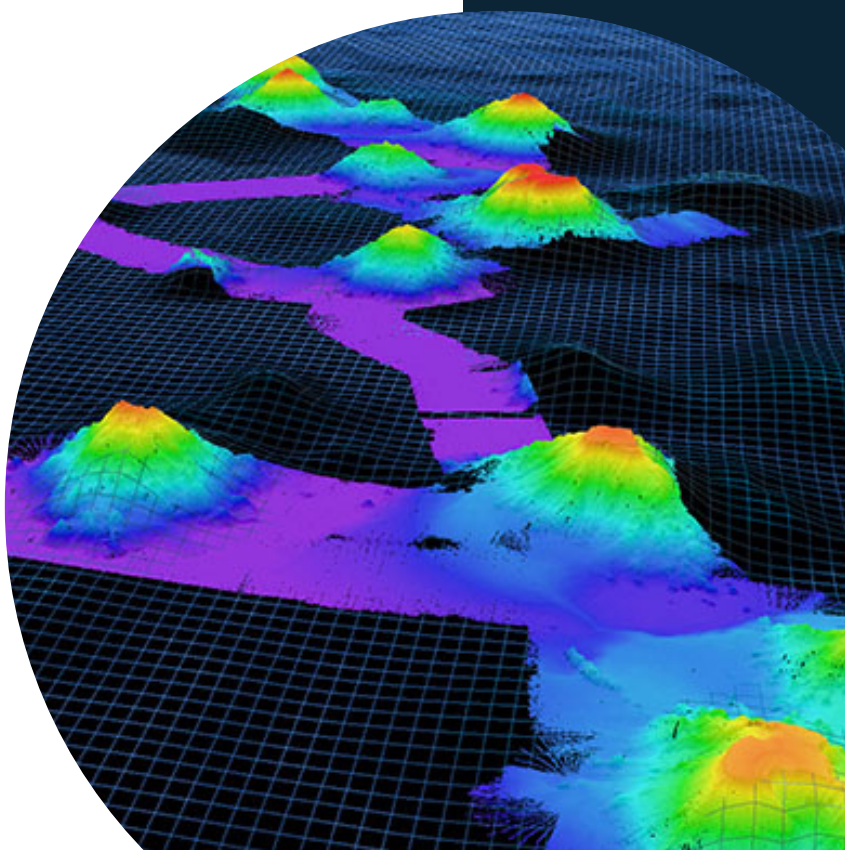
THE INAUGURAL AUS-US WORKSHOP ON OCEAN EXPLORATION AND MAPPING: FULL REPORT

7-8 DECEMBER 2021 - VIRTUAL (AEDT)



Australian Government
Geoscience Australia

CSIRO

NOAA

Report Contents

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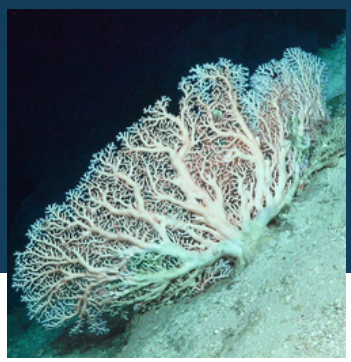
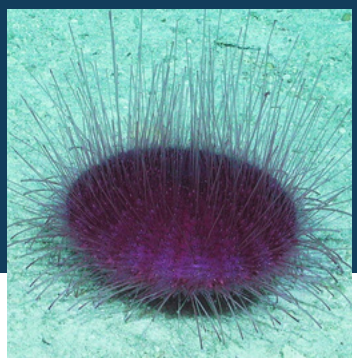
OUR OCEANS

EXPLORING EARTH'S LAST FRONTIER


The U.S. and Australia have a long and proud history of collaboration, and we will continue to build on that with our new ocean exploration and mapping partnership. Together we will open the new frontier of Ocean Science and Mapping, bringing the Blue Economy closer for our two countries and for our friends in the Pacific.

During this Inaugural AUS-U.S. workshop on Ocean Exploration and Mapping, held December 7- 8, 2021 virtually, our nation's experts explored synergies to advance domestic and international interests in ocean science and knowledge. Focused on using our nation's respective strengths and assets, they highlighted several areas and goals for initial collaboration, including:

1. Capability and Capacity Building: through personnel exchange and professional development
2. Standardized Community of Practice: sharing data and information to address global and domestic challenges;
3. Sensor and System Advancements: sharing in technology development to accelerate rather than reinventing and to encourage leaps of innovation;
4. Advancing United Nations Decade of Ocean Science for Sustainable Development: leveraging the global community to address issues that affect us all and our oceans.

While the organizing committee is formalizing the collaboration with a Memorandum of Understanding between initial partners, Geoscience Australia, the Commonwealth Scientific and Industrial Research Organisation, and the National Oceanographic and Atmospheric Administration, working groups will be organized to develop plans for these areas of common interest.

As we build up our collaboration and collective knowledge, we will look for ways to incorporate traditional knowledge and communities of practice. Importantly, we will share the experience with Pacific nations and regional communities and seek involvement to ensure maximum benefits for all. This collaboration is just the beginning and will be instrumental in addressing global issues, and unifying Pacific interests in the deep ocean.

OBJECTIVES AND BACKGROUND OF THE WORKSHOP

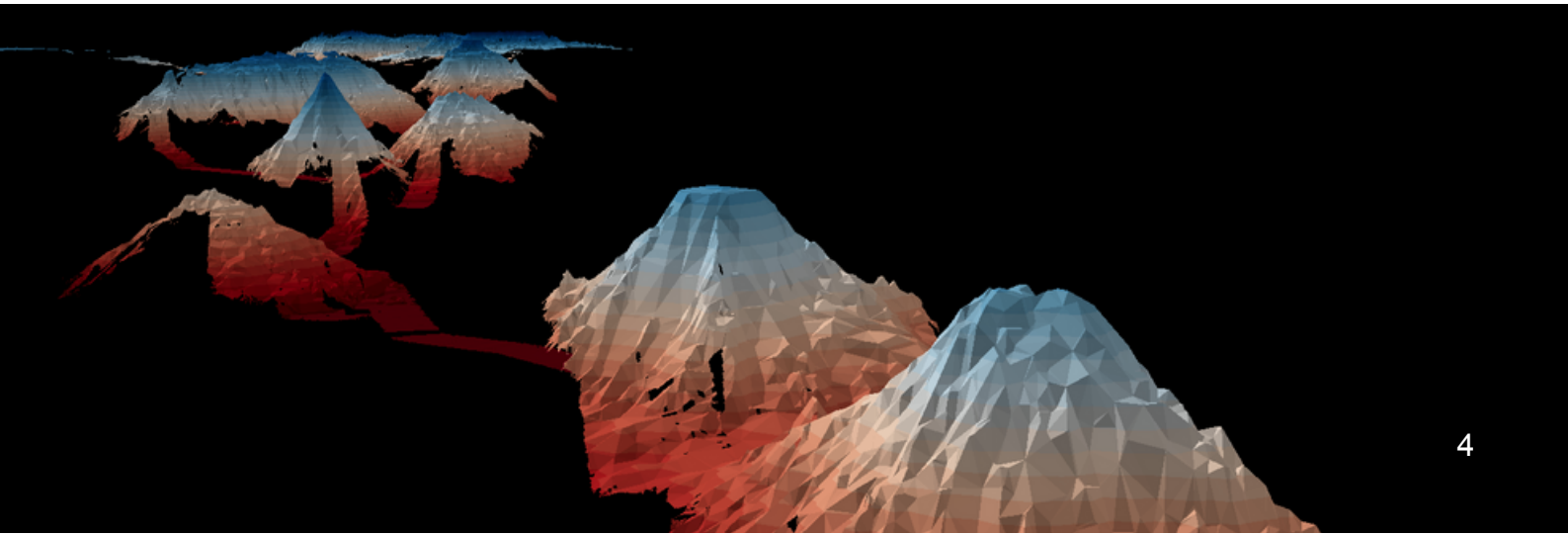
In August 2020, Australia and the United States of America (U.S.) held a Joint Commission Meeting (JCM) for Science and Technology Cooperation. This meeting included a session on Ocean Mapping driven by the countries' mutual interests in advancing ocean mapping and exploration, which is key to realizing the full potential of the blue economy.

Session participants included representatives from Geoscience Australia (GA), the Marine National Facility of the Commonwealth Scientific and Industrial Research Organisation (CSIRO), and the National Oceanic & Atmospheric Administration (NOAA). During this session, it was agreed that a new implementing arrangement would be mutually beneficial to help explore shared opportunities to advance ocean mapping and exploration.

Following the JCM, a working group with representatives from NOAA, GA, CSIRO, and the Australian Hydrographic Office (AHO) drafted a Memorandum of Understanding (MOU) highlighting seven principles for cooperation:

- Exchange information regarding current capacities and capabilities for mapping, exploring, and characterizing the ocean;
- Exchange information regarding ocean mapping, exploration, and characterization priorities and plans;
- Encourage the adoption of common mapping, exploration, and characterization definitions and standards;
- Identify technological gaps for mapping, exploring, and characterizing the ocean;
- Foster mobility, information exchange, and networking among staff and researchers;
- Explore the possibility of joint capacity and capability-building efforts in geographic areas of common interest that would advance the UN Decade for Ocean Science and other global initiatives, with an emphasis on low and low-middle income countries; and
- Explore the possibility of jointly planned and executed ocean mapping, exploration, and characterization expeditions and campaigns.

This workshop is the first in a series of workshops with the aim of better understanding each nation's drivers and priorities for ocean mapping and exploration as well as identifying and creating opportunities for collaboration between Australia and U.S. organizations involved in ocean mapping and exploration issues. This workshop was also designed to raise awareness within the AUS and U.S. governments of this collaboration being developed. At the end of this workshop, the attendees were able to identify a number of impactful opportunities to collaborate with a way forward.



LEADERSHIP OPENING REMARKS

ALISON ROSE: CHIEF OF SPACE DIVISION (FORMERLY PLACE, SPACE AND COMMUNITIES DIVISION) AT GEOSCIENCE AUSTRALIA

Alison Rose opened the workshop with a brief insight on key enablers of the Blue Economy as well as Australia's advancement in Ocean Science and mapping. She reviewed the long history of collaboration between Australia and the U.S. that sets the stage for a new partnership in ocean mapping and exploration. Alison highlighted the mutual interests in advancing ocean mapping and exploration demonstrated at the ocean mapping session during the 2020 Joint Committee Meeting (JCM) between Australia and the US, and shared the goal to realize the full potential of both countries' Blue Economies. She highlighted several important global drivers for pursuing a partnership in ocean mapping and exploration such as the United Nations Decade of Ocean Science for Sustainable Development (Ocean Decade), which aims to reverse the cycle of decline in ocean health and create improved conditions for sustainable development of the Ocean. Australia is also engaged in the High-Level Panel for Sustainable Ocean Economy (known in short as the Ocean Panel), which the U.S. signed onto at the recent COP26 meeting, joining 14 other Nations to deliver solutions to transition to a sustainable ocean economy. Alison called attention to Australia's firm commitments from the highest level of government to this important initiative, signaled by the Australian Prime Minister sitting on this Ocean Panel. In addition to the Ocean Decade and Panel, both Australia and the U.S. are major contributors to the Nippon Foundation - GEBCO Seabed 2030 project, a global initiative aimed at having 100% of the ocean floor mapped by 2030.

Alison drove home the concept that ocean exploration and seabed mapping are key to realizing the potential of the Blue Economy of both nations. Ocean mapping provides essential information on the location of seabed features and informs the planning and management of a variety of activities in the marine environment. Mapping is essential for safe maritime navigation; planning of infrastructure; assessment of offshore energy resources; fisheries management; biodiversity assessments; monitoring of ecosystem health; hazard modeling; marine sovereignty; and search and rescue.

She gave a brief overview of the Australian Blue Economy, which is forecasted to reach $100b per annum by 2025. Seabed mapping and seabed data are key contributors to the value of Australia's Blue Economy with a recent independent study finding that in 2018-19 seabed data directly contributed $9 billion in that year to the Australian economy and employed over 56,000 people. Moreover, economic modeling suggests that in 2018-19 $37 billion of economic activity was attributable to the use of seabed data during the start-up phases of several marine industries. Alison highlighted that by leveraging this potential, Australia is investing in building our capability in ocean science research. Led by the National Marine Science Committee, the marine science community is committed to an agenda of collaboration and coordination in delivering applied science to support the growth of the Blue Economy.

LEADERSHIP OPENING REMARKS

CRAIG MCLEAN: ASSISTANT ADMINISTRATOR AT NOAA'S OFFICE OF OCEANIC AND ATMOSPHERIC RESEARCH, NOAA

Craig McLean expanded on the U.S. initiatives and progress regarding the U.S. ocean systems. His remarks began with a moment of remembrance for the 80th anniversary of the Attack on Pearl Harbor which occurred on December 7th, 1941. He reflected on the way Australia and the U.S. came together to be victorious in World War II following that tragedy and how the same concerted effort was needed to address the issues facing the global oceans today. He went on to highlight the U.S.' longstanding support and major role in creating and sustaining the All-Atlantic oceans agreement between the Americas to increase data sharing and science. He also stressed the importance of an All-Pacific agreement to involve more countries in the Pacific that will create unified ocean data sharing. This is an important factor that will need to come to play in order to completely understand our relationship with the oceans.

Craig made a key point that Dr. Rick Spinrad, the previous chief scientist at NOAA and current Administrator at NOAA, originally initiated the U.S. talks on the Blue Economy and its importance.

Echoing Alison's remarks, he believes that mapping will be the key to bolstering the blue economies in both the U.S. and Australia. He noted that while there is currently no money included with the Ocean Decade, both countries must plan robust activities that will convince legislators to provide the resources to accomplish these objectives.

INTERNATIONAL CONTEXT

This session focused on providing an overview of relevant global initiatives, the global drivers for mapping and exploring the ocean, in particular the areas beyond the shelf edge ('deep' ocean), and the areas of cooperation that this collaboration is targeting. Global initiatives, such as the Ocean Decade and Seabed 2030, will provide opportunities for this collaboration to contribute to and leverage.

KAREN EVANS: TEAM LEADER AND PRINCIPAL RESEARCH SCIENTIST CSIRO OCEANS AND ATMOSPHERE AND FORMER MEMBER OF THE EXECUTIVE PLANNING GROUP AND INTERIM DECADE ADVISORY BOARD FOR THE OCEAN DECADE

Karen provided a deeper dive into the Ocean Decade. Global risks are increasingly due to environmental cases and these are showing significant challenges in achieving our sustainability goals. Major deficits are apparent because of a lack of efforts and education globally; so much so that none of the targets have yet to be met. An Implementation Plan Summary is the main framework for actioning ocean science and developing scientific knowledge that must be put into play in order to achieve our goals. This type of framework for action is important because it can be used across all platforms and create something greater in collaboration to deliver a sustainable future while encouraging innovations, co-creating, and co-designing.

She highlighted some of the great achievements of this first year of the Ocean Decade that can be reflected and built upon. Twenty-four National Decade committees have been founded, four collaborative research centers focusing on ocean science, 31 programs, 83 projects, and 38 global contributions all dedicated to ocean science, collaboration, and exploration. There will be a second call for programs and projects in January 2022.

KEVIN MACKAY, HEAD OF THE SOUTH AND WEST PACIFIC DATA CENTER FOR THE NIPPON FOUNDATION-SEABED 2030 PROJECT, AT NZ NATIONAL INSTITUTE OF WATER AND ATMOSPHERIC RESEARCH

Kevin presented on the Seabed 2030 project. Seabed 2030 is a collaborative project between The Nippon Foundation and GEBCO created to aspire and inspire to map the whole ocean floor by 2030, and compile all bathymetric data into a freely-available GEBCO Ocean Floor Map. For operation purposes, the project divides the Ocean into each area, each led by a different data center: North Pacific-Arctic Ocean, Southern Ocean, Atlantic-Indian Ocean, and South-West Pacific Ocean. The United States is tied to the North Pacific-Arctic Ocean network and Atlantic-Indian Ocean centers, while Australia is linked to the South-West Pacific, the Atlantic-Indian Ocean and the Southern Ocean.

Phase 1 of the project included finding out what parts of the ocean are already mapped. In 2021, this represented 21.6%, which is over a 15% increase from when the project was launched in 2018. The second phase of this project is mapping the gaps. With these gaps identified, the project leads are creating a plan for future mapping expeditions, which include identifying funding opportunities. It was highlighted that citizen-science can be leveraged to achieve the goals of the project. This is known as crowd-sourced bathymetry (CSB), where the collection of depth measurements from vessels, using standard navigation instruments, is undertaken while engaged in routine maritime operations. This approach is critical to achieving the project goal and must be promoted globally. Opportunities to support ocean mapping include funding mappers for ocean frontier mapping, collaborating with vessels, funding extra vessel days, CSB, and accelerating uptake of technology to accelerate the rate of bathymetric mapping.

INTERNATIONAL CONTEXT

MARK ALCOCK, SENIOR ADVISOR OF GEOREGULATION AND LAW OF THE SEA AT GEOSCIENCE AUSTRALIA

Mark spoke on the geopolitical drivers in Southwest Pacific and how new survey information was needed to address them and the challenges these States find in accessing survey capacity. The Southwest Pacific is home to some of the smallest States by population and land area with responsibility for some of the World's largest maritime jurisdictions. They are disproportionately vulnerable to the effects of climate change. They are challenged in their capacity to manage their jurisdictions by limitations in human and financial capacity. Without access to survey assets and scientific capacity building, these States will be disadvantaged in their capacity to make informed decisions about their futures and secure their rights over their continental shelf rights.

He noted that there are only two vessels managed by countries supporting the collection and sharing of data in the region and that these regional issues do not form part of the prioritization for ship time for either vessel. He highlighted that in solving the region's issues, it was necessary to support and empower the regional organizations established to empower the region, and not to compete or supplant them.

Lastly, he mentioned that seabed mining domestically and internationally will be highly important to monitor to ensure impacts are minimized. Understanding the resources, environmental baseline and monitoring, as well as providing freedom of access to this information so all can benefit from it are critical in supporting the sustainable administration of the ocean.

DAVID LEGLER, DIRECTOR OF NOAA GLOBAL OCEAN MONITORING AND OBSERVING PROGRAM

David gave insight on climate and the deep ocean. David's presentation began with an illustration of the phenomenon of global energy imbalance (around 0.5 W/m2), which cannot be accounted for in regards to global warming. This could be a phenomenon where the deep ocean takes in excess energy (a carbon sink), which in turn is causing the deep ocean to warm. The variability regarding deep ocean warming is still under research, but findings are unveiling the current vulnerability of ocean systems and in turn, may show what outcomes could come about.

Along with this imbalance, there is a range of processes in the deep ocean that we don't quite understand yet. These include ocean bottom processes such as turbulence parameters that govern mixing and deep ocean circulation like temperature. Unknown climate models and ocean processes are currently not being taken into account. He reinforced the importance of observing the deep ocean so we can better understand the rapid cycling and trend of ocean dissolving inorganic carbon.

Ocean methane is another key concept to be explored. The global ocean is responsible for 1-10% of the world's natural greenhouse gas emissions. Recent studies suggest major methane contributions closer to the coasts. Mapping can provide much-needed data and insight on ocean methane emissions in both coastal regions and the deep ocean through the repeated collection of volatile organic compounds (VOCs) & particulate organic carbon (POC) measurements and identifying climate-relevant processes as well as changes.

WHY MAP AND EXPLORE THE DEEP OCEAN?

GENENE FISHER (LEFT), ACTING DIRECTOR OF NOAA'S OFFICE OF OCEAN EXPLORATION AND RESEARCH, AND KIM PICARD (RIGHT), CHAIR OF AUSSEABED STEERING COMMITTEE AND ACTING DIRECTOR OF THE NATIONAL SEABED MAPPING SECTION AT GEOSCIENCE AUSTRALIA

Genene and Kim outlined the need for mapping and exploring the deep ocean as well as AUS-US ocean collaboration efforts. The majority of our planet (70%) is covered by the ocean and holds our biggest knowledge gap. For example, only 20% of our ocean floor is mapped, which is staggering considering how fundamental this information is to the management of our ocean, the development of infrastructure, and the safety of our communities, etc.

For these reasons, Australia and USA are establishing this collaboration, which will focus primarily on the "deep" ocean (beyond >200 m) as it complements other long-established coordination and collaboration efforts already in place for shallow and nearshore environments. The outcomes will however benefit all through its focus on capability development (e.g. staff, infrastructure, technologies, and methodologies exchanges, platform coordination, and innovations).

Further exploration is needed in areas with no (or low-quality) bathymetric data, information on the diversity and distribution of benthic habitats and resources, deep ocean biogeographic patterns and their connectivity, and where it supports priority science and management needs. Ocean exploration and mapping will also directly support a multitude of other global investments and initiatives such as informing traditional and renewable energy setting, evaluating the availability of critical mineral resources, discovering new species with biopharmaceutical/ biotechnology potential, assessing marine habitats and populations, driving innovation of novel technologies, and inspiring and educating the next generation of STEM professionals.

In Australia, there are multiple organizations, including government departments involved in one way or another in exploring and characterizing our ocean. Since 1998, these organizations formed the National Marine Science Committee which, in 2015, launched a decadal National Marine Science Plan. The Plan provides a set of recommendations aimed to strongly position Australia in tackling the development and sustainability challenges faced by our nation and to ensure we reach our Blue Economy potential. Collaborations like the Australia-USA one discussed here are projected to maximize return on investment for both maritime nations, leveraging opportunities for this mission, and improving the efficiency of at sea and onshore operations.

While CSIRO and NOAA already have a Memorandum of Understanding (MOU) to further scientific cooperation and research, this new MOU between CSIRO, Geoscience Australia, and NOAA will broaden the capabilities available to conduct ocean exploration and mapping research by narrowing the focus and including Geoscience Australia. There are seven areas of cooperation in this MOU.

The MOU is in its final draft, but we [the organizing committee] certainly welcome comments on the areas presented here. They are meant to be broad and permissive so that we can develop more detailed initiatives under their umbrella.

US NATIONAL DRIVERS FOR UNDERSTANDING THE DEEP OCEAN

This session focused on the U.S. national drivers and priority/interest areas for mapping and exploring the 'deep' ocean within the U.S. areas of responsibility, but also internationally (partnership with other nations' jurisdiction and international waters).

AMANDA NETBURN, ASSISTANT DIRECTOR FOR OCEAN SCIENCE AND TECHNOLOGY, OFFICE OF SCIENCE & TECHNOLOGY POLICY

Amanda gave an overview of the U.S. Strategy to map, explore, and characterize the U.S. Exclusive Economic Zone (EEZ) by 2040. As of January 2021, 53% of the U.S. coastal, ocean, and Great Lake waters remain unmapped. There are 5 goals of the National Strategy for Ocean Mapping, Exploration, and Characterization (NOMEC): 1. Coordinate interagency efforts and resources to map, explore, and characterize the U.S EEZ, 2. Map the U.S. EEZ, 3. Explore and characterize priority areas of the U.S EEZ, 4. Develop and mature new and emerging science and technologies to map, explore, and characterize the U.S. EEZ, and 5. Build public and private partnerships to map, explore, and characterize the U.S. EEZ.

Ocean mapping provides comprehensive data and information needed to understand seafloor characteristics, such as depth, bottom type, sediment composition and distribution, and underlying geologic structure. Ocean exploration provides an initial multi-disciplinary (physical, chemical and biological) assessment at an unknown or poorly understood area of the seafloor, sub-bottom, and/or water column. Ocean characterization provides comprehensive data and interpretations for a specific area of interest of the seafloor, sub-bottom, and/or water column, in direct support of specific research, resource management, policy-making, or applied mission objectives.

Highlights of current American regional campaigns include the Florida Coastal Mapping Program, Seascape Alaska, ASPIRE Expeditions, EXPRESS, and the Blake Plateau expeditions. Focused expeditions over the past several years by NOAA Ocean Exploration and partners on the Blake Plateau region off the southeastern U.S. coast have led to the discovery and documentation of the most extensive continuous cold-water coral mound reef ecosystem in the world. Future planned expeditions to the Blake Plateau by NOAA Ocean Exploration and partners from the U.S. Geological Survey and the Bureau of Ocean Energy Management aim to complete the mapping of the deep water portions and identify future remotely operated vehicle dive sites.

RACHEL MEDLEY, CHIEF OF THE EXPEDITIONS AND EXPLORATION DIVISION WITH NOAA OFFICE OF OCEAN EXPLORATION AND RESEARCH (OER)

Rachel discussed NOAA's extensive ocean exploration partnerships abroad. NOAA Ocean Exploration is the only U.S. federal program dedicated solely to ocean exploration, and uses the NOAA Ship Okeanos Explorer as a primary mechanism for these national and international ocean exploration efforts. NOAA prioritizes expeditions based on partners' priorities and multi-stakeholders needs, and uses a variety of tools and mechanisms to explore. NOAA works closely with the science and resource management community to assess data gaps and determine where exploration data is most needed. NOAA then conducts expeditions, partnership projects, and grants opportunities to address those exploration priorities. NOAA OER is committed to sharing discoveries with all, including the public, through the OER website, social media channels, and live or near real-time video feeds. It is also critical for NOAA that all data collected be documented in full in an open-source format that is archived and released publicly in a timely manner.

A major highlight of NOAA's international partnerships is the Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE) program, a multi-year multi-national collaborative field campaign in the North Atlantic providing publicly accessible baseline data to increase understanding of the North Atlantic Ocean. The effort is also providing critical information relevant to emerging blue economy sectors, including sustainable fisheries, offshore energy, coastal and offshore hazards, and others. This effort is coordinated by NOAA, but is closely linked to domestic and international partners and projects, and is endorsed by the Galway Statement on the Atlantic Ocean Cooperation implementation committee.

JOHN NYBERG, DEPUTY NATIONAL HYDROGRAPHER IN NOAA OFFICE OF COAST SURVEY

John discussed NOAA's National Ocean Services international engagements. The U.S and Australia are already two nations strongly involved collaboratively in ocean exploration. A large percentage of U.S. international partnerships originate from the International Hydrographic Organization (IHO). The IHO is responsible for coordinating nautical charting around the world and hydrographic standards. IHO is made out of a technical and a regionally-focused body. The Hydrographic Services and Standards Committee is focused on the S100 data model and how to implement these standards over the coming years. The regional coordination is focused on capacity building, product ownership and principles, and the General Bathymetric Chart of the Oceans (GEBCO) reporting. Under the Inter-Regional Coordination Committee (IRCC) are regional hydrographic commissions where NOAA is involved in four: U.S./Canada Hydrographic Commission (USCHC), Meso-American and Caribbean Sea Hydrographic Commission (MACHC), Arctic Regional Hydrographic Commission (ARHC), and South-West Pacific Hydrographic Commission (SWPHC), of which Australia is also a member. The International Center for Electronic Navigational Charts is managed by the United Kingdom Hydrographic office. This is a body containing 47 members that coordinates the distribution of electronic charts, and organizes quality control and capacity building. NOAA manages a regional International Centre for Electronic Navigational Charts (IC-ENC) Quality Control Arm with two vice-chairs, including one Australian expert.

The United Nations Committee on Global Geospatial Information Management (UN-GGIM) runs an initiative aiming to develop an information framework to strengthen geospatial information management, which serves as a resource to provide information to governments efficiently. NOAA and other maritime organizations are in the process of developing an operational framework for Integrated Marine Geospatial Information Management (IGIF-H) to be used as a supplement. The goal is to coordinate geospatial marine information around the world to ensure trackable progress on the sustainable development goals, as well as offer guidance on developing programs.

Some long-standing agreements held between the U.S. and other nations include the U.S./Korea joint project agreement on satellite-derived bathymetry, advancing chart production techniques, advancing standards, and building S100 converters, and the U.S./Japan agreement since 1964 focused on ocean mapping and exploration capabilities.

AUSTRALIAN NATIONAL DRIVERS FOR UNDERSTANDING THE DEEP OCEAN

This session focused on Australia's national drivers and priority/interest areas for mapping and exploring the 'deep' ocean within Australia's areas of responsibility, but also internationally (partnership with other nations' jurisdiction and international waters).

MICHAEL CLARKE, ASSISTANT DIRECTOR FOR NATIONAL HYDROGRAPHIC STRATEGIES OF THE AUSTRALIAN HYDROGRAPHIC OFFICE (AHO)

Michael provided an overview of the AHO and the potential areas of collaboration. The AHO, focused on all aspects of hydrographic charting, is becoming a data-centric organization, influencing the way collection, use, and dissemination of data takes place. The AHO also endeavors to grow the hydrographic industry and capabilities regionally to ensure Australia continues meeting its obligations for provisions of nautical products and services under the National Authority under the Hydrographic Navigation Act.

Since 2018, the AHO leads the HydroScheme Industry Partnership Program (HIPP); a national program for data acquisition focused on hydrographic surveying activities delivered through collaboration with industry and the hydrographic community to meet charting priorities. The HIPP adopted a focus area approach to undertake hydrographic survey activities and areas within these focus areas are prioritized according to a robust surveying planning process utilizing a risk assessment tool. The collection of hydrographic data has increased twelve-fold since the inception of the HIPP. Recently, oceanography has become another focus with data sharing with the U.S. and UK. Over the next five years, it is expected that data will exponentially grow. Therefore, it is critical that a better understanding of the management of data through its entire lifecycle takes place.

JASON MUNDY, FIRST ASSISTANT SECRETARY OF PARKS AUSTRALIA IN THE DEPARTMENT OF CLIMATE CHANGE, ENERGY, THE ENVIRONMENT AND WATER (DCCEEW)

Jason presented on the national drivers for understanding the deep ocean. The purpose of DAWE is to enhance Australia's agriculture, environment, heritage & water resources through regulation & partnership. DAWE aims to improve stewardship & sustainable management of Australia's environment and unique heritage and integrate new capabilities & technology-enabled delivery to meet the demands of an increasingly connected, changing & complex world. This is critical for Australia considering it has one of the world's largest EEZ, with 37% (2.8 million square kilometers) of it declared a marine park. With that size and the remoteness of some parks, challenges are numerous to better understand the natural systems. Only 15% of Australian Marine Parks are mapped, but recent commitments in the form of large investments and strong national and international drivers about ocean leadership and management will turn the tide.

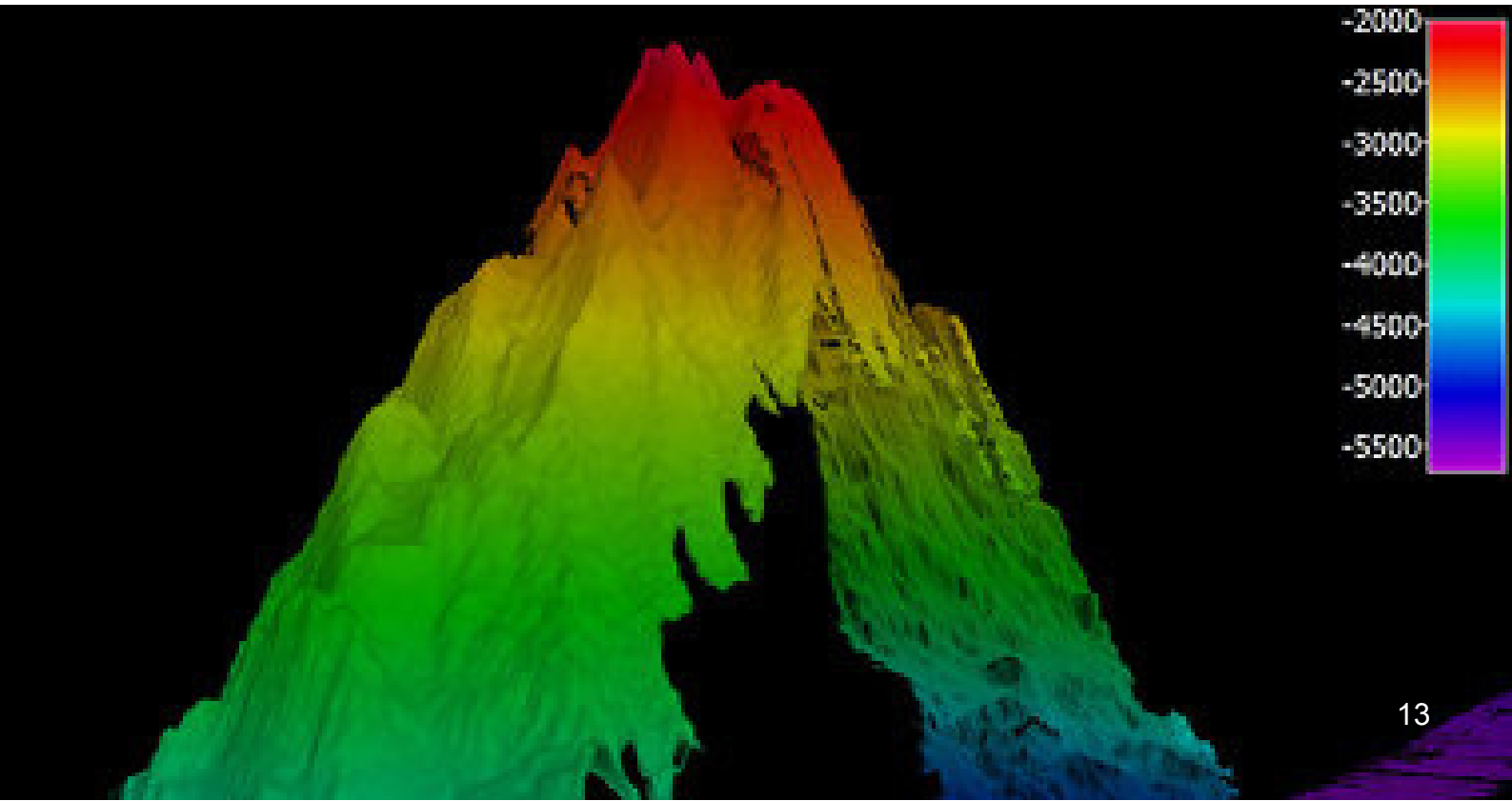
The Ocean Panel, a major commitment, was established in 2018 to accelerate global action to transition to a sustainable ocean economy. The U.S. joined The Ocean Panel in November 2021 [at COP26] alongside Australia and other Panel members, and committed to sustainably manage 100 percent of the ocean within national jurisdictions, guided by Sustainable Ocean Plans, by 2025. In December 2020, the Ocean Panel launched its Transformations for a Sustainable Ocean Economy with recommendations on how the world can make a rapid transition to a sustainable ocean economy. These include better harnessing of ocean science, technology, and data, including filling major data gaps on marine ecosystems and the ocean floor.

TARA MARTIN, ACTING FACILITIES PROGRAM DIRECTOR FOR CSIRO'S MARINE NATIONAL FACILITY (MNF)

Tara spoke on Australia's seabed mapping infrastructure and capabilities. Although the continent of Australia is about the size of the mainland USA, Australia is an island nation with 70% of its territory in the marine realm and less than 25 % of its ocean floor mapped to modern standards. Gaps are even worse when extending this knowledge of the deep waters of the Pacific.

Australia owns a small fleet of research vessels with most operating in shallow coastal waters. In recent years, significant investment into Australia's marine research capability has been made, including funds allocated to develop a southern coastal research fleet, the delivery of a new polar research and supply ship, the RSV *Nuyina* with full ocean mapping capabilities, and the increase to 300 operational days of the RV *Investigator*, Australia's dedicated blue-water research capability run by the MNF.

The MNF is owned and operated by CSIRO on behalf of the Australian nation and is overseen by an independent steering committee. Applications for sea time are open to Australian researchers and their international collaborators through an independent peer-reviewed process. One of the key strategic streams for application that may apply to this collaboration focuses on multi-disciplinary and collaborative projects that address key policy drivers. The RV *Investigator* offers research capabilities in oceanographic, atmospheric, biological, geoscience, and maritime heritage disciplines. This vessel is the world's first permanent vessel-mounted GAW station in the southern hemisphere. The current capability plan aims to ensure that MNF's technology maintains currency to answer the next scientific challenges with medium-term priorities focused on, increasing automation, and capability for deep-sea and surface research.



EXPLORING AND PLANNING OUR COLLABORATION

We aimed to explore and plan collaboration in means of defining targets and priorities, and then create and report out on a high-level plan in which priority activities will be delivered. The second day began with a deliberation on specific activities this collaboration can and should conceive. The workshop began with activities meant to conceptualize ideas on collaboration in relation to four distinct themes: technology, people, location, and procedures. Experts from both the U.S and Australia brought about discussion and ideas to explore the next steps in achieving our multitude of goals with success.

THEME 1: TECHNOLOGY

Before developing more technology it will be imperative to assess each country's current goals and in turn, determine what is needed to accomplish those goals. Better understanding of technology options and expertise will generate tools that are best for mapping and exploration operations, which may not always be satisfied by the same tools. To do this, a comprehensive understanding of what technology already exists and its scope must be met before focusing on new developments. Gaps first must be identified both in the means of data and of technology to achieve proper impact. Identifying these will aid in a comprehensive understanding of the current state and future needs of technology. The knowledge surrounding the types of technology available and what capabilities can be met with these existing mechanisms must be shared and documented. This will initiate a focus on applications to define "the right tool for the right job." With new and emerging technologies, there will be a need for training and familiarization of these tools for professionals. Similarly, data and technology sharing will be important factors in avoiding overlaps and increasing efficiency during expeditions. Data gaps must be known and filled; the most efficient way to do this is through data sharing multilaterally, avoiding overlap in exploration and data collection. The creation of a centralized catalog of the specific assets and technologies that exist and are accessible will better acknowledge what resources are available and where gaps exist. This assessment will consequently aid the development of collaborative plans for addressing technology gaps and mapping and exploring areas of mutual interests.

Beyond bathymetry, additional types of mapping and non-mapping technologies will be necessary to achieve the common vision of supporting the blue economy. For example, including seismic data into ocean mapping efforts in order to gain a better understanding of subsurface features and geological histories will help explain the formation of the seabed. Also integrating Artificial Intelligence (AI) and Machine Learning (ML) into data processing will improve efficiency while using telepresence and cloud services will increase accessibility, broaden participation, and expedite and enhance data access, analysis, and dissemination. To be able to interpret this collective data, international standards should be considered. We globally need data specifications for quality assessment, quality control, and interoperability to bridge the gap between stakeholders and allow mutual understanding of the quality of research.

Refining a clear framework for advancing and increasing the use of autonomous vessel and vehicle operations as well as establishing operating procedures and regulations for their increased autonomy at sea is essential. There should be an analysis of current and future use of satellite imagery to increase knowledge on geothermal measures, sea-level change, and ocean systems in general. Knowing the temperature of the sea surface can tell scientists a lot about what's happening in and around the ocean. Temperature changes influence the behavior of fish, can cause the bleaching of corals, and affect weather along the coast. Satellite images of sea surface temperature also show patterns of water circulation. Information gathered by satellites can tell us about ocean bathymetry, sea surface temperature, ocean color, coral reefs, and sea and lake ice, thus proving a worthwhile technology for ocean exploration. Scientists also use data collection systems on satellites to relay signals from transmitters on the ground to researchers in the field.

Another important tool to be utilized is crowdsourcing. Ocean mapping is already looking to supplement traditional methods by crowdsourcing bathymetry data, and ocean exploration too can capitalize on the power of the crowd's tools and data. Standardization is the key to interoperability and data sharing. Setting standard platform capabilities (such as ensuring each platform has a standard hydrographic cable), so that tools can be developed for broad application is imperative to the success of crowdsourcing exploration efforts. Furthermore, by developing recommendations for data and platform standards, partners and contributors will likely have a greater sense of accomplishment knowing that their contributions are impactful, which in turn builds a larger contributor base to collaboratively expand the exploration footprint.

THEME 2: PEOPLE

The topic of "who" relates to the personnel and entities to build partnerships with to create a stable global initiative. There are discussions to create a multi-government investment project aimed at collaboratively gathering data in international waters, and importantly, to enable innovative solutions for faster mapping and data release. Both the United States and Australia are members of International Centre for Electronic Navigational Charts (IC-ENC) which could be beneficial to leverage. An international policy team or working group may help leverage these existing partnerships in international organizations.

In the Atlantic, the 'Galway Statement on Atlantic Ocean Cooperation' was signed by representatives of the European Union, the United States, and Canada who agreed to join forces on Atlantic Ocean Research. The goal of the Galway statement is to better understand the Atlantic Ocean and promote the sustainable management of its resources through increased coordination and cooperation. Developing a Galway-like statement and/or a research alliance, similar to the All-Atlantic Ocean Research Alliance (AAORA), for the Pacific Ocean could contribute to international unity as well as the potential for an Ocean Decade Action Plan.

Building relationships with indigenous communities and the First Nations in the region is important early in this effort. These island communities are most vulnerable to climate change and creating a dynamic and respectful relationship will be the first step in building collaboration to meet the needs of all. While exploring the EEZs of small Island nations in this region, collaboration must be transparent as the local stakeholders need to be engaged in planning and execution where possible. The Secretariat of the Pacific Region Environment Programme (SPREP) offers a route to these nations. Additionally, any capacity building that can be done with these nations and indigenous communities is greatly appreciated and can be shared to inform others about this relationship.

Development of a pool of technical staff, available to work on partner vessels to foster collaboration in new ways of working while cross-decking between programs, can be helpful to ensure joint success and consistent procedures. Additionally, if working in the same area on or with multiple platforms, this will help reduce overlap as previously mentioned in the technology section. It is also critical to identify opportunities for collaboration with philanthropic entities, private organizations and independent research vessels which will aid exploration, and where early-career hydrographers, ocean explorers, and taxonomists can be cross-trained. This collaboration can also maximize the opportunities that could be provided to students and early career professionals, expand professional capabilities by sharing educational tools and resources with educators, and increase efficiencies through cross-training and collaborating with professionals, universities, and/or government agencies.

THEME 3: LOCATIONS

The discussion on the potential locations for expeditions focused on identifying common areas of interest and areas that would benefit greater goals for the region. It was discussed that while Pacific islands are in need of support due to their vulnerability to climate change impacts, surveying in local jurisdictions (U.S. and Aus waters) may be logistically easier at first, then the focus could move to the broader Southwest Pacific within the next 5 years.

The Pacific region has 20 tropical Small Island Developing States (SIDS), most of which are exposed to a large number of natural hazards, such as typhoons, storms, droughts, floods, landslides, volcanism,

cyclones, earthquakes, tornadoes, and tsunamis. Altogether, the Pacific SIDS has a land area of 555,572 km2, of which Papua New Guinea comprises 81.5%. The Pacific SIDS contain a total of 5019 islands, islets, and atolls and have a combined coastline of 31,541 km. The territorial waters of the Pacific SIDS cover a total maritime area of 26,911.685 km2. To conserve the ecological biodiversity and the limited natural resources with commercial value (e.g., coconuts, fish, timber, pumice, minerals, hydropower, petroleum, and natural gas), Pacific SIDS put marine and terrestrial protected areas in place (on average 13.9% of their territorial area). As of 2018, marine protected areas (MPAs) covered on average 13.6% of the territorial waters of the Pacific SIDS with New Caledonia protecting as much as 96.6% of its territorial coastal and marine ecosystems.

Capacity-building efforts in SIDS are indispensable for the achievement of both individual and collective ocean-related 2030 agenda priorities for sustainable development. There is a strong international initiative surrounding SIDS as their vulnerability to climate change increases. Thirty-eight UN members have been classified as SIDS and are grouped into three broad regions: the Pacific (as mentioned above); the Caribbean; and the Atlantic, Indian Ocean, Mediterranean, and South China seas (AIMS) regions. Committing to aiding and building capacity with these SIDS has become a high-level priority as they are at the forefront of climate action. With their ocean territories being some 20 times greater than their land area, pioneering the Blue Economy paradigm that promotes sustainable use of ocean resources while generating economic growth and preceding and restoring ocean ecosystems is crucial.

Other locations of interest (in terms of ocean mapping and exploration) are remote areas in the Pacific Basin south of the equator; places like Samoa, Fiji, and the Tonga Trench will be of high mutual interest to both the United States and Australia because of rising sea levels.

Australian deep water marine parks are of interest as this aligns with the Department of Environment, Agriculture and Water's priorities (now Department of Climate Change, Energy, the Environment and Water) encompassing seamounts, canyons, and abyssal plains. Areas just outside of, or with oceanographic features connecting them to, MPAs should be prioritized as well to inform understanding of ecosystem connectivity within and outside of managed areas. The priorities and support of other ocean nations like New Zealand and Pacific Island Nations who are invested in the Tasman Sea, are entwined. Having a proportion of operations from participating entities in the high seas to contribute to this initiative and collaborate through this bilateral agreement, would be significant in achieving our goals. The development of robust thematic and geographic requirements from partners to align and strengthen bilateral agreements is necessary.

THEME 4: PROCEDURES

To successfully employ and deploy for a prosperous ocean mission, procedures and priority deliverance must be fleshed out. A uniform discussion surrounding procedures needs to take place in order to accomplish ocean exploration and mapping goals. There needs to first be a definition for baseline exploration. It is important that multiple entities will be involved and there should be a means of formal communication established. Some ideas on how to ensure this collaboration progresses are: to create topical working groups, create an implementation plan, and establish an annual meeting to report on progress and strategically plan for the next year.

For U.S. and AUS entities, there should be a once-a-year committee meeting requirement. The annual meeting would bring together topical working groups: Standards for data interoperability and sharing, at sea coordination to ensure effective and non-duplicative acquisition, capacity building, technology acceleration, legal and policy, education and outreach. Each of these working groups has separate but significant importance in fulfilling international ocean goals.

Creating an initial inventory of standards and procedures that are already in use between nations will reveal gaps and overlap within our collaboration. This inventory can inform the development of an implementation plan focused on data sharing and expertise exchange. Nations involved can then develop methods for the analysis of information and optimize the use of assets for maximum gain. Protocols for marine sample management like physical archiving and digital records will be ideal. Similarly, developing a best-practice method for calculating the percentage of seabed mapped, explored, and characterized that,

could be applicable globally. Examples of tools and methods for collaboration are standard operating procedures and/or best practices, product specs, ingestion tools, archiving, and AWS data management. Entities should participate in sharing their ongoing procedures for scientific research permits and collaborate to share ways of developing products for non-expert and end-users. Doing this will aid in developing best practices globally. In order to write a charter for working groups to collaborate, different subgroups need to be established with volunteers. There is currently a hydrographic working group already meeting between the U.S. and AUS. The purpose is to share and align procedures with management capabilities to improve initiative and collaborate through this bilateral agreement.

SUMMARY DAY 2

A high level plan summarizing the outcomes of Day 2 of the workshop and following the MoU areas of cooperation is included in Figure 1. This plan is a living document that provides the grounds to further developing collaborative activities.

NEXT STEPS

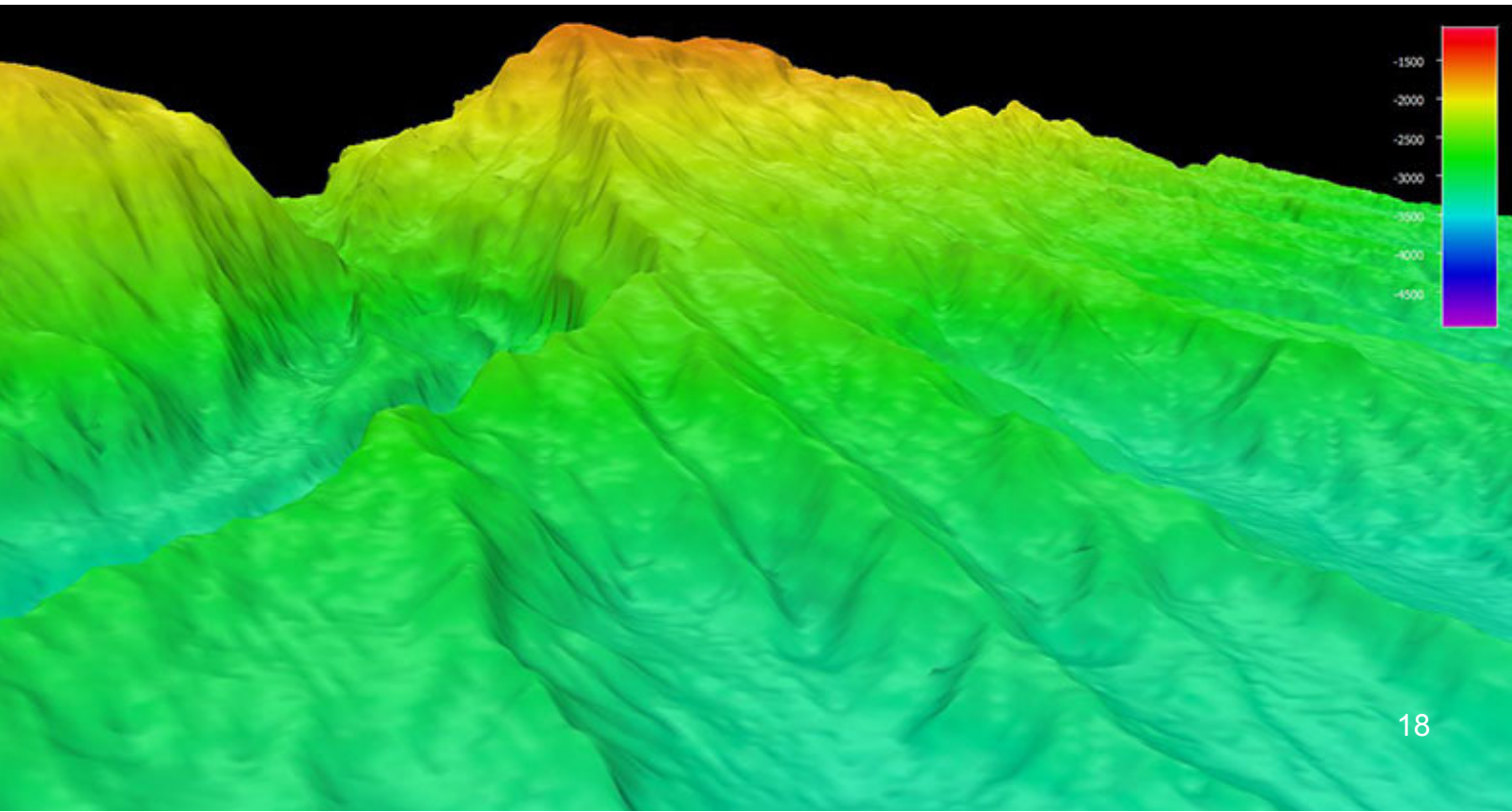
The information and discussion gathered during this inaugural workshop will be instrumental in how this collaboration between Australia and the U.S. on ocean exploration continues and grows. Over 2022, the next steps for the organizing committee will be to formalize the collaboration with a Memorandum of Understanding between Geoscience Australia, CSIRO, and NOAA. During this time, working groups will be organized around key themes and corresponding action items that were discussed on Day 2 of the workshop.

Figure 1: High level plan summarizes the outcomes of Day 2 of the workshop. This plan is a living document that provides the grounds to further developing collaborative activities.

Goal: Further scientific and technological cooperation in Ocean mapping and exploration between NOAA, CSIRO and GA

Objective: Facilitate the exchange of scientific resources, personnel, technical data & products, and knowledge to support the development and improvement of exploration and hydrographic services

Cooperation Areas	Activities: *what we will do*	Outputs: *what we will produce*	Outcomes: *what we will achieve?*
CA 1: Building capability and capacity We will exchange information current and future capacity and capability for mapping, exploring, and characterizing the ocean and foster mobility and networking of staff and researchers.	• Develop an asset inventory, incl. capability and value • Develop strategy for asset use • Scope industry readiness and forward plans • Make existing data openly accessible • Develop accessible crowd-sourced capability • Develop a pool of experts • Develop engagement plan to ensure inclusive collaboration	• Asset inventory • Strategy for asset use • Industry inventory • Datasets openly accessible • Proposal to build accessible crowd-sourced capability • A formal framework to support national capability in ocean mapping activities • Inclusive engagement plan	• More efficient use of our assets • Support industry through effective government investment • Improved management of the estate and growth of the blue economy • Improved information and community uptake • Enhanced acquisition capability and more sustainable • Broaden application
CA 2: Adopting best-practice & standard We will encourage the adoption of common mapping, exploration, and characterization best-practice, definitions and standards	• Establish an inventory and share Ocean mapping Standard Operating Procedures (SOPs) • Develop SOPs for infrastructure and data assets	• Catalogue of SOPs • SOPs	• Improved consistency and use of existing assets, and broaden their application • Better support decision-making
CA 3: Acquiring new data & information We will exchange information on ocean mapping, exploration, and characterization priorities and plans, and explore possibility of joint expeditions	**Undertake collaborative activities in the following areas:** • National: American Samoa, Tasman Sea • High seas: Tonga Trench, Aus deep water MPAs & connecting areas • Regions of interest: Pacific Island	• Data and insights	• More comprehensive knowledge of the ocean for the area • Better decision-making • Enhanced profile of Aus/US in the international community
CA 4: Advancing UNDOS We will explore the possibility of joint capacity and capability building efforts in geographic areas of common interest that would advance the UN Decade for Ocean Science and other global initiatives.	• Develop multi-government initiative to support high-seas mapping and characterisation • Support UNDOS through the development of new international policies • Undertake Science & Technology capability building amongst SIDS community	• Multi-national collaboration • Galway-like statement and All-AORA like for the Pacific • Activity plan for CB for SIDS	• Aus/US support tangible action in UNDOS • S&T capacity strengthened locally, nationally and regionally amongst SIDS



ANNEX A: PARTICIPATING ENTITIES

Participants invited to the workshop included government representatives with interest in the subject matter. These came from the U.S. and Australia with few from New Zealand considering their strong participations into ocean mapping and global initiatives. Organizations invited include:

- Ocean Exploration Research, NOAA
- Office of Coast Survey, NOAA
- Ocean and Atmospheric Research International Activities, NOAA
- Global Ocean Monitoring and Observing, NOAA
- National Centre for Environmental Information, NOAA
- White House Office of Science and Technology Policy
- Geoscience Australia
- Commonwealth Science and Industrial Research Organisation
- Australia Marine National Facility
- Australian Hydrographic Office, Australian Geospatial-Intelligence Organisation
- Australia Department of Defence
- Australia Department of Agriculture, Water and Environment
- Australia Department Foreign Affair and Trade
- Australian Antarctic Division
- Australian Institute of Marine Science
- Australia Bureau of Meteorology
- Museum of Victoria, Australia
- Land and Information New Zealand
- National Institute Water and Atmospheric, NZ
- Parliamentary Commissioner for the Environment, NZ

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ANNEX B: PRESENTATIONS

Annex of presentations can be found here.