make the 2019 GOSE Workshop a success. Thank you to the American Society of Civil Engineers (ASCE) for hosting the Workshop and providing the ASCE Bechtel Conference Center in Reston, VA for the Workshop location. Thank you to the steering committee members who spent months planning the workshop, identifying speakers, and assisting with many workshop details. Thank you to the Consortium for Ocean Science Exploration and Engagement (COSEE) and College of Exploration teams for all the brainstorming, planning, organization, and logistical support that made the workshop a success. Finally, thank you to the Atlantic Ocean Research Alliance, College of Exploration, COSEE, the European Commission, the National Oceanic and Atmospheric Administration, and Seabed 2030 for the financial support that helped with speaker travel expenses.

2019 GOSE Workshop Steering Committee

Tina Bishop, College of Exploration
Kelly Brumley, Fugro
Ivan Conesa-Alcolea, European Commission
Vicki Ferrini, Lamont-Doherty Earth Observatory
Andrea Gingras, University of Rhode Island
Liesl Hotaling, Eidos Education
Gordon Johnston, International Federation of Surveyors
Paula Keener, Global Ocean Visions
Frank Muller-Karger, University of South Florida
Ana Noronha, Ciencia Viva
Cheryl Peach, Scripps Institution of Oceanography
Tsuyoshi Sasaki, Tokyo University of Marine Science and Technology
Francesca Santoro, Intergovernmental Oceanographic Commission
Gail Scowcroft, University of Rhode Island
Peter Tuddenham, College of Exploration
Dawn Wright, ESRI
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A. Executive Summary

The Global Ocean Science Education (GOSE) Workshop is an international ocean science education and ocean literacy initiative organized since 2015 by the Consortium for Ocean Science Exploration and Engagement (COSEE) and the College of Exploration. The first GOSE Workshop was held in the U.S. at the University of Rhode Island Graduate School of Oceanography. It was followed by the 2017 GOSE Workshop held at the UN Headquarters in Paris and 2018 GOSE Workshop held at the UNESCO Office in Venice, both in partnership with IOC-UNESCO. The 2019 GOSE Workshop took place in Reston (Washington DC) at the headquarters of the American Society of Civil Engineers (ASCE) from 13 to 15 November and was organized in partnership with the Atlantic Ocean Research Alliance and Seabed 2030. The workshop focused on bringing together ocean science researchers, education professionals, and business leaders to discuss recent advancements in seabed mapping and ocean observing and the integration of research results into education resources for enhanced global societal ocean literacy, decision making, and sustainable development. Another important workshop theme was to identify education strategies in support of the existing marine-related workforce and innovative paths forward in which to increase engagement with the maritime sector. Workshop discussions were framed within the context of the upcoming United Nations Decade of Ocean Science for Sustainable Development (the Decade). As in previous GOSE Workshops, there was also active participation of the Intergovernmental Oceanographic Commission of UNESCO. Attending GOSE were 66 delegates representing 14 nations. These delegates were a mix of representatives from government, business and industry, science, and education sectors. A diverse group of graduate students and early career professionals also participated in the workshop and provided important perspectives.

Plenary presentations and panel discussions focused on the importance of ocean observing to society. It was acknowledged that ocean observing should be recognized as a public utility. The challenge of “measuring life” and concrete examples of ocean data critical to management and policy decisions was highlighted by the speakers, as well as the need to develop ocean observing education resources for a variety of audiences. Other plenary presentations and panel discussions focused on the importance of seabed mapping for society. The lack of a global, systematic seabed map is a serious limitation, hindering the development of all the other marine sectors, from knowledge of the thermohaline circulation to ecosystem mapping. Seabed mapping also has to take into account societal needs, geological value, and opportunities of cooperation. Discussion focused on the need to identify the gaps between experts and the public and opportunities to provide the public with stunning visuals and societal stories.

Other important discussions focused on possible strategies for broader engagement with the maritime industries, including the need to provide short courses to provide the current workforce with information about new tools and techniques and sustainability challenges, as well as the importance of industry participation in international efforts in support of the Decade. In the related breakout group discussions, there was common agreement on the need to develop ocean literacy resources for business personnel.

Individual delegate benefits from the workshop included an increased awareness of the Decade and potential opportunities to be involved; idea sharing across sectors, countries, and disciplines; opportunities for networking and potential collaborations within and across sectors; and deeper appreciation of the importance of ocean observing and seabed mapping for society, as well as industry needs and concerns. A positive outcome from the workshop was broadening the reach of GOSE, not only within science and industry, but also by fostering a new connection with engineering. Involvement of the ASCE Coasts, Oceans, Ports and Rivers Institute (COPRI) added a new dimension to workshop discussions and for connections to all the workshop themes. This strengthened the GOSE relationship of ocean science and engineering, which has already started to develop new avenues for potential collaboration.

Since the Decade served as a context for many workshop discussions, delegates collaborated to identify priorities and recommendations for enhancing ocean education, literacy, and awareness over the Decade. The highlight recommendations below resulted from the plenary presentations, panel discussions, and
breakout groups. Following these recommendations are action steps that the GOSE community will take over the next year. Recommendations and action steps related to the workshop themes of ocean observing, seabed mapping, the engagement of business and industry, as well as the open space topics of aquaculture, tourism, shipping, coastal development, and workforce development are outlined in the report.

- There are several national reports related to ocean literacy. These reports and recommended best practices need to be synthesized so that they can be shared across nations to benefit the Decade.
- Workshops for early career scientists (ECS) with sustainability officers and business leaders could provide ECS tools to reach the public, as well as assist more senior scientists in reaching diverse audiences. They must be engaged in the design as well as implementation phase of education and outreach activities.
- Engagement of youth is important (younger than early career professionals) during the Decade. Youth want to be active. We must ensure that existing barriers to participation; especially among youth from indigenous communities, communities of color, and economically marginalized communities; are reduced to ensure participation of youth from these communities as well.
- There is a great need for network of networks to coordinate the GOSE community internationally. There is great interest in establishing a coordinating hub, but there currently is no funding. Such a network or alliance has the potential to make a significant contribution to the Decade.
- A consensus prospectus from the GOSE community that identifies priorities and strategies could help to build bridges to the research enterprise. This would be very helpful for government agencies in trying to generate funding.
- Sustained engagement of business and industry remains an important focus for the GOSE community.
- During the Decade, it would be important to have a clearinghouse and repository for teaching and ocean literacy resources. The IOC’s redesigned Ocean Portal can be used for this purpose.
- A coordinated social media campaign about seabed mapping and ocean observing during the Decade would reach many audiences.
- Another important consideration for the Decade is science equity. Data collection must involve viewpoints of traditional and indigenous knowledge. A framework and a set of guidelines for ensuring that traditional knowledge is integrated into the Decade would be helpful. This framework should take into consideration a combination of indigenous knowledge and working waterfront knowledge.
- Language is a major issue. We need a common language across communities to bridge the silos. We need to use this common language in correlating the ocean literacy standards to the six societal outcomes for the Decade. This language also needs to be integrated into the messaging for seabed mapping and ocean observing.
- Citizen-relevant calls to action related to ocean science and sustainable development need to be developed.
- Develop a one-day, online course based on the Decade for individuals in the shipping industry.

**Action Steps for 2020**

- Conduct two webinars in 2020 to provide information about the Decade
- Promote the adoption of the IOC’s Ocean Portal as a repository for education resources
- Further explore the potential of an alliance of networks in support of the Decade
- Work with the Ocean Race to incorporate information about the Decade into community events
- Plan the next GOSE Workshop
- EMSEA offers students a free membership for a year
- Explore collaboration options for 2022 Ocean Sciences Meeting
B. Workshop Goals and Overview
Gail Scowcroft, Peter Tuddenham, Ivan Conesa-Alcolea

The 2019 GOSE Workshop welcomed 66 workshop delegates, representing 14 nations. Delegates discussed the importance of ocean observations and seabed mapping for the global society, as the ocean community looks forward to the United Nations Decade of Ocean Science for Sustainable Development (Decade) and the increased engagement of business and industry partners. The 2019 workshop provided the opportunity for delegates to meet colleagues from across the globe, engage in stimulating dialog, and contribute their expertise.

Since the first GOSE Workshop in 2015, the international community focused on ocean science education within the research, policy, business, and education sectors, has expanded. The GOSE community held a successful event, Ocean Literacy for All, in conjunction with the first UN Ocean Conference and submitted a Voluntary Commitment to increase global ocean literacy that, with the IOC’s leadership, has been almost completely met. The upcoming Decade is the direct result of the IOC’s leadership. The 2019 GOSE Workshop has furthered support of the IOC’s work in preparation for the Decade.

The workshop’s two and a half days were designed to encourage rich discussions within plenaries, panels, breakout groups, and open space time, as delegates explored ways to make a difference together in support of the Decade. The Decade offers great opportunities to the international ocean science community, including all sectors related to ocean observing and seabed mapping. As the community works towards reversing the decline in ocean health and supporting increased sustainable development, discussions from the GOSE 2019 Workshop provided recommendations for individual and collaborative activities through 2030 and beyond.

Key goals of the 2019 GOSE Workshop were to:
• further develop an international ocean science education community focused on the education pipeline - elementary through graduate school and into the workforce with the full engagement of the ocean science research, education, business and industry, and policy sectors;
• broaden current ocean literacy initiatives by developing international partnerships and strategies for leveraging international ocean science research initiatives;
• bring together ocean science researchers, education professionals, policymakers, and business leaders to discuss recent advancements in seabed mapping and ocean observing and the integration of research results into education resources for enhanced global societal ocean literacy;
• identify industry needs for education and opportunities for the existing marine-related workforce and develop a path forward to increase engagement with the maritime sector; and
• develop recommendations in support of the Decade.

C. United Nations Decade of Ocean Science for Sustainable Development (Decade)
C.1 Plenary I: Overview of the UN Decade of Ocean Science for Sustainable Development
Craig McLean, National Oceanic and Atmospheric Administration and Executive Planning Group, UN Decade

In the 1970s, we didn't know half of what we know today about the oceans, but we knew that we were doing things to the oceans that were not healthy. We now have before us a time where we're returning to a global awareness of oceans and what we humans have caused as threats to oceans. It is with that in mind that we approach this Decade of Ocean Science for Sustainable Development. We need to address these questions: what do we each plan to achieve during the Decade and what should we not excuse ourselves from doing now?

To meet Decade goals, it is important that funding agencies across the globe come together to co-fund projects. We also need to bring all sectors into the conversation. During the 2019 Our Ocean Conference, the sixth such conference initiated by Senator John Kerry, we had the financial industry, big business,
bankers, and re-insurance talking about how we're going to generate a circular economy to create a sustainable ocean economy, attaining the sustainable development goals because it's healthy for the global economy. It's helpful for every nation's individual economy. Europe is making strides in this arena and it is starting to take effect here in the U.S. In Europe if you want a loan, you have to cite the climate impact of your business or initiative. There is an understanding that this is good for business and leads to a circular economy - it's healthy for the economy and generates revenue and opportunity, while ensuring sustainability.

Although the official start of the Decade is January 2021, several organizations and entities have already begun Decade-related activities. The Seabed. 2030 team, well organized, started out in Monaco a couple years ago with the support of the Intergovernmental Oceanographic Commission (IOC) and the International Hydrographic Organization. We realized that we needed to do something more aggressive to truly map the world's ocean.

We need to be socializing the statistics that highlight why the ocean is so important. The sustainable development goals basically support the blue economy in addition to meeting SDG14 goals. When the proposition came for the IOC to coordinate a decade of ocean science for sustainable development, it was widely approved, and now we have every organization in the UN charged to pursue the attainment of these objectives. The IOC has articulated six main categories for the Decade that track to the UN’s sustainable development goals. A map of the world's oceans is imperative. If we're taking the pulse of the planet with Argo floats and other types of survey instruments that we have distributed around the globe, we can watch the pulse and respiration of the ocean rise and fall as well as oxygenation and de-oxygenation. However, without knowledge of the ocean’s “anatomy”, we can’t effectively achieve sustainability of the ocean’s resources. So mapping of the global ocean has begun with support of the Nippon Foundation, GEBCO, and nations around the world. We (the U.S.) are a partner in the North Atlantic Research Alliance and the Seabed 2030 Project.

The Decade is a vision. We're going to populate it, and we're going to achieve it. In addition to mapping, we must be monitoring every ocean basin with an ocean observing system. If you look at the distribution of ocean observing systems today, the Arctic is bare, and the greatest change on our planet is occurring there. We have to increase our observations in the Arctic, but let's do that at all major ocean basins conducting an inventory of our ocean ecosystems. We have new tools that are coming online now in genetics, and we have growing abilities to quantify the ocean ecosystem from viruses to whales and including the viruses that are in the stomach of the whale. We can be looking at the totality of the marine environment and watch it change. However, we don't even have a baseline for the marine environment globally today. It's changing too fast to establish a baseline. These new tools will allow us to do that. There is a group in the IOC that's responsible for data management globally. It has sculpted the design for a data portal that can be the place for everyone to go and get information across timescales so that we justify early readings with late readings and possibly even define standards with which we could all comply for data categorization and metadata. That's going to be a very important opportunity.

Another key arena for the Decade is the establishment of a global multi-hazard warning system. This requires collaboration between the natural and social sciences, so that people can gain understanding as to why they need to be responsive. To accomplish this as well as the other goals of the Decade, we can't do it alone with just the IOC and a few other organizations. We need to be bringing multi-sector groups together to collaborate as you are doing in the GOSE Workshop. Many nations are realizing the efficiency and the economic gains of a circular economy for the blue economy. It's simply good for business, and by bringing
in co-investment with the commercial and the philanthropy sectors along with the NGO community, we have a greater chance of a successful Decade.

**Decade Goals: Focus on Societal Outcomes**

**A Clean Ocean**
Sources of pollution are identified, quantified and reduced, and pollutants removed from the Ocean.

**A Healthy and Resilient Ocean**
Marine ecosystems are mapped and protected, multiple impacts, including climate change, are measured and reduced, and the provision of Ocean ecosystem services is maintained.

**A Predicted Ocean**
Society has the capacity to understand current and future Ocean conditions, forecast their change and impact on human wellbeing and livelihoods.

**Decade Goals: Mission-Oriented**

**A Safe Ocean**
Human communities are protected from ocean hazards and the safety of operations at sea and on the coast is guaranteed.

**A Sustainable Productive Ocean**
The provision of food supply and alternative livelihoods are secured.

**A Transparent and Accessible Ocean**
All nations, stakeholders and citizens have access to ocean data and information, technologies, and are capable of making informed decisions.

We have an Executive Planning Group for the Decade with representatives from the United States, Portugal, Mexico, China, Fiji, Germany, Russia, South Africa, Australia, India, Sweden, Egypt, Korea, and Japan. We advise the IOC as an institution on where we should be going with the Decade. We're having regional workshops to obtain stakeholder engagement. These regional workshops will help to build the science plan for the Decade, but you can't produce science for just the sake of science. The Decade has a focus - attaining the sustainable development goals. The planned research will have a policy and social application.

The ocean holds key resources for our survival as a species. We will need to continue to observe the ocean and be able to forecast its conditions. By leveraging the opportunity that the Decade is presenting, people will be able to attain measures and have access to tolls that they normally would not have had access to. Prices may not go down, but the leveraging opportunity with partnerships is going to go way up because we have enthusiasm and a confluence of international interest. We know we've got to do something now. The Decade’s Executive Planning Group invites your ideas, your enthusiasm, and your help in socializing what this Decade has to offer and how we can be doing more together than what we could possibly do by ourselves. We can develop the science that we need for the ocean and the future that we want and attain the sustainable development goals along the way.
C.2. Plenary II: Ocean Literacy for the Decade
Francesca Santoro, Intergovernmental Oceanographic Commission

As we approach the Decade, we can celebrate our community’s success. This is the fourth Global Ocean Science Education (GOSE) Workshop, a result of international engagement. We collaborated to hold a successful 2017 side event, Ocean Literacy for All, at the first UN Ocean Conference. With support from the Swedish Ministry of the Environment, we have satisfied all the activities included in the voluntary commitment that was submitted to the UN for the Ocean Conference. We produced the Ocean Literacy Toolkit, now translated into five languages and used in 35 countries. The IOC launched the first edition of the online Ocean Literacy Platform, through which the community can archive and share resources. These successful activities have contributed to ocean literacy being approved by the IOC General Assembly for inclusion as a priority for the Decade.

We want to include all stakeholders in the ocean literacy discussion and in planning for the Decade’s activities: the education, research, business and industry, policy and decision-making sectors; philanthropies; citizens and civil society; and the media. Through this inclusivity, we will create a Generation Ocean. To achieve this during the Decade, a broad ocean literacy campaign will be critical. We will need to: 1. promote the use of science in decision-making; 2. communicate the message that protecting the ocean is good for business; 3. communicate the benefits of ocean observations and listen to the needs of stakeholders; and 4. spark fascination about the ocean. Scientist and educators must engage with storytellers.

The ocean literacy strategy for the Decade has four key elements. It must first be centered around the Decade’s societal outcomes, which provide a clear and easily understandable vision for the desired state of the ocean. These societal outcomes in turn are related to the decade’s objectives, as well as research and development priorities. The strategy must also include learning outcomes that identify learning needs and the opportunities for each of the societal outcomes. Considering that ocean literacy ultimately aims to transform understanding of the ocean into tangible action for sustainability, the strategy must recognize that ocean literacy can directly or indirectly provide contributions to progress each of the societal outcomes. Finally, the strategy must consider key stakeholders identified by the Decade, as well as a potential to contribute concrete contributions to each of the societal outcomes.

A workshop held in Venice in December 2019 brought together an invited group of experts to discuss the elements of an ocean literacy strategic plan for the Decade. At the writing of this report, the outcome from this workshop, a draft strategic plan, is available for broad community comments.
D. Why Do We Need Ocean Observation?

D1. Panel I: Importance of Ocean Observing for Society and Related Education Activities

Moderator: Ana Noronha, Ciencia Viva Panelists:
Dina Eparkhina, European Global Ocean Observing System
Frank Mueller-Karger, University of South Florida
Kaitlin Noyes, Bermuda Institute of Ocean Sciences

Dina Eparkhina
This Panel discussed the importance of ocean observing for society. In recent years, ocean observing has been recognized as very important for educating the public and achieving sustainability in the political economy. The Ocean Literacy Principles have been adapted in many countries, which has contributed to bringing ocean literacy into mainstream culture. We have seen best practices springing up, including the use of the IOC’s Ocean Literacy for All Toolkit and the implementation of the E.U.’s Sea Change Project. There are some national reports related to literacy. We need to synthesize these different reports and best practices. We also need standards so that we can attain unity in ocean observing efforts. In 2019 EuroGOOS initiated an Ocean Literacy Expert Group from across EuroGOOS’ 40 EU research institutions. The expert group of 15 members from nine countries, representing five EuroGOOS regions, is studying what is happening across these institutions from public engagement to formal education. The study participants reported that it was important for them to see what the others do in similar institutes, and they got inspired by their colleagues’ best practices. EuroGOOS is intending to use the survey data as it develops a community of practice.

Thus far, the survey data has shown that most of the reported activities focus on schools and the public, and there is a lack of activities that address policy makers, public authorities, or industry. A lot of the activities are multi-topic but individual topics include fisheries and aquaculture, biodiversity, leisure, plastics, and technology careers. So the next steps for EuroGOOS are to finish analyzing the survey results, look for other partnership opportunities, explore things with sea basins, contribute to the developmental best practices.

Frank Mueller-Karger
The main reason for doing ocean observing is to understand life. We have been measuring basic physical parameters, such as temperature, salinity, and oxygen, and we are now going to be measuring plastics and bathymetry. Yet the one thing that we are very far behind in measuring is life in the ocean and the pressures and impacts on life, including our own. So we need to think about how we are going to change that and understand how life is changing on this planet and in the ocean in particular. Today we know so little about life is in the sea, and we have to change that. What is changing? Are species migrating? Are they changing their ranges? If we don't measure these things, we will not understand. Marine life clearly provides benefits for us. It's part of the economy, and it sustains many coastal communities.

Marine biodiversity is a proxy for ecosystem services and monitoring biodiversity is fundamental for managing these ecosystems. What we can do on a global basis are things like producing a typical picture of ocean chlorophyll based on satellite observations. However, that's just for the surface of the ocean. The ocean is on average four kilometers deep. We need to get beyond measuring chlorophyll. Chlorophyll is a bulk measurement. It doesn't say anything about who's there. It doesn't tell you what kind of fish or what kind of pipeline exists in terms of biodiversity. When we go to global databases like OBIS, which now lives within the IOC, there are large gaps where there are no records, even after over a hundred years of data records. If we go deeper into the ocean, it's even worse. At the bottom of the ocean, there is almost no biodiversity data. The number of data records contributed by the Census of Marine Life (2000-2010) was very important. However, in the past five years, the number of records produced for measuring life in the ocean has decreased. So as you map the ocean, it doesn't just mean mapping the bottom topography of the ocean. It should also mean mapping life. We need to incorporate that thinking in the planning otherwise we could be 30 years from now thinking why didn't we measure life on the bottom of the ocean when we mapped the bottom of the ocean?
The vision and goal of the Marine Biodiversity Observation Network is to develop a community of practice to integrate the measurement of marine life with mapping efforts; and capacity building is at the core of this effort. We intend to develop databases and datasets over time and space and then have products that look at abundance and trends. We're working with several groups around the world to develop essential climate variables. Climate variables include, for example, ocean color. We are also working on essential biodiversity variables and then linking all of these with other variables, such as climate variables. These are not parallel, disconnected efforts. We need to make sure that these things are coherent with each other. So we are working with the Global Ocean Observing System (GOOS) on the IOC to try and collect requirements. This will help us to develop an observing system that integrates biology to GOOS, and then produce products that are useful and then have kind of a loop that helps us understand how we can improve those systems. So for our education, the need to make better networks is enormous among people doing education formally, informally within universities, and within museums and aquariums. A lot of them are not well connected. So can we do that? Can we use the Decade to help network these groups?

As we move into the Decade, we must emphasize the observation of life in the sea. We need to promote common standards so that we can under compare things across space and time, which is not currently being done. Everybody collects biological measurements in their own lab, does it their own way, stores data on their personal computer and much of that data is not accessible. So can we use opportunities like working with Seabed 2030, GOOS, the Marine Biodiversity Observation Network to promote these ideas? During the 2019 OceanObs meeting a breakout session was focused on developing capacity to better address these issues. A consensus document from the ocean observing community for capacity building priorities is now under development. Priorities range from physical infrastructure to engaging policy makers to ensuring sustainable financing. The consensus document will be open for community comments, and the final version will be presented at the 2020 Ocean Conference in Lisbon.

**Kaitlin Noyes**

Education strategies related to ocean observing have been developed by the team at the Bermuda Institute of Ocean Sciences that focus mainly on informal science education. We capitalize on the geology and location of Bermuda for ocean observations and have been doing so since 1903. We share our data and observations with the broader Bermuda community through a suite of five local programs called Ocean Academy. This program is almost entirely funded by the insurance and reinsurance industry in Bermuda. We focus on field and lab experiences, innovation challenges, and mentorships as tools for this Academy. The first gateway that has been very helpful to us is the power of underwater robotics. It is an entry point to engage students, but we also then integrate ocean observations and opportunities to collect data.

We've been partnering with the Marine and Advanced Technology Educational Center or MATE for the last six years, running an underwater robotics competition for Bermuda. This has been giving us a chance to create innovation challenges and integrate ocean literacy principles. The competition gives us entry points to engage students multiple times throughout the year. It allows us to communicate with them about different ocean literacy principles. The competition has created a buzz within the Island and everybody wants to have the bragging rights of having won. One of the challenges from this year was focused on the mid-Atlantic ridge. The students had to design an ROV to do a video transect and then retrieve a bathymetric sample. Our students get so excited about how they're going to collect the sample, that they completely forget that they're going to learn seven different ocean features to be able to get the points for that challenge. This has also allowed us to introduce a host of observation data. Students are introduced to technology solutions for visualizing data. One of our student participants, aged 16, found a means to use his cell phone to make plankton observations to send to his friends.

This year we were able to team up with the University of Rhode Island and National Geographic to test out two different types of deep sea cameras of completely different designs. We also brought in experts to talk about the intersection of careers and in engineering and oceanography with the students. Emerging careers in artificial intelligence (AI), including how AI will be used to analyze hours of deep sea observations, were explored.
The last gateway that we’ve found to be really helpful is the power of ocean stories. Hurricane Humberto in September 2019, a category three hurricane was just off our shores. We used this story as an entry point to speaking about ocean observing. We also used this story to speak with teachers about ocean heat content and introduced our observations with autonomous underwater vehicles. We have found that when participants are sharing their stories about natural disasters, it opens up a larger conversation about how satellites and air and ocean observation are combining to make us more prepared for these types of natural disasters. Our job is to create programs that draw participants into looking at ocean observations and hopefully leave them asking more questions.

**Audience Questions and Answers**

- These amazing things are being done with kids. Could we do these kinds of things in the training that we are developing for the business sector? Can we create that interaction and emotional link with the ocean also with adults?
  - The Road Scholar program for travelers 55 and over brings people to Bermuda. We conduct very similar activities with these participants as we do with the students.

- You mentioned the Census of Marine Life, which was thought to have made such a big contribution, and now we realize it was just a tiny contribution to our understanding of marine life, even though it lasted 10 years with over 1,200 expeditions. Do you have any thoughts about scaling that up to what we need to accomplish during the Decade? Do you have any thoughts about how we're going to marshal the funding and the international collaborations necessary?
  - That's what we're trying to do with the Marine Biodiversity Observation Network. We have very close collaborations with OBIS, an output of the Census of Marine Life, and the IOC. We are also linking those to the geo groups on the other side. The only way that we're going to get there is to convince everybody that doing this is very important, and we're not there yet. There are so many issues that compete for funding, that to find the financing is going to be hard work. So we need to network together and really push us with one voice and a common message.

- All three of you have indicated that stories are really important, charismatic fauna are good hooks, and everyone perked up in the room when they saw kids on the screen. Is there a way to combine those to tell stories about the seabed, sea bottom creatures, and sea floor exploration, as well as inspiring curiosity about the ocean?
  - Cartoons are great vehicles for bringing these elements together. For example, all of the groups we have engaged over the last decade knew what plankton were because of the Sponge Bob cartoon. Students connect with the cartoon creatures and so do adults. New cartoon creatures could also have a voice that reach multi-generations. We also need to go beyond that and connect not only kids but older people too and help them understand what's out there and why, what the relationship is between life in the ocean and our own life; but it has to have a usefulness. There has to be an element of ocean literacy that demonstrates the business case, the value of having ocean observations about life, and interpreting how those observations were made. If we don't make that connection to the business community, it's going to be very hard to raise the funding. One of the most helpful constructs that we can have, at least at the IOC, to help you would be to do what the global ocean observing community has done, which is to identify community perspectives regarding priorities because then, from an operational agency's perspective, we can look to fund these priorities, because it's the sense of the community towards a purposeful outcome. So for the education community, where you can be building bridges to the research enterprise, you could be developing a consensus prospectus. That would be very helpful for government agencies in trying to generate funding.


Joaquín Tintoré Subirana, Balearic Islands Coastal Observing System

The Balearic Islands Coastal Observing System (SOCIB) is strengthening science based multiplatform, multi-disciplinary and integrated approaches to ocean observation and open data from events to climate. SOCIB is an observing and forecasting system, which is a national research infrastructure. We do our best
to combine scientific excellence with impact and relevance to support society. Our work is carried out by a
great team of people that are together trying to connect the pieces of the puzzle, including engineers and
ocean scientists. Mitigation of ocean issues is part of this puzzle.

A key message is that persistence, integration, optimism is absolutely essential to solving marine issues
related to sustainability. We are in an emergency situation, and we need to reorganize and act. Our scientific
objectives or societal objectives were different a year or two years ago. Now we are in a global warming
ocean climate emergency and need to act. If we have an emergency situation, we have to act accordingly to
address the problem. To understand ocean warming and the role of the ocean in planetary warming, we
need to characterize the current ocean state and variability at different scales – local and global; basin and
sub-basin; local and coastal interactions.

We all know that the ocean is a complex system, but no matter how complex, we need to manage the ocean
and its interactions with the coasts in line with sustainability principles and following a knowledge and
ecosystem-based approach. We need two basic things for this: 1.) A long-time series of physical and
biogeochemical data to untangle the variability at the scales where the variability is more important in the
ocean and, as a result, the effects on the ecosystem are more significant. (This scale is what is known as the
oceanic weather, with cyclonic and anticyclonic eddies developing from meanders of major ocean currents,
in a similar way to weather patterns in the atmosphere. Cyclones and anticyclones characterize and
determine the atmospheric weather that influences our lives; and they also characterize and determine the
oceanic weather with impact on the marine ecosystem.) and 2.) Synoptic data. Unfortunately, both are very
scarce, and if available, they do not cover the spatial and temporal scales that would be needed for sound
and science-based management. This is very important to realize.

Today we know that the ocean is full of eddies and not just meso-scale eddies. The
maximum ocean kinetic energy is in those eddies, and is essential to understanding
climate (heat transport, vertical exchanges),
ocean health and ecosystem variability
(nutrients, spawning areas), and operational
response (SAR, oil spills, plastics). So we
better measure and observe it, otherwise
we're not really looking at the key elements
of the three dimensional movement in the
ocean.

We cannot continue doing business as usual. There are growing changes in ocean research and growing
changes in society. This has led to the Decade. Rick Spinrad has said, “The Blue Economy is a knowledge-
based economy looking to the sea, not really for extraction of natural goods but for data to address societal
challenges and inspire solutions.” New technologies are fostering a paradigm shift in ocean observation and
data availability. We are moving from single platform, ship-based observations to multi-platform observing
systems. SOCIIB provides infrastructure for a multi-platform observing and forecasting system, from
nearshore to open-ocean.
Over the last decade, the SOCIB observing and forecasting facilities have allowed us to conduct 87,478 CTD profiles, 12,461 total days of Argo profiler observations, 11,140 temperature profiles, and 3,000 days of beach monitoring. Our data center provides real-time free access data that can be downloaded, and it is quality controlled. Our data is made directly available to search and rescue organizations throughout Spain and Europe.

Another example of how SOCIB data is contributing to ocean science and society is the study of bluefin tuna migrations. The Balearic Islands are one of three worldwide spawning grounds for Atlantic bluefins, and no one has known why. The story is beginning to unfold due to the combined expertise on bluefin tuna ecology from the researchers at the National Institute of Oceanography and SOCIB’s expertise in physics and operational oceanography. Mesoscale eddies are playing a part. At the beginning of the summer, the bluefin tuna move from the feeding in the North Atlantic to the spawning grounds in the Mediterranean. The spawning ecology of this species is highly linked to the oceanographic conditions. Research has allowed for improving the assessment of the population status carried by ICCAT (International Commission for the Conservation of Atlantic Tunas), which is responsible for establishing the fishing quotas. This study is opening new lines for developing novel methods for improving species sustainability.

SOCIB is also tracking sea turtles in the Mediterranean using gliders, finding that the eddies also play into this story and that the turtles dive to the 30 chlorophyll maximum depth. In addition, we are using sea turtles to collect temperature profiles to complement near real-time ocean monitoring systems. These findings and others are integrated into SOCIB education and outreach efforts. Disseminating our research promotes ocean literacy. SOCIB has a fantastic team of three experts leading the ocean literacy and society engagement efforts. Examples of our initiatives include a dedicated work line for students, meetings for stakeholders, design of education activities and materials, onsite activities, open lab days, and workshops. SOCIB strives to achieve discovery, learning, generation of awareness, and inspiration. So everything really aligns with enhancing ocean literacy. We also have a suite of multimedia resources for education, including an iPhone application, videos, websites, infographics, etc. We have accomplished all this in eight years. However, we have changed the focus from conducting many activities with a few participants to activities that reach more people. This is being accomplished through partnerships such as with EuroGOOS and GOOS.
Example of SOCIB products for the public:

**Audience Question and Answer**
- You mentioned that you have funding coming from the private sector bank and partnerships with the private sectors. At the same time, you have to develop partnerships to improve the number of participants. How can you develop these partnerships with the private sector to get funds and resources? You also mention that you need partners with specific skills to develop and enhance your outreach activities.

- I should have said that the SOCIB observing system is a public research infrastructure. In terms of the partnership with the private sector, it's very difficult. I think it's only through showing that we are reliable, and are able to do things, and this takes time. So again, it's persistence, integration, and optimism that lead to success.

**D.3. Breakout Group I: Integrating Ocean Observation into Ocean Education/Ocean Literacy Initiatives**
Participants were given the following list of possible discussion topics:
A. Using ocean observing data in programs for museum and aquarium audiences during the Decade
B. Using ocean observing data in K-12 science
C. Using ocean observing data in social science and humanities
D. Currently available ocean observation resources and materials
E. Using the media and social media to highlight ocean observation initiatives

The five breakout groups summarized their discussions and recommendations as follows:
- It is important to have society-driven science. Two strategies may help this:
  i. Early career scientists are more in tune with society driven issues and seem to be more comfortable with different audiences. So workshops for early career scientists that include sustainability officers and business leaders could give them tools to reach the public as well as assist more senior scientists in reaching diverse audiences. There is a new class of employee (sustainability officer) in a wide variety of sectors (businesses, municipalities, etc.) who desire to bridge science with stakeholder needs. Can the GOSE community hold workshops to interact with these folks to learn about their context/needs and provide ideas/strategies/products that they can use to work with their superiors?
ii. Every community thinks about sustainability differently. Workshops are needed to gain understanding of community needs and identify community-defined sustainability. Can we engage with communities to better understand their definitions, needs, and contexts? Then we can act to bridge what ocean observation resources/information/products could be developed to support their needs. The strategies for interactions could include workshops, focus groups, surveys, or idea contests. One issue is that communities need fine scale maps and predictions, which are not necessarily provided by large gridded ocean observation networks. Citizen science (like weatherbug.com or a sea-level/wave stick) might help validate/calibrate models and make them more local/relevant. Predictions include flooding, wave damage, fish concentrations, and/or coastal erosion.

• Larger projects that have a larger outreach budget have more potential to identify best practices. Also, it would be beneficial to network or coordinate these large projects, such as projects funded by the U.S. National Science Foundation that have substantial broader impact activities.

• It is important to harness the power of machine learning. What are people “Googling” about the ocean?

• It is important to make a personal connection to oceanographic data. Harness the power of student-driven data gathering initiatives and citizen science.

• We need places to learn about best practices and about the successes and failures of larger government-funded outreach initiatives - one access point that exposes all of the component pieces to find the full aggregation. We also need dedicated curators and ways to make the resources more discoverable.

• It would be beneficial to create an international working group or network focused on ocean education and ocean literacy. The network should be a network of established networks.

• During the Decade, it would be important to have a clearinghouse and repository for teaching and ocean literacy activities. Perhaps a task force could be established that is focused on communicating during the Decade.

• Partnerships with social science and humanities experts would be beneficial in developing concepts for ocean observing learning. We need to better understand what the public is learning from the data. Involve/engage local community/stakeholders from the planning phase to ensure science is meeting needs of local community and that local knowledge is incorporated into planning.

• It is important to engage Indigenous communities, which have been making ocean observation for millennia. Start with the elders and determine local relevance.

E. Why Do We Need Seabed Mapping?

E.1. Panel II: Importance of Seabed Mapping for Society and Related Education Activities

Moderator: Paula Keener, Global Ocean Visions Panelists:
Gordon Johnston, International Federation of Surveyors and AORA
Tommy Furey, Marine Institute of Ireland
Laura Brothers, U.S. Geological Survey
Nicola Bridge, National Marine Aquarium (UK) and European Marine Science Educators Association
Robert Panipilla, Friends of Marine Life

The panel discussed the following questions:

1. With so much of the deep ocean unmapped, how can priority areas to be mapped be identified to support ocean sustainability? Are the regions currently being mapped addressing ocean sustainability? Mapping areas beyond national jurisdiction are selected using a number of criteria, including the presence of vulnerable marine ecosystems, known risks of natural hazards, human activity and pressures, and stakeholder needs. An example of a prioritization approach is the work being conducted by the Atlantic
Ocean Research Alliance and the Atlantic Seabed Mapping International Work Group (ASMIWG). A series of parameters, activities, and characteristics were synthesized in GIS to assist in identifying potential areas for mapping. A grid overlay was developed of 400 x 400km² survey blocks, equivalent to an achievable area to map within a typical seagoing vessel survey leg. Analytics of the GIS data and grid overlay pointed to certain survey blocks potentially being more important than others.

An example of a national mapping mission is that of the U.S. Geological Survey (USGS) Coastal and Marine Hazards/Resources Program. Their mission is to inform society of the hazards and challenges of changing coastal and marine environments by providing robust and scientifically defensible assessments, maps, models, and forecasts to protect coastal communities and improve natural resource management. They do this by employing a variety of techniques, including seafloor mapping. USGS seafloor mapping includes collecting bathymetry, backscatter and sub-bottom data, and it is often accompanied by some form of ground truth data, including grab samples, seabed video, or cores. The USGS selects areas to be mapped on U.S. continental shelves based on the presence and magnitude of threatened coastal population centers, infrastructure, resources, and other strategic needs. They also study deep ocean environments to understand the geology and physical processes that cause marine hazard events (e.g., earthquakes and tsunamis), to survey mineral and energy resources and deep-sea ecosystems, and define the U.S. Exclusive Economic Zone.

Most existing High Seas based seabed mapping in the Atlantic and globally is localized contextual mapping, targeting a specific feature or resource. It is the view of the ASMIWG, supported by discoveries during the opportunistic mapping undertaken by the group in areas traditionally assumed to contain no diversity, that areas identified as lower priority by the above GIS process, may in fact prove to be rich in biodiversity and ecosystem value, due in part to the unknowns, rather than the knowns. For this reason, a systematic seabed mapping approach is recommended by the group, to achieve a baseline full coverage map of the shape, depth and habitat of our uncharted ocean seafloor.

A local example of mapping for sustainability is coastal mapping off Kerala, India. This has allowed communities to understand their nearby seabed and associated ecosystems, leading to better decision making and management. In addition, several large scale national seabed mapping programs are currently underway, and in development, for sustainable ocean management, and to map national Economic Exclusive Zones (EEZ) for territorial designations under the United Nations Convention on the Law of the Sea.

2. Are there innovative products and services being produced that will promote ocean sustainability?
An example of innovation for sustainability is Ireland’s “mapping for modelling” that supports the development of storm surge models for coastal risk management, and aquaculture catchment carrying capacity, to determine sustainable food growth potential in coastal bays. While limited High Seas / Mid-Ocean based products and services may exist at this point in time, seabed and habitat mapping is leading to designation of Marine Protected Areas, often home to sensitive habitats including rare species of sponges and corals.

In 2015, experts listed a total of 228,450 marine species worldwide and estimated that between 500,000 and 2 million more multi-celled marine organisms were still unknown. More mapping is essential. Marine life may give rise to significant economic impact, e.g., sponges and mollusks are among species that have yielded cancer-fighting agents. Sensitive offshore ecosystems need to be mapped so that species host to novel compounds with potential future pharmaceutical and biomedical applications can be protected, and their potential impact on future human health fully explored. Further marine prospecting for "blue biotechnology" could also help develop materials resistant to heat, toxins, etc.

Atlantic mapping has led to a significant increase in basin scale research and operational collaboration, as well as data sharing, capacity building, education, and public engagement. Many mapping data sets are now available online. In addition to making all of its data and interpretive products associated with seafloor mapping efforts available on the web, the USGS is developing alternative formats to engage users and a
broader audience. Some of these newer formats include story maps and web portals. Telepresence technology, web mapping services, and social media use have also allowed for sharing mapping activities and discoveries with a diverse and geographically wide scientific and public audience. Data analytics and spatially based assessments allow for ocean states, such as the presence of plastics to be determined. It is now known that 90% of ocean plastic comes from just 10 river systems, eight of them are in Asia (the Yangtze; Indus; Yellow; Hai He; Ganges; Pearl; Amur; and Mekong) and two are in Africa (the Nile and the Niger). It is estimated that by 2050 there will be more plastic than fish in the ocean. All UN Sustainable Development Goals can be related to seas and the ocean. However, the issue of governance remains. Who is directly responsible and has jurisdiction over International waters?

3. How are best practices being communicated/shared?
Standards have been determined by a joint enterprise of the International Federation of Surveyors, the International Hydrographic Organization (IHO), and the International Cartographic Association for educational basics and competencies through the International Standards of Competence for Hydrographic Surveyors and Nautical Cartographers. Forecasting models need better data with greater coverage, higher resolution, and for temporal elements a degree of currency. Best practices used by the U.S. Geological survey include story maps and their user friendly video and image portal. Best practices identified by the UK’s Ocean Conservation Trust include coupling urgency with solutions, showing how conservation efforts benefit human prosperity and animal well-being, and building on baseline knowledge. Best practice seabed mapping Standard Operating Procedures are being collated by the Atlantic Seabed Mapping International Working Group. These will be made available to potential future contributors to Atlantic seabed mapping and the global Seabed 2030 initiative.

4. Where are the intersections of ocean observing and seabed mapping, and how might capacities be built within these intersections in support of the Decade?
Thermohaline circulation modelling requires much greater resolution, e.g., North Atlantic variations into the Norwegian Sea and the western extent of the El Niño and La Niña weather patterns impacting on the Pacific. The Ocean Observing and Seabed Mapping communities need to work together to meet the Decade’s goals. An example in development is an Irish partnership between the national seabed mapping program INFOMAR (see below for more information on INFOMAR), and the Strategic Marine Alliance for Research and Training, which trains ocean observers to map and mappers to make ocean observations. It is critical that we achieve a better understanding of the resolution of mapping required for different ecosystem and oceanographic modelling applications, and regions. Atlantic basin-scale oceanographic and/or ecosystem modelling requirements are not comparable with shelf edge studies of upwelling in valuable fisheries habitats, differing again from nearshore requirements for storm surge prediction, flood risk management, and coastal erosion assessment.

The Government of Ireland has made a significant commitment to seabed mapping of the Irish EEZ, embedding it in the national marine plan as a specific cross cutting action, with a multi-year investment in mapping, transferring the data to knowledge, and promoting associated research and innovation in both industry and research sectors. INFOMAR is the national seabed mapping program which is jointly managed by Marine Institute and Geological Survey Ireland. A successor to the Irish National Seabed Survey, it is an €80m program between 2006 to 2026 with an estimated four to six times return on investment. As a national program, INFOMAR’s broad cyclic approach to seabed mapping activities has been to map human activity and pressures, identify sensitive habitats, establish stakeholder requirements, estimate survey effort and cost, plan operational activities within budget and vessel constraints, and track progress relative to targets, with the aim of completing Ireland’s EEZ mapping by end 2026. Central to the ethos of INFOMAR’s challenge to seabed mapping for sustainable development is:
- taking a systematic approach to deliver a full coverage baseline map of the seabed depth and shape;
- deployment of hi-tech data sharing, dissemination and visualization systems;
- strengthening modelling capacity and activity through higher resolution bathymetry and project support (e.g. H2020 TAPAS);
- improving ecosystem research through better understanding of seabed type and benthic habitat; and
- employing innovative approaches to coastal habitat assessment, including studies of seaweed resources.
Ireland has been effective in its communication of the importance of seabed mapping, having demonstrated the economic potential through a cost benefit analysis, having shared it’s discoveries and findings through an open data policy and collaborative partnership approach and through continuous engagement in outreach, education, and ocean awareness events. The capacity build program has expanded recently, through content development for classroom education (Scoilnet partnership), and more significantly towards delivery of seabed mapping training to 3rd level M.Sc. students and international Horizon 2020 Eurofleets+ marine researchers. The latter two initiatives are being delivered by INFOMAR in partnership with Ireland’s Strategic Marine Alliance for Research and Training.

To expand Atlantic seabed mapping cooperation and activity to underpin the UN Ocean Decade of Science for Sustainable Development, a critical transition is required from random opportunistic transit mapping, towards a systematic operational survey program. To deliver this, a resourced cooperative initiative needs to evolve, supported by governments, industry, and the research community, providing shared infrastructure access and encouraging a more open approach to research and innovation. More importantly, it requires interdisciplinary cooperation and partnerships to bring together ocean observation and modelling, bathymetry, benthic habitat, geoscience, ecosystem and climate, and social scientists, to create the knowledge and tell the story of our Atlantic Ocean of opportunity.

5. How can the importance of seabed mapping to society be communicated?
A global seabed mapping exercise could be an important engagement tool to bring the seabed to life for citizens who are entirely disconnected from the ocean. Research in the UK shows that there is a popular belief amongst many members of the public that the ocean is vast, unchanging, suffers isolated problems, and is a simple ecosystem. Reducing this disconnection by bringing the ocean floor to life – showing how it has many of the features that appear on land – can play a direct role in how citizens value the ocean.

Challenges facing public engagement with seabed mapping (e.g, Seabed 2030) include:
- A lack of coordinated messaging across countries and sectors regarding the necessity to map the seafloor;
- The need to provide greater access to data that could be used by educators and science communicators;
- A public disconnection with the seafloor (how can public interest be sparked?)
- The need to address why mapping the seafloor a compelling story (when there are so many other issues facing society);
- The timescale of exploration could be difficult to keep interest levels up;
- Development of examples that show how seafloor mapping can be linked with curricula; and
- Development of methods to engage students and the public.

There are several opportunities that could be explored for addressing the challenges above. The national marine education networks, EU network of marine educators, networks of aquariums and museums, and other related networks could be engaged to help translate and disseminate information about seabed mapping activities and resulting data. International collaboration in seabed mapping is a new and exciting story that may be of great interest and surprise to the public. The story of the seabed and this collaboration needs to be told, not just using facts/figures/data. Curricula can be aligned with seabed mapping via geography, history, science, and math. In addition, students could be engaged with stories about the wide variety of careers linked to ocean exploration in general and seabed mapping specifically. The public would benefit from exhibitions that use virtual reality that employs actual footage from the seabed and other examples of seabed activity.

Vicki Ferrini, Lamont-Doherty Earth Observatory and Nippon GEBCO Seabed 2030 Project

The Seabed 2030 Project is a collaborative project between The Nippon Foundation and the General Bathymetric Chart of the Oceans (GEBCO) organization, which operates under the joint auspices of the International Hydrographic Organization (IHO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO. The goal is to inspire the complete mapping of the world’s ocean by 2030 and to compile all bathymetric data into the freely-available GEBCO Ocean Map. This will promote sound policy decisions,
the sustainable use of the ocean, and scientific research that is informed by a detailed understanding of the global ocean floor.

Four Regional Centers (Arctic and Northern Pacific; Atlantic and Indian Ocean; South and West Pacific Ocean; and Southern Ocean) conduct stakeholder engagement events, build upon ongoing efforts, identify data gaps, and serve as hubs for regional coordination and data assembly. A Global Center at the National Oceanography Centre in Southampton, UK, is responsible for the generation of global products and the dissemination of global products and services.

What does 100% of the ocean being mapped mean? There are Seabed 2030 goals that target specific resolutions for specific water depths:

A data viewer is being produced that will provide access to many types of archived data, including singlebeam, multibeam, electronic navigational chart, and crowd sourced bathymetry data. There are many sources for this data, which is currently being contributed by 40 countries across multiple sectors, including government, academia, industry, and the private sector. Many types of vessels are being used to collect data, including government survey vessels, academic research vessels, fishing boats, cruise ships, cargo ships, and private boats and yachts.

Since the initiation of Seabed 2030, there has been a two-fold increase in the global ocean bathymetric map resolution from ~1km to ~500m. Coverage has more than doubled from 6% of GEBCO’s goal in 2014 to
15% of GEBCO’s goal in 2019. As the project continues, it is expected that advancements in technology will increase data acquisition, processing, integration, sharing, and cooperation, growing the mapping community. To prepare for this, GEBCO is training the next generation of scientists and hydrographers in ocean bathymetry. Thus far, 96 students from 43 countries have received training. GEBCO is already working to addressing the Decade’s priority areas for mapping as well as its broader goals, including greater connection with the public to enhance global ocean literacy.

**Audience Questions and Answers**

- **How is GEBCO assuring the accuracy of data?**
  - We are engaging with the hydrographic offices and commissions to get them engaged and onboard, which will increase our capacity to assess data accuracy.

- **Do data centers raise suspicion by other countries? How do other countries see themselves as a player?**
  - There is outreach to nations, and we offer them whatever we can, as well as offer them to join the project. We are using alumni of the training program to get the information and messaging out in their respective countries. Centers were chosen because of demonstrated success of doing this work.

**E.3. Breakout Group II: Integrating Seabed Mapping into Ocean Education/Ocean Literacy Initiatives**

Participants were given the following list of possible discussion topics:

- A. Using seabed mapping and bathymetry products in programs for museum and aquarium audiences during the Decade
- B. Using seabed mapping and bathymetry products in K-12 science
- C. Using seabed mapping and bathymetry products in social science and humanities
- D. Currently available seabed mapping resources and materials
- E. Using the media and social media to highlight Seabed 2030 and other mapping initiatives

The five breakout groups summarized their discussions and recommendations as follows:

- A coordinated social media campaign about seabed mapping during the Decade will reach a lot of audiences. It could focus on Ocean Literacy Principle #7 - *The ocean is largely unexplored*. It is important to foster the positivity of the ocean mapping campaign. Fostering the idea that the seabed is part of your nation will increase relevance. Engage and use professional social media experts as well as social media influencers. Using the beautiful data visualizations from seabed mapping on social media channels could be used as a way to hook viewers into learning more about the seabed, the project, and the Decade (the visualization, whether animated or not, needs to be linked to a story that is compelling).

- Look to previous campaigns’ pre-social media and how they contributed to undersea seascapes.

- Continue to bring groups together at each other’s conferences to provide crossovers between outreach and science.

- Develop specific language from Seabed 2030 to insert within OLP #7 for literacy campaigns to concentrate on for messaging.

- Storytelling is important. If it is done well, it can make the relevance of seabed mapping appealing to people. It can show how seabed mapping (as well as other ocean observations) are solving a problem in specific communities. An example given was how coastal mapping can show local communities where beach erosion is occurring and why this is an important issue for their community. Storytelling provides an opportunity to connect a wide range of audiences with unusual phenomena happening locally.

- Science equity is important, so as seabed mapping occurs, there needs to be a process for sharing the results beyond the scientific community. This is particularly important when mapping the seabed of coastal communities. It is important to provide communities with accurate, actionable information, based on the research.
• One way of making seabed mapping relevant is to integrate indigenous observations of the same area being mapped with western scientific methods. This may add some interesting understandings to the proceedings, and if done well, builds trust with those communities. Be sure to give credit where indigenous knowledge is used. Seabed 2030 should ideally include a traditional knowledge statement and include people from indigenous communities in the training programs.

• Make clear the links to how mapping activities correlate to the six societal outcomes for the Decade.

• Fishers have intimate knowledge of the seabed. Develop a training or certificate program for the fishers.

F. Ocean Science Education and Ocean Literacy in Support of the Blue Economy

F.1. Plenary VI: Strategies for the Engagement of Business and Industry
Michael Jones, TMA BlueTech™

TMA BlueTech™ includes both the ocean and water/waste water when considering the Blue Economy. The organization participated in the European Commission’s meeting that led to the publication of the Report on the Blue Growth Strategy: Towards More Sustainable Growth and Jobs in the Blue Economy. The Blue Economy needed an inclusive definition like the UN Economic Commission for Africa that includes ocean, lakes, rivers, and underground water. The Ocean Economy can be addressed individually.

The Ocean Economy is enormous and growing rapidly. In 2016 the Organization for Economic Cooperation and Development (OECD) conducted a study on the The Ocean Economy in 2030, which showed that the U.S. ocean economy in 2010 was approximately $1.5 trillion and would double to grow to $3.0 trillion by 2030. This growth is twice as fast as any sector of the U.S. economy. Yet these are conservative estimates, as the North American Industry Classification System codes to properly capture the data regarding all the Ocean Economy related industries. TMA BlueTech™ is working with the U.S. Department of Commerce to rectify the issue so that the U.S. can develop the first baseline understanding of its true Ocean Economy. What also needs to be taken into consideration is the multiplier effect. When we did this for California, we determined that the ocean sector is the largest of any industry in the state’s history.

Although the Ocean Economy is essential, it only recently began to garner international attention and become a focus for policy. Industries, such as underwater communications, marine renewables, unmanned underwater vehicles, marine and survey vessels, hydrography, marine security, oil and gas, and ocean research, all contribute to the global economy.

Since the OECD study, many other studies and conferences have been held with either an Ocean Economy focus or inclusion, including:
• the first NOAA study on value of ocean observation (2016)
• the first UN Ocean Conference (2017)
• the first EU Blue Invest Day (2017)
• the Kenya Sustainable Blue Economy Conference (2018)
• the first EU Blue Economy study (2018)
• the second EU Blue Economy study (2019)
• the EU Blue Invest in the Mediterranean (2019)
• US National Academy of Sciences and White House event related to the Blue Economy (2019)
• the second EU Blue Invest Day (2020)
• the second UN Ocean Conference (2020)

The EEZ, a 200-mile exclusive use to sea and seabed assets of coastal nations, provide opportunity and power for future growth, but how can they be used sustainably? Workforce development and ocean education are critical for the future growth of the Ocean Economy, and this must be done with the UN’s sustainable development goals in mind. We must unleash innovation to address important components of
the Ocean Economy, including how to thoroughly use resources (the circular economy); how to clean up ocean pollution, such as nuclear waste (dumped from 1946 through 1993), phantom netting, plastics, sunken vessels (with oil onboard), and unexploded ordinance; how to sustainably develop and maintain floating platforms for airports, desalination plants, energy production, and ports; how to reduce noise pollution; and deal with salt intrusion from saline farming.

TMA BlueTech™ has established critical BlueTech clusters to protect the ocean by focusing on the Triple Bottom Line (people, planet, and profit) to balance economic, environmental, and social equity factors. These clusters are regional concentrations of related industries that help increase its competitiveness globally. The BlueTech cluster technology and service companies help us understand problems and are critical to developing and deploying solutions. This also promotes workforce development and job growth in the 16 sectors of the Ocean Economy:

- Aquaculture and Fishing
- Boats and Shipbuilding
- Defense and Security
- Marine Recreation
- Ocean Instrumentation
- Ports and Maritime Transportation
- Robotics and Submarines
- Very Large Floating Platforms
- Biomedicine
- Cables and Connectors
- Desalination/Clean Water
- Ocean Energy and Minerals
- Oceanography and Marine Science
- Professional Services
- Telecommunications
- Weather and Climate Science

TMA is also focused on education and outreach. In 2017, we established a partnership with the San Diego Unified School District to develop BlueSTEM Academy and Career Pathway. In 2019, BlueTech began being integrated across grades K-12 with over 100,000 students to promote STEM and align student education to industry needs. New programs include a three-day summer Blue Economy immersion program for high school students and internships. We have also initiated the Blue Economy Education Collaborative with 40+ regional organizations focused on ocean/water education.

The growing Ocean Economy and goals of the Decade call for further workforce development, ocean education, and ocean literacy to ensure sustainable use of the ocean’s resources. Further, ocean observing is essential to address the big 5: food, water, real estate, energy, and medicine. Addressing ocean related issues can’t be achieved without collaboration across sectors and across national boundaries. We must work together to capture the attention of the global citizenry and ensure that our messages are relevant, leading to sustainable growth and use of ocean resources.

**Audience Questions and Answers**

- **How will BlueTech jobs be distributed in the future?**
  - We will need people skilled in technology and trades; the workforce will not be heavy on PhDs.

- **What is the outcome/forecast for ocean mining?**
  - We do not focus on that specifically, as we are focused on sustainable industries; for example, there is a company which has created a forward osmosis process to withdraw lithium from seawater to eliminate mining for it.

**F. 2. Plenary V: Ocean Literacy, Knowledge Transfer, and Career Development for a Sustainable Blue Economy**

Mary Kavanagh, Minister-Counselor, Research and Innovation, Delegation of the European Union to the U.S.

Our ocean challenges are too big to be addressed by one nation or one organization but are an issue for all nations. Our well-being depends on the well-being of the ocean. The Blue Strategy is growing within the EU. It is being designed to overcome barriers that impinge Blue Growth. Without innovation in the Blue Economy, economic growth will be held back. In addition, the lack of skilled workforce is already
preventing growth. This shortage of skilled staff will increase into the future if we do not do something now. There is a general lack of information about career availability. This also needs to be addressed. At the EU level, the Blue Careers project is establishing pilot programs between education and business to close the workforce gap. The Mentor Project is one of these projects. Three key factors in all these projects are education, industry cooperation, and lifelong learning.

There is a sense of global urgency about the health of the ocean and human impacts on the ocean. The ocean is warmer, more acidic, and less productive. The sea level is rising and impacting infrastructure around the world, not to mention the compounding factor of the greater intensity of storm surge due to sea level rise. The UN’s sustainable development goals call for action, and international cooperation is essential. The Decade and other activities, such as the green deal for Europe, are intended to contribute to a climate neutral economy goal. For overall, it is climate change that is the most pressing global problem affecting the ocean and all of Earth’s systems.

The trans-Atlantic Galway Agreement has helped to spur the interest in the need for collaborative ocean research and ocean literacy. EU research proposals now have broader impact requirements, in much the same way as U.S. research proposals. The Atlas project is one of the EU research and innovation projects selected with these criteria. The ultimate objective of this project is to create a trans-Atlantic, ocean-aware society. In 2017, several private sector players agreed to contribute to this objective by providing apprenticeships.

A new push for multi-lateral cooperation is needed. We can use workshops like this to create new opportunities, such as the development of training programs for business and industry. The EU believes in the fundamental goals of ocean literacy. Your work here in this workshop should help countries all over the world.

Audience Question and Answer
• How is the EU working so that the Blue Growth initiative isn’t harmful to the ocean?
  - We cannot ignore that our resources are finite. All the projects we fund directly are intended to not have adverse environmental impacts and will promote positive growth. The missions will focus on investing heavily in areas of research which will ultimately support sustainable development and economic growth.

Moderator: Peter Tuddenham, College of Exploration Presenters:
Diz Glithero, University of Ottawa and Canadian Ocean Literacy Coalition Kelley Brumley, Fugro
Thomas Chase, American Society of Civil Engineers and Steve Balint, Balint Consulting Steven Ross,
University of North Carolina Wilmington and the ATLAS Project Zacharias Siokouros, Maritime
Institute of Eastern Mediterranean

The panel addressed, “What are the current workforce training needs?” Rather than give formal presentations, the panelists collaborated on addressing the question as follows:
There is still a major issue with gender equity in marine industries, including in consultancies and offshore mapping. Women are only 12% of the mapping industry. There is a robust percentage of women in maritime academies (30-40%), but there is a low percent working in the industry. The industry needs to be more gender friendly. Get women in engineering, hire them, and keep them.

The shipping industry needs a lot of engineers across all the engineering disciplines. There is a significant shortage of electrical and marine engineers needed for the shipping industry in developing countries, both aboard the ship and shoreside. Part of this has to do with the perception of the available jobs, and it takes time to change the perception of what type of person can work in shipping. Communication is important. We need more Blue Careers events. In addition to shipping, there is a workforce shortage in offshore and gas, cruise ships, and tourism industries.

Many marine industries have internship programs and bring in students, who help with projects. This gives
them a taste of real-world jobs before they graduate. We need more of these apprenticeships across all ocean industries. It is not just about building skills; it is also about how the experience shapes the person and the relationships they build.

In the past 15 years, women have taken over as a larger percentage of ocean science graduate students. This has changed rapidly and tremendously. The growth in career choice has not yet translated into growth for female PhDs in the workforce. Another problem that we see in academia is that education programs are still rather stove-piped. Students tend to be more specialized and narrowly focused. This turns out to be a disadvantage, as the problems related to the ocean and society need a greater breadth of knowledge and perspective to address the problems.

Civil engineering in the Blue Economy is a new sector. We need engineers that are getting solid training with a minimum of a Master of Science degree in civil or marine engineering. There is a shortage of naval architects and engineers that build coastal structures. How do we get the younger generation aware of these future jobs, get them interested, and have them commit to the field? The Blue Economy is a new avenue for civil engineering. In the future there are several growth sectors within the civil engineering workforce related to ocean enterprises - material science, big data management, harvesting data to make better predictions, and marine renewable energy.

How do you mobilize the citizenry to be motivated to enter the workforce? What are the current education needs to increase ocean literacy and job awareness? Ocean literacy can connect the dots. What is the bigger hook, and can we take the lead on that initiative? We know that experiential pedagogy is the most effective way to get students interested in science, yet we don’t act on what we know. We need to be more conscious of the Arctic, which represents 50% of the world’s coastlines. Indigenous people are ocean observers, ocean experts. We need to make space for other ways to know about the ocean.

**Audience Questions and Answers**

- How do you see the issue of addressing the need to get people on ships in the early career stage? People are coming to Ireland on their own dime to get the experience on ships.
- Part of the issue is dealing with the silos problem. We need creative ways to move money from federal agencies to industry. We can bring students in as interns from other universities to get training from other professionals, but we need to think creatively outside the silo. We also need training programs that introduce students to real skills, such as getting them on boats in industry where they can find training. Being an engineer on a ship, you need to be multi-purposed, so these engineers need more practical training. Educational systems cannot change quickly. Industry is changing much more quickly. In addition to trying to move the needle in higher education, we must work with the existing workforce.

- Where do you see opportunities to provide the needed training you describe?
  - Community colleges are underutilized. We need more partnerships with these two-year higher education institutions so that they are preparing students for real careers in marine industries. Some of us in industry have tried to develop these kinds of partnerships, but we run into walls, bureaucratic roadblocks, and paperwork that we don’t have time to manage.

- If we desire a blue economy and recognize that we need to educate and enhance ocean literacy, how do recommend that we have Blue Economy education materials?
  - Ocean literacy is such a nebulous concept for most people. We need to find the relevance. Around the Blue Economy, there is a need to better articulate its relevance. There is a need to get better at articulating that return on investment. We know the value of ocean literacy for business anecdotally, but we need to find a way to measure it and put its value into a business-friendly language. If you want to bring people in marine industries, you need to make them love the sea.

- We need to better integrate the education and research sectors, but we also need to bring science education to business. Can we bring tech education to scientists?
  - We need to broaden the education base so that students appreciate other disciplines. A question for
education professionals is how can changes be made to curriculum to put a little bit of other disciplines into narrowly focused majors?

- To expand the Blue Economy and grow it, there is an elephant in the room. International regulatory folks are charged with determining what can be done in the ocean. Regulators and decision makers need to be addressed in the Blue Economy picture. They also need to be ocean literate.

- The same education resources and/or courses that the GOSE community develops for business and industry could be easily adapted for the decision maker community.


Delegates were given the following list of possible discussion topics:

A. Using national and international networks to engage the blue economy business community during the Decade
B. How can business and industry support ocean science education during the Decade?
C. How can the ocean science education community support the blue economy?
D. What kinds of ocean science education opportunities do businesses need?

The breakout groups summarized their discussions and recommendations as follows:

- There is concern that the Blue Economy encompasses such a wide range of companies and workforce needs that the breadth is overwhelming. Blue Economy clusters may be the way to focus on building partnerships with a few key partners who can be early adopters, but the educators need to know what the benefit is to the companies, i.e., how education solves some problem they have with their workforce needs.

- The Blue Economy is growing, but students don't know what types of jobs are available. The Human Library is a possible platform for ensuring that students are connected to people who are working in Blue Economy businesses. One opportunity is to ask Blue Economy companies to participate by encouraging/enabling their staff to include their profiles in the Human Library.

- What do we already know about job needs? The Marine Advanced Technology Education (MATE) Center's job skills survey reports were mentioned (see https://www.marinetech.org/workforce/). Some existing courses already exist for some marine technology-related jobs. While this does not represent the breadth of the job types and skills that will be needed now and in the future, there was agreement not to reinvent wheels. Perhaps some of these certification courses can be put online (if they are not now). It's not clear how well those courses are known by the Blue Economy community.

- In thinking about the Decade, we talked about focusing on innovation (which will be the theme of the 2020 World Oceans Day). So perhaps this is an opportunity for a communications campaign. Borrow the #ThinkOcean Twitter handle. The innovation could focus on innovations in sustainable development challenges that need to be addressed (e.g., food and aquaculture, marine plastics, technologies, education, and renewable energy solutions).

F.5. Large Group Discussion I: Development of Education Opportunities for the Existing Marine-Related Workforce

The IOC conducted the first pilot program in December 2019 for the business community. How can the GOSE delegates support this? If it is available, we could provide information and data with regards to what are the needs of the private sector. There must be a needs assessment survey for broad distribution to get more viewpoints about business and industry needs for training, and we must reach beyond the established community. An initial survey was conducted by the IOC in 2019. One of the outcomes of the survey was that business and industry do not only need information about the ocean, they also need training on how to communicate, how to effectively communicate to the community, and how to engage the community. The need for communication skills is not just related to their products, but they want to be able to communicate about sustainability, ocean sustainability.
Insurance companies may be a good target for a pilot program; they must deal with the sort of actuarial issues related to risks. They are also not the usual targets for ocean education and outreach activities. This is also true for mortgage lenders and other financial institutions that are working with potential homeowners along coastlines.

It would be beneficial to offer a half-day training program for business and industry at the next GOSE Workshop. The first ocean risk summit was held in 2018 in Bermuda. It was sponsored by XL Catlin, which has now merged with AXA XL. They have ocean literacy included on their website, and they have an extensive ocean literacy campaign. Representatives from this company would be good to engage in a training program.

F.6. Breakout Group IV: Groups Develop Outreach Plans for Implementing Education Opportunities for Business and Industry During the Decade

- **Aquaculture**

  A group focused on aquaculture met to discuss how related research projects during the Decade should inform best practices that could be shared across nations. This effort is intended to support the Decade goal of a sustainable, productive ocean to ensure food supply. There is a lot of information existing on aquaculture practices. In the US, NOAA's Office of Aquaculture and Sea Grant College Program offer significant educational and regulatory information on aquaculture and its practices. NOAA's Office of Aquaculture already has international collaborations and NOAA's Office for Coastal Management has developed a toolbox for sustainable coastal fisheries called the Coastal Aquaculture Planning Portal. Sea Grant' has produced a *Ten-Year Vision for Aquaculture* and can inform the US vision for transfer of knowledge into practice.

  It would be good to develop case studies to showcase ways that ocean observation data and research can be used to support the aquaculture industry. Positive and negative examples should be included in these case studies, including what can go wrong if you don't follow best practices, which must be geared toward sustainability, and how sustainable practices are enhanced by integrating the relevant ocean observations and research results. The process for developing case studies has to be iterative, so that we learn the needs of the aquaculturists and regulators in conferences in different countries (because issues are variable depending on country). These activities should be connected to the UN Food and Agriculture Organization (FAO) to ensure that there are clear linkages between FAO activities and the Decade's activities (perhaps this already exists so need find out).

  A related piece is to encourage aquaculturists to collect and contribute data (to be defined). An aquaculture company gets some sort of recognition that they are contributing to the Decade’s goals and to get the recognition or certification, they would have to share their data. This wouldn't need to be as stringent as the Aquaculture Stewardship Council (ASC) and Marine Stewardship Council (MSC) requirements.

  A concrete activity that could be conducted within the next year could be a program to address public perceptions on aquaculture through museums, aquariums, chefs, fairs/conferences, hotels, site visits of aquaculture operations, stories of the benefits/dispelling myths, and coastal communities (prosperity/traditional practices). One tool for assisting public perception could be developing an ecolabel for aquacultured fish that is connected to the Decade’s sustainability goal. It could be a way to amplify the message, because it is connected to the Decade. One of the criteria for obtaining an ecolabel is reporting data on their harvests and practices. To make this viable, we would have to get the Conservation Alliance for Sustainable Seafood (CASS) involved.

  A first action would be to connect with the Coastal Ecosystem Learning Center Network, CASS, ASC, World Aquaculture Society (https://www.was.org/), and AORA Working Group on Aquaculture to assess their interest in this effort to change public perceptions and determine if they are aware of the Decade’s goal related to a sustainable, productive ocean to ensure the provision of food supply. (Also note that 2022...
is UN Year of Artisanal Fisheries and Aquaculture.)

An example where education could make a concrete difference in sustainable practices involves personal care products containing seaweed extracts that are sold in pharmacies, gift shops, hotels, etc. Labels will state that the seaweed is organic. However, the labels don’t state what species the seaweed is, where it came from, or if it has been sustainably harvested. There can be coastal risks associated with seaweed harvesting, as well as impacts on coastal communities. Education and better labeling could help consumers make more sustainable choices.

Recommendations:
• Develop a certification program for the aquaculture industry which integrates the Decade’s sustainable development goals.
• Connect with organizations who are trusted partners, such as museums and create basic level content about aquaculture, and use the partners to disseminate the information.
• Stakeholder engagement – develop a tip sheet on how to address public concerns.
• Develop case studies/stories that could be shared in a traveling exhibit.
• Connect with the other entities who deal with the issues associated with the public perceptions of aquaculture. There are already museums and aquariums dealing with aquaculture. It would be good to identify them and create a list of what is already happening. Which institutions would be good dissemination outlets? There are also some networks involved with aquaculture education, such as the Coastal Ecosystems Learning Network and Conservation Alliance for Sea Food Solutions. These organizations have been introduced to the Decade and its goals. They are thinking about this, but they don't necessarily have well formulated plans. So there's an opportunity for us to assist them in developing plans to address the Decade.

Tourism
To do anything with the local tourism industry, you really have to first and foremost engage the local authorities involved with tourism, as well local business stakeholders. There is interest in engaging hotels in partnerships and in training and hotel staff. There are other services and businesses that could also be reached, including beach operators; golf clubs; camp grounds; sailing, surfing, and canoeing establishments; tour operators; and other service industries that support marine tourism. It would be ideal to connect all these service industries together in a partnership that would encourage those communities to adopt more sustainable practices. It would be beneficial to develop maps of local businesses. The GOSE community could produce poster, information materials, and digital messaging that the local service industries could use and that are relevant to the communities where they are located. There are some interpreter centers that communicate ocean messages, getting students and the public into the coastal zone. Outreach to these local centers could help them to be aware of the Decade and its activities.

Recommendations:
• Use The Ocean Race, which will be stopping in ten locations around the world, as a way to share information about the Decade with local communities. The route of the race will have the boats traveling through different ecosystems, which could serve as the foundation for sustainable development stories.
• Engage the local community and businesses to think about local issues and solutions.
• Encourage the Green/Blue hotel model. Reach out to there people in The Ocean Race and to host city hotels, perhaps they can connect us then to corporate headquarters.
• Partner with the seabed mapping community to provide the communities visited by the race with seafloor mapping information and visuals. This information could be integrated into the messaging of the race.

Coastal Development
Coastal development is an issue for communities, states, and nations around the world. To improve sustainability, local authorities, as well as citizens, need to be more ocean literate. Science provides models and predictions of climate change impacts to coastlines and coastal communities. This information, delivered in relevant and understandable language, could help authorities and citizens better understand
how their own communities will be affected. They could learn to use databases and other tools to continuously access information. It would be helpful to develop a toolkit for decision maker, much like the ocean literacy toolkit that has been published by the IOC for educators. Another education focus could be to assist local authorities and decision makers about the return on investments made to create more sustainable options for local coastal development. This could help them to take more sustainable action and to develop more sustainable policies.

Recommendations:
- Develop a Toolkit for Coastal Development.
- Collect information from various sources and section it by types of environments and age groups. This toolkit could be handed to education institutions as well as local authorities and governments.

**Shipping**
There is quite a lot of information dedicated to the shipping industry already, available from both the shipping industry players and from the International Maritime Organization (IMO) regarding the Decade. After reviewing this material, the group believes this is a good place to start. Starting with this content, key companies involved in the shipping sector, including cruise lines, could be targeted as audiences for one-day online courses, generally covering the Decade, its goals, and opportunities for the shipping industry. A model program would train the trainers, recognizing the great variety of cultural differences that exist in the shipping industry. So, the key would be having people from inside the industry to conduct training. We would also help the targeted businesses to understand how they could collect data in support of the Decade.

Recommendations:
- Develop a one-day online course based on the Decade for individuals in the shipping industry.
- Mine the available content, getting IMO endorsement, and develop content and learning materials for the course.

**Ocean Observing**
There are certainly linkages between the Decade goals, the ocean observing enterprise, and ocean literacy. The ocean observing enterprise is evolving very quickly, and there are new tools and industries involved in ways of observing the ocean that are constantly emerging. We cannot really know the education needs of the industry. We must engage with them before we really understand who they are. Then it would be important for the Decade to build a portal could allow for the creation of ocean visualizations and some way of “seeing” the data for different types of users. A help desk could direct users to the right resources.

Recommendations:
- Form partnerships with the ocean observing community to assist with the integration of their work into the Decade’s activities.
- It would be good to have a “help desk” or framework that would facilitate where people in the ocean observing community could get information on how to contribute to the Decade.

**G. Working Groups on Seabed Mapping and Ocean O: Actions and Plans for Implementation During the Decade**

Discussions centered on recommendations for collaborative activities that could take place during the Decade. Below is a summary of these discussions:
- It is important that the idea of storytelling is reinforced and that ocean research and education community work with experts to make seabed mapping data relevant to people, helping them understand how it relates to their everyday lives and explaining to them how it might be solving a problem in their own community. An example is the mapping of beach erosion and how going back to the same area time and time again to map it can provide valuable data to municipalities. This is also a means of sharing what is fascinating about what's happening on the seafloor. There are fantastic data visualizations that are coming from seabed
mapping and using those as an attractor through social media channels can serve as a gateway to then have folks dive deeper into particular topics that may be of interest to them.

- Another important consideration for the Decade is science equity. Data collection must involve viewpoints of traditional and indigenous knowledge. Obviously, this may not be necessarily true for the deep ocean, but it is definitely important for mapping conducted along the littoral zone. It is also important that data is getting back in the hands of communities; that they're seeing and learning from it; and that it's relevant to them.

- Language is a major issue. We need a common language across communities to bridge the silos. We need to use this common language in correlating the ocean literacy standards to the six societal outcomes for the Decade. This language also needs to be integrated into the messaging for seabed mapping and ocean observing.

- The seabed mapping data are web friendly, aquarium friendly, audience friendly, and school friendly. Although there are great visuals, what's sometimes missing is the context of the connectivity of those visuals to something that really matters - the societal benefits. People are interested in shipwrecks and climate change, but those are difficult ties to make to mapping, except for the fact that the wrecks are on the seafloor. Who needs to include mapping in ocean literacy? Who are we going to message and where is this going to make a difference? Should the messages be going to school schoolchildren or policymakers? Or should the messages target social media influencers? Who's going to get interested in mapping or ocean observing that makes these topics important to a lot of people? Another group of course is educators, and potentially an important group are the people who are entering the workforce now, who are going to have wealth in the next 10 to 15 years. We should be targeting them during the Decade. These people are going to be buying stock, buying equities, and selecting their investments. So they could potentially steer their investments into things that promote sustainability, away from oil and gas, and into new things related to where seabed mapping and ocean observing might make a difference. So overall, we need to develop an outreach strategy for the Decade that it takes these things into consideration. What are the visuals, who is the audience, what is the context, and how's the audience going to be influenced?

- One implementation activity for the Decade could be building a campaign around “Ocean Blackout.” The fact that the map is largely black draws attention to Ocean Literacy Principle number seven that the ocean is largely unexplored. However, we wanted to foster the positivity that there's an opportunity, a real opportunity here to explore versus the crisis of the knowledge gaps. Although we know that the dearth of knowledge is very real, the campaign would focus on “please help us map and continue to create a map that is no longer mostly black.” As was stated earlier, it would be beneficial to engage professional social media experts and social marketing professionals to help in creating the content for seabed mapping and ocean observing social media campaigns. We also need to identify who are going to be the best advocates or influencers to discuss seabed mapping and ocean observing during the Decade. The testing of messages can be done with inexpensive tools like Facebook and Facebook messaging to see what messages are working best for different audiences.

**H. Lightning Round I: Student Presentations**

Moderator: Nicola Bridge, National Marine Aquarium and EMSEA Presenters:
Emiliano Gonzalez Santin, Ulster University
Maro Pontiki, University of Delaware
Bianca Prohaska, Florida State University and U.S. All-Atlantic Youth Ambassadors
Jaya Roperez, Center for Coastal and Ocean Mapping
Alicia Wilson, University of Georgia and U.S. All-Atlantic Youth Ambassadors

**Emiliano Gonzalez Santin**

There is still a major issue with gender and racial diversity within the geosciences. When controlled for identical education and experience, studies have shown that presumed male lab manager resumes were evaluated better than female resumes and resulted in $4000 difference in salary offers. Other research has shown that when minority job applicants alter their ethnicity information on resumes, they are 50% more
likely to receive a callback than those who don’t. Other studies have shown that 71% of women and 41% of men have reported being sexually harassed when conducting science related field research. Even more staggering is that 26% of women and 6% of men reported being sexually assaulted while conducting field research. Ninety percent of women and 70% of men who were targets of harassment were trainees or junior employees. Several organizations are actively working to combat these issues, including the International Association for Geosciences Diversity, the Geological Society of America, the American Meteorological Society, and Sparks for Change.

_Maro Pontiki_

Ocean observing scientists at the University of Delaware are studying wave-ice interactions to inform the design of offshore and coastal structures. Experimental research is looking at extreme wave events and the impact on coastal erosion and dune erosion physics. These research topics have a direct relationship with society. Education and outreach activities have been a collaboration between the scientists and education professionals involved in COSEE; the American Society of Civil Engineers Coasts, Oceans, Ports, and Rivers Institute; and the University of Delaware. Programs have provided hands-on experiences and other opportunities for students to learn about the research.

_Bianca Prohaska_

As one of the Atlantic Ocean Research Alliance (AORA) All Atlantic Ocean Youth Ambassadors, I have been working to better understand current workforce needs. AORA is bringing students together to assist them in promoting sustainable development and stewardship of the Atlantic Ocean in their activities. Lessons are learned about how to influence community, develop campaigns, intersect with policy, and use media.

_Jaya Roperez_

The Nippon Foundation and GEBCO have provided a post-graduate training program in ocean bathymetry. This takes place at the Center for Coastal and Ocean Mapping (CCOM) at the University of New Hampshire. Thus far 96 post-graduate students from 43 countries have participated in the one-year intensive capacity-building program leading to graduate certificate in ocean mapping and IHO/FIG/ICA Cat A in Hydrographic Surveying, where six international students are being sponsored every year. Each student goes back to their country with not just the knowledge and experience gained but also access to networks of professionals in the ocean science community, which serve as a resource to help advance ocean mapping in their home countries. Some alumni have also become part of international working groups and committees. One of the milestones that the alumni have made is being able to show that diversity is not a hindrance but actually strength and advantage to reach a common goal by winning the Shell Ocean Discovery XPRIZE challenge in May 2019. Sixteen of the the training program alumni worked closely with technical advisors and leading industries to advance unmanned deep seafloor mapping and exploration. We did not want to create something that already exists but instead looked for the gaps where we could improve the technology and create what is missing – the unmanned surface vessel capable of launching and recovery of the AUV. It also provides positioning for the AUV and a communication link to the land operation station. In the end, there were 80 individuals from 22 countries who contributed to the success of the team.

Another activity supported by CCOM in 2019 has sent alumni onboard DSSV Pressure Drop to collect bathymetric, water column, and backscatter data, while the vessel is transiting to its next dive expedition location. I was able to make two transits, totaling to 35 days of mapping and data processing across the Indian Ocean and North Atlantic to Artic Ocean. In addition to the overwhelming feeling of being able to contribute by adding value to the transit through collecting and processing multibeam data while in place, I feel privileged to be able to be the person who can make people appreciate the seafloor and realize the importance of mapping it. We are now working on making online modules to teach any interested individual to clean bathymetric data and ensure quality control to help achieve the goals of Seabed2030 and at the same time add to their personal technical competencies.

_Alicia Wilson_

As a Knauss Fellow stationed with the U.S. National Wildlife Service and as an All Atlantic Ocean Youth Ambassador, I have had the privilege of great mentors. These experiences have convinced me that there is
a great need for opportunities like this. Graduate students need experiences beyond research. Fellowships, such as those offered by the Knauss program are invaluable. In addition to skill building, professional connections are made that can last a lifetime. The benefits of being involved in the Atlantic Ocean Research Alliance include the opportunity to collaborate with fellow early career professionals outside of the U.S. These are important bridges to be built, especially with the Decade approaching.

Audience Questions and Answers
- As young researchers do you feel you have been encouraged by your supervisors to become better communicators?
  - No, I have followed my own initiative.
  - Yes, my major professor really supports me, but I have had to look for the opportunities.
  - No, unless it was a blog for a funding agency.
  - No, unless it was presenting at a conference.

- What advice could you give us to make this workshop better and more inclusive in the future?
  - Offer a travel allowance, increase the workshop’s social media activity/presence.
  - Reach out to advisors at universities so that they can inform their students about the opportunity to participate.
  - Organize networking specifically for the young people.
  - Create a virtual hub where people can tune in if they are unable to travel.
  - Reach out to community colleges to increase diversity.

- How will you support the Decade?
  - I need to become aware of what it is all about and try to help.
  - The Summer Schools can help to promote the Decade, as well as World Oceans Day. There are many youth groups that could be connected for a larger impact.

I. Lightning Round II: Early Career Professional Presentations
Moderator: Tara Donaghy, Fisheries and Oceans Canada
Presenters:
Katie Geddes, National Oceanic and Atmospheric Administration
Tinah Martin, Lamont Doherty Earth Observatory
Willem De Moor, JPI Oceans
Chris Siverd, Moffatt & Nichol

Willem De Moor
JPI Oceans was established in 2011 as an intergovernmental platform, open to all EU Member States and Associated Countries who invest in marine and maritime research. It is a membership organization of science, industries, and funding agencies. JPI’s strategic research and innovation agenda includes the exploration of deep-sea resources, technology and sensor development, science support to coastal and maritime planning, climate change impact on physical and biological ocean processes, effects of ocean acidification on marine ecosystems, food security, and microplastics. JPI Oceans has eight staff members based in Brussels. Skills needed to conduct JPI Oceans’ education and outreach include communication and writing skills, the ability to analyze and synthesize, project management skills, and problem solving skills. In addition, staff members must be multi-lingual.

Tinah Martin
As an early career professional in Madagascar, which has over 5000 kilometers of coastline, I had the opportunity to learn more about marine protected areas through the Nippon Foundation/GEBCO training program through the Seabed 2030 program. The internship has helped me to learn about accessing bathymetric data, engaging communities in seafloor mapping, and connecting ocean science communities. I have also had exposure to communicating with different types of audiences. I will be bringing the mapping skills I have gained back to Madagascar.

Chris Siverd
As an early career professional, I have had the opportunity to work on two projects in New York City, one
on Coastal Storm Risk Management and a feasibility study for New York and New Jersey Harbor Areas (HATS). My company’s specialty is coastal engineering and long-term studies. I have been able to conduct research on a flood risk reduction system for New York City. It is rewarding to be able to work on problems that impact society.

**Katie Geddes**

As a program analyst with the NOAA Office of International Affairs, I have been able to be involved in planning for the Decade. My interests are centered on the human dimensions of marine management and taking science into an international forum. I am involved in an early career ocean professional task group. Our task group activities include:
- Identifying the key needs, interests, and potential contributions of member states contributions to the Decade, across all stakeholder groups and for all ocean outcomes under the Decade, including use of a survey to gather information;
- Encouraging and facilitating the engagement of member states in the Decade preparation phase, including through meeting participation;
- Incorporating contributions into the development of the Decade Implementation Plan by the Executive Planning Group; and
- Scoping potential engagement strategies for the Decade implementation phase (post-2020), including a network of networks.

**Audience Questions and Answers**

- **Have you made any connections here with some mid-to-late professionals that can impact your career forward?**
  - I would like to be an educator. So talking with educators here gives a different perspective. I have picked up some tips about how to communicate what I am doing to a non-expert. I would like to train future experts.
  - Our discussions have inspired me to consider more of the human dimension... what kind of message do we need to get out over these next ten years?
  - The ten-year time scale of the Decade provides enough time to conduct studies that incorporate communities. I want to encourage scientists to have conversations within communities.
  - I am thinking more about the term, literacy in light of ocean literacy. What is your perspective on how you think that term is perceived in the community? Is there another term that we should be thinking about?
  - One concern is the translation of the word literacy. We need a survey of how literacy translates in the five UNESCO languages. It does have an intuitive meaning.
  - Well, literacy has a wonky translation in Dutch. It refers to reading. This is similar in many languages. We need to start looking for better terminology. Perhaps use terms like ocean communication and engagement, or better yet use the word education. Practically every language has a word that means education.
  - 70% of people in Madagascar do not go to school for many reasons. The ocean is their school. I am inspired to bring more indigenous knowledge into science.

- **In how many networks are you involved?**
  - Only part of one because there is a time limit. Since I have a good job, I am not looking for a job. As an early career professional, time management is a big thing.

- **What are your career aspirations?**
  - I want to engage in education initiatives related to Seabed 2030.
  - There are very few only US citizens that are coastal engineers. Need to train Americans to be coastal engineers.
  - I see myself moving up within NOAA, into a management and supervising role. I have strong mentors and want to do what they do.
J. Open Space Session – Furthering the Goals of the Global Ocean Science Community
Following the format of traditional Open Space Sessions, delegates "self-organized" in discussion groups that focused on their topics of interest.

Youth Engagement During the Decade
There needs to be a process for engaging youth in this Decade. If we do not develop this process, we are missing an opportunity. There have been ongoing discussions at NOAA about how to do that. It is important that we start with how we can we incorporate that youth voice in some of the Decade planning that's going on now. Youth can potentially be engaged at the town halls that are happening at science conferences over the next year. We need to connect with the youth engagement networks that are already making an impact. We also need to be able to share our successes and strategies across nations.

There are a lot of opportunities to engage youth in terms of leveraging existing events. We came up with some operating principles or guidelines for moving forward. We don't need to reinvent the wheel. We just need to use infrastructure and opportunities that already exist. As the GOSE community continues to come together, we need to be thinking about who isn't at the table yet and be as inclusive as possible. We can focus on giving youth a voice, both in the planning and the implementation. We can engage youth, make them aware of the Decade and its activities but then step back and allow activities to be youth driven, with the appropriate support. It is important to deliver the message to youth that science informed decision making is imperative, while allowing them to develop their own calls to action.

Mobilizing Citizens
It is important to identify the calls to action on a citizen level. If bright, well-educated students, such as those who spoke yesterday, don't know that the Decade is on the horizon, then the majority of youth and citizens around the country don't know. For example, Canada had a decade for sustainable development (2005 to 2014). It came and went with less than nine percent of teachers across Canada knowing it even existed. It was a higher education, a government, and science driven initiative. However, it stayed in those communities. So how does something like the Decade become a social movement? What do we want in 2030, how will we know we succeeded, and what does that look like? What do we want citizens to know, feel, and do? These questions must be addressed. Then consistent, cohesive messages and branding need to be developed based on the answers to these questions.

We need to begin with getting citizens to think about the ocean, it as simple as that. The calls to action need to build on each other in a progressive fashion - year one’s call to action leading to a year two call to action, and year two’s call to action to year three’s and so on. So there would be quantifiable actions achieved by the end of ten years, such as X million people took action on/participated in a specific activity. This would allow us to describe the impacts. There is still a need to identify the calls to action, how to measure them, and how to move forward together globally.

Traditional Knowledge
As has been stated earlier, it is important to develop a framework and a set of guidelines for ensuring that traditional knowledge is integrated into the Decade. This would include a combination of indigenous knowledge and working waterfront knowledge. The creation of an advisory committee for the Decade that includes traditional knowledge partners would be beneficial. It would also be advantageous to hold a meeting with traditional knowledge representatives from around the world during the Decade to highlight their contributions to ocean science for sustainable development.

Building Bridges Between Science Education Professionals and Industry
There is high interest in developing and implementing a certificate system for schools, business, and industry professionals. Participating institutions and businesses, after completing a certain number of hours, could receive a “ocean literacy label” or certificate that shows that they have committed to educating their students and employees about the ocean. During the Decade, this certificate program could be offered by a coordinated group of trainers in several countries, tailoring the program to local issues and concerns.
Building a Network of Networks
This topic is very important, as it is a high need for the GOSE community. However, it is a very broad topic. What are the needs of a network of networks and what would be some of its goals and activities? Step one is to design the network, i.e. how it operates – its operating principles and terms of reference. If such a network is established, it must be useful for its members. Main goals for the coordinating hub of such a network would be:
• facilitation of partnerships,
• dissemination of important research being conducted during the decade, and
• sharing of best practices and resources across member networks.

With the Decade’s focus on the ocean, there are bound to be new educational materials being developed, such as those already being developed in the EU. These materials could be shared on the IOC’s Ocean Portal, which is about to be redesigned. The network could support the use of this portal. This group agreed to assist by providing feedback as the portal is redesigned. Another concrete step is that the group has agreed to collaborate on hosting two webinars during 2020 to share information about the decade as it emerges over the next year.

K. Large Group Discussion II: Reflection on the 2019 GOSE Workshop and Ideas for 2020
• This year’s GOSE workshop has focused on two groups that are already working together in support of the Decade – ocean observing and seabed mapping. These are two huge global ocean science programs with which ocean literacy should align. Every topic can’t be tackled at once. Perhaps it would be advantageous to spend the next year focused on these two areas.

• To align education and research efforts, we need to have the opportunity to meet and work together across sectors.

• The job of the GOSE community is to communicate in simple terms how scientists, educators, business and industry professionals, and policymakers can connect to the Decade. All sectors will need assistance to tap into the resources and opportunities as the Decade proceeds.

• What advice can the GOSE community provide to the Executive Planning Group on how to capitalize on existing frameworks? Scientists need help on how to engage we can provide guidance that way as well. The GOSE community network could be of great assistance with this.

• A couple of messages that we can share with our colleagues:
  - for the decade we would like to have a common dissemination vehicle that we all can use;
  - we need to continue the discussion of network building and collaboration;
  - if we have a mechanism for sharing resources, such as the redesigned Ocean Portal, it won’t need to just focus on ocean observing or seabed mapping, the infrastructure will accommodate all the themes.

• In addition to webinars about the Decade, we should consider a webinar to provide feedback on the Ocean Portal and communication strategies.

L. Plenary VII: Importance of Ocean Science Education in Support of the UN Decade of Ocean Science for Sustainable Development
Margaret Leinen, Scripps Institution of Oceanography and Executive Planning Group UN Decade

The Decade’s Executive Planning Group (EPG) is meeting to work with the IOC on the development of the science plan for the Decade. An initial document with several ideas was drafted. The goals of the Decade evolved from this document. The first global planning meeting for the Decade included people from the private sector, advocacy organization, and the science community. The participants elaborated on what it
means to have a safe, transparent ocean and what the Decade would do to achieve that.

Regional meetings are also being conducted so that there are opportunities for people to comment on the draft of the science plan. This is absolutely a work in process. Even after we develop the plan, it will go back out to all the communities, including the GOSE community, for comment. We know that there is a huge challenge in trying to make people aware of the Decade, inform them about the ocean. We are still in the process of deciding exactly how the Decade will develop its ideas for that. That is why this group is so important. It will inform IOC and those working on the Decade on what you think are priorities and best practices, not just to inform people about the Decade, but to inform people to “think ocean.”

A communications firm has been hired for the Decade. I will be looking to see if they are focusing that communication about “the Decade” or about the “ocean” and its role in sustainability. The engagement of youth is on the agenda for the Decade. Determining effective ways to engage youth can be a challenge. You can help us with this. The conversation has revolved around putting early career scientists on the Executive Planning Group, but how do we focus on engaging youth as well as engaging early career scientists? We also need help to understand how to get past a credibility issue with youth and citizens in general and how to engage in a way that says we are listening.

I. Final Reflection

We need to move beyond ocean literacy to “thinking ocean” and ocean awareness. This is a more inclusive way of thinking. The GOSE community has an important opportunity to influence thinking about global ocean education, literacy, and awareness during the Decade. As planning continues through 2020, the community can provide recommendations to the EPG about increasing ocean awareness. If we are going to establish a network of networks or an alliance around the Decade, we need to think about this as being a big effort to promote that ocean science.

The structure of the GOSE Workshop is unique. It involves scientists and educators with industry and policymakers included in the conversation. Continued connections need to be established between the sectors. Engagement is critical to raise awareness. With a cohesive communication strategy, we can create a “generation ocean.” This is not just about the Decade, but about the ocean. Major Decade-related topics can be used as hooks, while connections are made to what people can relate. An alliance for the Decade can be the way through which we can disseminate the information. We must keep working together, communicating together, and broadening our reach.
APPENDIX A: 2019 GOSE Workshop Agenda

WEDNESDAY, November 13, 2019

9:00 Welcome and Introductions
   Gail Scowcroft, Graduate School of Oceanography, University of Rhode Island
   Peter Tuddenham, College of Exploration
   Ivan Conesa-Alcolea, European Commission

9:15 Workshop Goals and Overview
   Gail Scowcroft and Peter Tuddenham

9:30 Plenary I: Overview of UN Decade of Ocean Science for Sustainable Development
   Craig McLean, National Oceanic and Atmospheric Administration and Executive Planning Group, UN Decade

10:00 Plenary II: Ocean Literacy for the Decade
   Francesca Santoro, Intergovernmental Oceanographic Commission

10:20 Coffee Break

Why Do We Need Ocean Observation?

10:40 Panel I: Importance of Ocean Observing for Society and Related Education Activities
   Moderator: Ana Noronha, Ciencia Viva
   Panelists:
   Dina Eparkhina, European Global Ocean Observing System
   Frank Mueller-Karger, University of South Florida
   Kaitlin Noyes, Bermuda Institute of Ocean Sciences

   Joaquín Tintoré Subirana, Balearic Islands Coastal Observing System

11:40 Breakout Group I: Integrating Ocean Observation into Ocean Education/Ocean Literacy Initiatives
   Example Discussion Topics:
   A. Using ocean observing data in programs for museum and aquarium audiences during the Decade
   B. Using ocean observing data in K-12 science
   C. Using ocean observing data in social science and humanities
   D. Currently available ocean observation resources and materials
   E. Using the media and social media to highlight ocean observation initiatives

12:20 Breakout Group I Reports

12:40 Lunch

Why Do We Need Seabed Mapping?

13:20 Panel II: Importance of Seabed Mapping for Society and Related Education Activities
   Moderator: Paula Keener, Global Ocean Visions
   Panelists:
Gordon Johnston, International Federation of Surveyors and AORA
Tommy Furey, Marine Institute, Ireland
Laura Brothers, U.S. Geological Survey
Nicola Bridge, National Marine Aquarium (UK) and European Marine Science Educators Association
Robert Pani Pilla, Friends of Marine Life

14:10 Plenary IV: Seabed 2030 Report
Vicki Ferrini, Lamont-Doherty Earth Observatory and Seabed 2030 Project

14:30 Breakout Group II: Integrating Seabed Mapping into Ocean Education/Ocean Literacy Initiatives
Example Discussion Topics:
A. Using seabed mapping and bathymetry products in programs for museum and aquarium audiences during the Decade
B. Using seabed mapping and bathymetry products in K-12 science
C. Using seabed mapping and bathymetry products in social science and humanities
D. Currently available seabed mapping resources and materials
E. Using the media and social media to highlight Seabed 2030 and other mapping initiatives

15:10 Breakout Group II Reports

15:25 Coffee Break

15:45 Plenary VI: Strategies for the Engagement of Business and Industry
Michael Jones, TMA BlueTech™

16:10 Working groups on seabed mapping and ocean observing meet to discuss breakout group actions and formalize plans for implementation during the Decade

16:50 Working Group Reports

17:10 Lightning Round I: Student Presentations
Moderator: Nicola Bridge, National Marine Aquarium and EMSEA
Presenters:
Emiliano Gonzalez Santin, Ulster University
Maria Pontiki, University of Delaware
Bianca Prohaska, Florida State University and AORA U.S. Ambassador
Jaya Roperez, Center for Coastal and Ocean Mapping
Alicia Wilson, University of Georgia and AORA U.S. Ambassador

17:45 Short Film
Ana Noronha, Ciencia Viva

18:00 Adjourn, buses leave for dinner venue 18:15 Group Dinner

THURSDAY, November 14, 2019
9:00 Welcome and Review
Ocean Literacy and Ocean Science Education in Support of the Blue Economy

9:15 Plenary V: Ocean Literacy, Knowledge Transfer, and Career Development for a Sustainable Blue Economy
   Mary Kavanagh, Minister-Counselor, Research and Innovation, Delegation of the European Union to the U.S.

9:40 Panel III: Blue Economy, Emerging Marine-Related Technologies, and Education Needs
   Moderator: Peter Tuddenham, College of Exploration
   Presenters:
   Diz Glithero, University of Ottawa and Canadian Ocean Literacy Coalition
   Kelley Brumley, Fugro
   Thomas Chase, American Society of Civil Engineers and Steve Balint, Balint Consulting
   Steven Ross, University of North Carolina Wilmington and the ATLAS Project
   Zacharias Siokouros, Maritime Institute of Eastern Mediterranean

10:30 Coffee Break

10:50 Breakout Group III: Strategies to Educate the Marine-related Workforce; A Certificate Program for Business and Industry
   Example Discussion Topics:
   A. Using national and international networks to engage the blue economy business community during the Decade
   B. How can business and industry support ocean science education during the Decade?
   C. How can the ocean science education community support the blue economy?
   D. What kinds of ocean science education opportunities do businesses need?

11:35 Breakout Group III Reports

11:50 Large Group Discussion I: Development of Education Opportunities for the Existing Marine-Related Workforce

12:15 Lunch

13:15 Breakout Group IV: Regional Groups Develop Outreach Plans for Implementing Education Opportunities for Business and Industry in Their Regions During the Decade (or breakout by topic area)

14:15 Breakout Group IV Reports

14:30 Lightning Round II: Early Career Professional Presentations
   Moderator: Tara Donaghy, Fisheries and Oceans Canada
   Presenters:
   Katie Geddes, NOAA
   Tinah Martin, Lamont Doherty Earth Observatory
   Willem De Moor, JPI Oceans
   Chris Sivert, Moffatt & Nichol

15:00 Coffee Break
15:20  Breakout Group V: Regional Groups Develop Collaborative Activities for the Decade continued (groups can also breakout by ocean science themes)

15:50  Breakout Group V Report Out

16:20  Introduction to Open Space Session
       Peter Tuddenham

16:35  Short Film
       Thomas Chase, American Society of Civil Engineers

16:50  Adjourn

FRIDAY, November 15, 2019

9:00  Welcome and Review

9:15  Open Space Session – Furthering the Goals of the Global Ocean Science Community
      (Groups identify topics of interest for discussion)

10:15  Coffee Break

10:35  Open Space Continues

11:10  Open Space Group Reports

11:25  Large Group Discussion – Reflection on 2019 GOSE Workshop and Ideas for 2020

11:40  Plenary VII: Importance of Ocean Science Education in Support of the UN Decade of Ocean Science for Sustainable Development
      Margaret Leinen, Scripps Institution of Oceanography and Executive Planning Group
      UN Decade

12:05  Box Lunch for Travelers
APPENDIX B: List of Delegates

<table>
<thead>
<tr>
<th>Delegate</th>
<th>Institution/Organization</th>
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<tr>
<td>Armstrong, Andrew</td>
<td>National Oceanic and Atmospheric Administration/University of New Hampshire Joint Hydrographic Center</td>
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<td>Babb, Ivar</td>
<td>University of Connecticut</td>
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<td>Bamy, Idrissa Lamine</td>
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<td>Bishop, Tina</td>
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<td>Bridge, Nicola</td>
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<td>Chen, Bob</td>
<td>University of Massachusetts Boston</td>
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<td>Conesa-Alcolea, Ivan</td>
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<td>Ferrini, Vicki</td>
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<td>University of Rhode Island Inner Space Center</td>
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<td>Glithero, Lisa (Diz)</td>
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Roperez, Jaya
Center for Coastal and Ocean Mapping, University of New Hampshire

Ross, Steve
University of North Carolina Wilmington and the ATLAS Project

Ryan, Melissa
Global Foundation for Ocean Exploration

Santoro, Francesca
Intergovernmental Oceanographic Commission

Schaefer, Terry
National Oceanic and Atmospheric Administration

Schoedinger, Sarah
National Oceanic and Atmospheric Administration

Scowcroft, Gail
University of Rhode Island Graduate School of Oceanography and Consortium for Ocean Science Exploration and Engagement

Siokouros, Zacharias
Maritime Institute of Eastern Mediterranean

Sivert, Chris
Moffatt & Nichol

Skrabal, Stephen
University of North Carolina Wilmington

Smith, William
Organizing For Development

Snowden, Jessica
National Oceanic and Atmospheric Administration

Stefany, Betsy
The SABENS Group

Strauss, Rochelle
Gesner and Associates Environmental Learning

Tintoré, Joaquín
SOCIB and IMEDEA (CSIC-UIB)

Tuddenham, Peter
College of Exploration

Valauri-Orton, Alexis
The Ocean Foundation

Wilson, Alicia
U.S. Fish and Wildlife Service

Yarincik, Kristen
Consortium for Ocean Leadership