Editorial

Renewed vigour
It's been an eventful year for Seabed 2030.

We're delighted to have participated in a whole host of events, spanning across the globe, meeting long-standing supporters and forging new alliances in support of the global mission of a complete map of the ocean floor.

This year we also celebrated the 120th anniversary of the General Bathymetric Chart of the Oceans (GEBCO). For over a century now GEBCO has pioneered ocean exploration and mapping, becoming the definitive reference map for scientists, hydrographers and ocean explorers alike.

The Nippon Foundation-GEBCO Seabed 2030 Project was launched six years ago to act as a catalyst to GEBCO's enduring endeavour.

In this time, we have entered into partnerships with over 50 organisations. These, together with a large number of other data contributors, have been instrumental in seeing the total percentage of the seabed mapped increase to just under a quarter – a feat that would not be possible without collaborative working on an international scale, coupled with the steadfast support of our parent organisations.

As a testament to realising the ambitious, yet necessary, goal of inspiring the complete mapping of the ocean floor, Seabed 2030 also underwent a major rebrand this year. In addition to our new logo, we were pleased to roll out the new Seabed 2030 website, which I hope will prove to be a valuable resource hub containing the latest developments and news updates pertaining to the project.

More recently, we were excited to launch the official Seabed 2030 podcast – Revealing Hidden Depths. Each month the podcast provides updates about the project, dives into interviews with members of the ocean community, and explores the various innovative technologies and methods being used to obtain bathymetric data.

As we come close to entering a new year, we are excited to build on this momentum and there is already much to look forward to, including the inaugural conference of the Ocean Decade, of which Seabed 2030 is a flagship programme.

The recent COP28 conference once again puts the ocean – the planet's life-support – on the global stage. The Ocean Pavilion, in particular, focused attention on the importance of a healthy and sustainable ocean, for all of us.

It's imperative that this global commitment to safeguarding the ocean is emboldened as we edge closer to the end of the decade. The clock is ticking, and there is still much to be done – but this vital mission is one that can be realised with a united international community.

Jamie McMichael-Phillips
Seabed 2030 Project Director

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Making the GEBCO grid available at multiple resolutions

The GEBCO global terrain model is currently made available as a 15 arc-second interval grid. This resolution is close to what can be expected from a modern, surface-mounted multibeam system over the majority of the world's oceans. However, users of the data set have different requirements, with some needing more detailed/higher resolution bathymetry in some areas (multibeam systems will also acquire data at higher resolution in shallower water areas). Therefore, to provide users with a more flexible product, the Seabed 2030 Technical Team (made up of technical experts from Seabed 2030's Regional Centers and the Chair of GEBCO's Technical Sub-Committee) have been looking at making GEBCO's grid available at multiple resolutions.

At the start of the Seabed 2030 project a set of depth-dependent 'resolution goals' were defined to help determine how much of the ocean floor has been mapped Mayer et al. (2018). This is effectively an estimation of data density. With each release of the GEBCO grid, the Project's progress is computed. This is not determined from the 15 arc-second gridded product, but from the contributed source bathymetry data using algorithm developed at the North Pacific and Arctic Regional Center.

Based on work done by the Seabed 2030 Atlantic and Indian Ocean Center, the Seabed 2030 Technical Team have been working to define a methodology for generating and distributing multiple-resolution data products for GEBCO that are consistent with these depth-dependent goals and based on the resolution of the source bathymetry data contributed by the global community. The resolutions of new data products and grid node spacing are defined for each depth range in Table 1. The grid node spacing within this scheme ensures that grid nodes will line up at different resolutions enabling the co-registration of gridded products at each resolution.

Depth range (meters)	Grid resolution (degrees)	Approximate grid resolution (meters)
0–1,500	0.001	100
0 – 3,000	0.002	200
0 – 11,000	0.004	400

Table 1. Depth range and resolution for GEBCO multiple resolution grid products

It is intended that:

• The new higher-resolution grids would be 'sparse populated' – i.e. only grid cells that are based on measured data are populated.

• Only contributed data that meets, or exceeds, the resolution goal for each depth range would be integrated into the higher-resolution data products as defined in Table 1. i.e. data will not be over-sampled to provide higher resolution products.

• The grids would be delivered in geographic coordinates.

• The 15 arc-second interval grid will continue to be delivered as a global fully-populated grid, with areas not supported by direct measurement based on predicted bathymetry.

The Atlantic and Indian Ocean Regional Center Team prepared a test dataset to enable the development of a data delivery system by the Global Center. The test dataset was generated by reviewing and recompiling all data within the Atlantic/Indian region near Australia where contributed data supports the resolution goals within each of the depth bands. Data were then reviewed and re-edited to ensure that the new products are of high-quality when gridded at higher resolution.

The Global Center used these data to develop a new interface for making the multiple resolution grid products available. This allows the user to view the geographic coverage of the various grids and select areas to download in netCDF, data GeoTiff or Esri ASCII raster formats. The application also includes the option to download the data in the form of imagery.

The image below is a screen shot from the beta version of the multi resolution grid sub-setting application. It shows the coverage of data from the 400m resolution grid (rainbow colours) plotted on shaded relief imagery generated from the GEBCO global grid. The dialog box on the right allows the user to select the data layers and format for download.

Global Center (continued)

Further work now needs to be done at the Regional Centers to finalise the development and quality control of the multiple resolution grids and at the Global Center to finalise the data delivery application. We look forward to beginning to deliver higher resolution data products to the global community in the coming year.
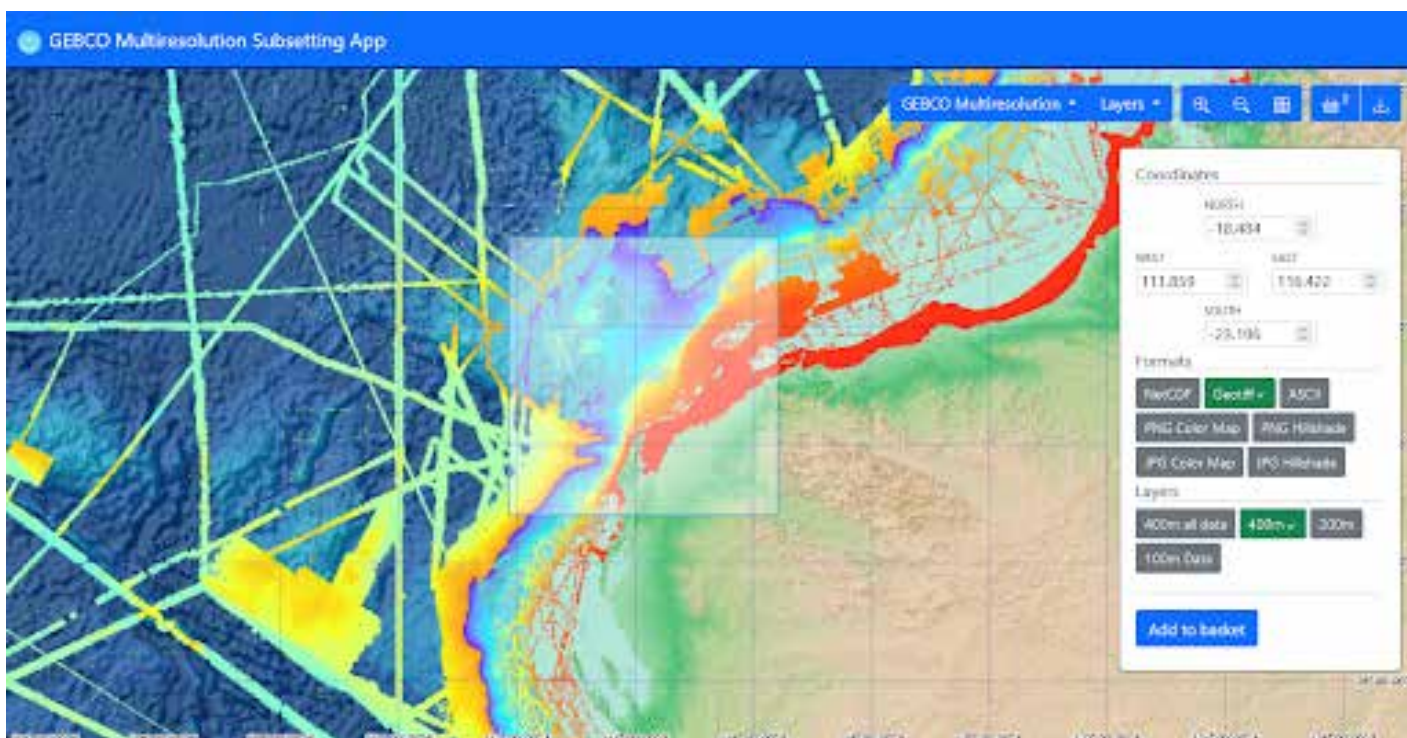

Figure 1. GEBCO multi resolution grid sub-setting application

(Mayer et al. 2018): Mayer, L.; Jakobsson, M.; Allen, G.; Dorschel, B.; Falconer, R.; Ferrini, V.; Lamarche, G.; Snaith, H.; Weatherall, P. The Nippon Foundation—GEBCO Seabed 2030 Project: The Quest to See the World's Oceans Completely Mapped by 2030. Geosciences 2018, 8, 63. https://doi.org/10.3390/geosciences8020063

Southern Ocean Regional Center

It's been an eventful year for Seabed 2030's Southern Ocean Regional Center. We were delighted to welcome Tea Isler, who is pursuing a PhD, as well as Natalie Cornish who joins our team as the Hydrographic Data Manager.

Tea's focus is on 3D visualisation of hydrothermal vents in polar regions using photogrammetric techniques. The optical reconstructions will be based on micro-bathymetric data collected by towed camera systems and remotely operated vehicles. Though her background is in mathematics and science, it was during her Master's in Geospatial Data Analysis at University College Dublin that Tea got to experience life at sea and discovered seabed mapping!

Natalie Cornish is a multi-disciplinary scientist, interested in all methods of environmental mapping. She began her career as a geographic information systems and remote sensing technician, fascinated by the abundance of information captured by earth observation satellites or queried from geospatial databases. She has worked on a range of topics from forest, wetland and drought mapping, to pitching 3D models to national parks and assistant teaching. Her projects often involved aerial or spaceborne optical sensors as well as (semi-) automatic processing chains. In 2020, she shifted her focus to applied marine science, wrote her thesis on satellite-derived bathymetry and graduated with a Master's in hydrography. After a brief pause from science, her first Arctic contract with the Greenland Institute of National Resources aboard RV Tarajoq further cemented her love for all things ocean tech. This year, she

Tea Isler

Natalie Cornish

Southern Ocean Regional Center (continued)

is proud to join the bathymetry team at AWI, both on land and on upcoming expeditions with RV *Polarstern*. Her main focus will be on outreach, data acquisition and data management for Seabed 2030's Southern Ocean Regional Center.

Soon after she arrived, Tea left Bremerhaven on RV Polarstern for the two successive expeditions PS136 and PS137 to the Arctic. Expedition PS136 left the port of Bremerhaven for a four-week work project supporting the time-series studies at the Long-Term Ecological Research observatory HAUSGARTEN. Multibeam, sonar and optical datasets were collected onboard the AWI towed camera system OFOBS (Ocean Floor Observation and Bathymetry System). A total of nine dives were carried out successfully where different biological species were observed on a diverse seafloor. On the next expedition, PS137, the deployment of OFOBS and other instruments was limited due to the difficult ice conditions in the area of study. Nevertheless four successful dives revealed complex topography with discoloured rocks and sediments affected by hydrothermally activity. The effective planning of the OFOBS dives locations was made possible thanks to the higher resolution bathymetric maps obtained by the processing of multibeam data collected during the expedition.
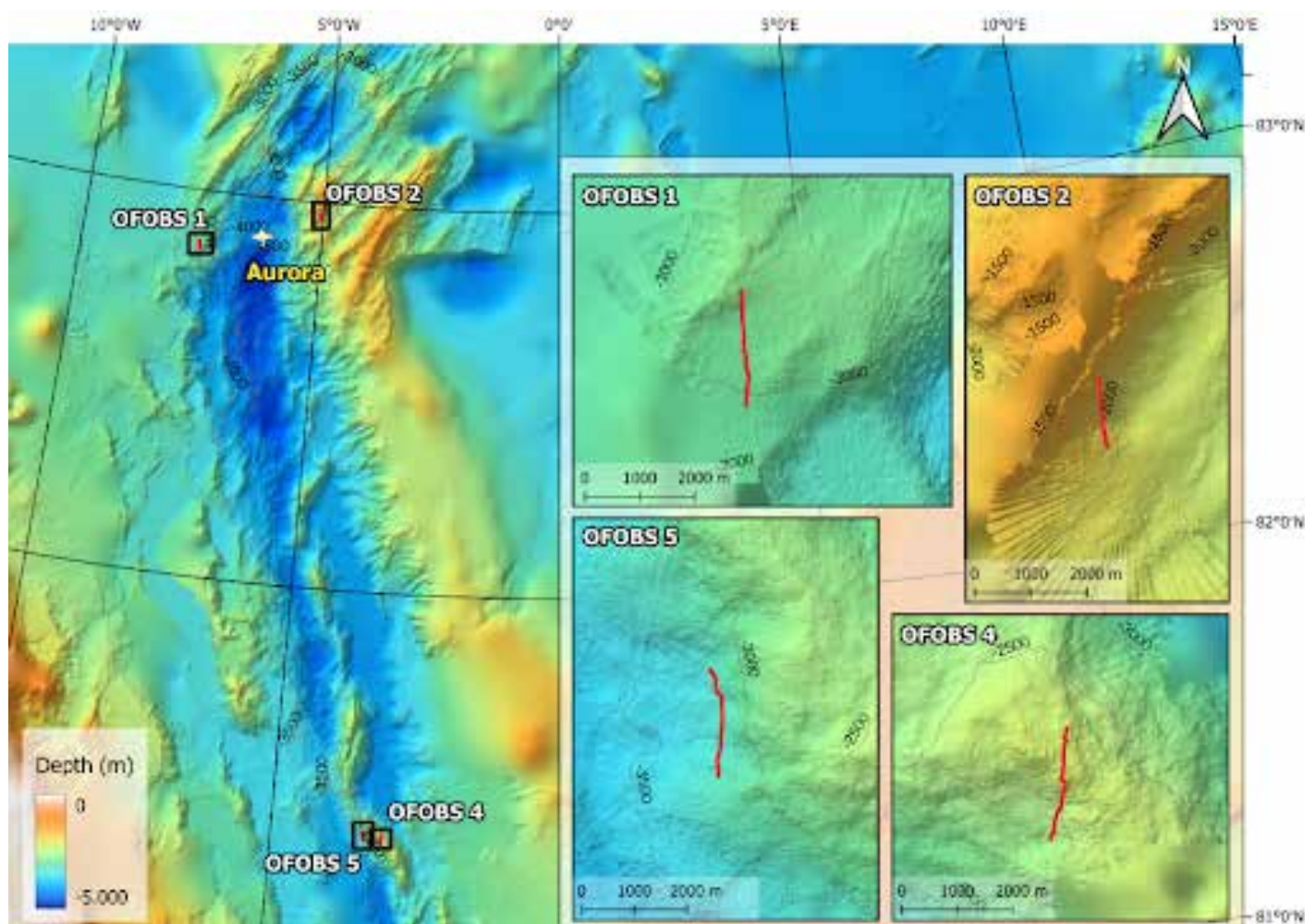

Image showing the survey area of expedition PS137 with RV *Polarstern*. Newly collected high-resolution multibeam echosounder data is superimposed on IBCAO. Red lines indicate the tracks of the deep-towed Ocean Floor Observation and Bathymetry System (OFOBS) recording visual seafloor imagery and micro-bathymetry.

Center Head:
Dr Boris Dorschel
southern-ocean@seabed2030.org

Arctic-North Pacific Regional Center

The Seabed 2030 Arctic-North Pacific Regional Center is working intensively to compile IBCAO Version 5.0 (International Bathymetric Chart of the Arctic Ocean) – a gridded digital depth model on a Polar Stereographic projection, specifically designed for users working with the Arctic Ocean, as it better portrays the bathymetry of the northernmost latitudes than the standard GEBCO geographic grid.

The IBCAO 5.0 grid is planned to be released soon, following the recent Fifth Arctic-Antarctic and North Pacific mapping meeting, which was held from November 27-29 in Bremen, Germany. The first IBCAO grid was released in 2000. When Seabed 2030 was established, the task of compiling a specific Polar Stereographic grid of the Arctic Ocean naturally fell to the joint Arctic-North Pacific Regional Center.

Figure 1. The sonar operating station on Swedish Icebreaker *Oden*. Photo: Agneta Fransson, Norwegian Polar Institute.

In early 2023, Marcus Karlsson joined the Seabed 2030 team at Stockholm University (SU). With two Master's degrees, one in Meteorology and one in Astronomy, Marcus has a solid background in data handling. At the end of September, Florian Vacek began working with the team at SU as a substitute for Silvia Salas Romero, who is on parental leave. Florian recently graduated with a Master's degree in Physical Geography at SU.

The ARTofMELT 2023 expedition with the Swedish icebreaker Oden went northwest of Svalbard earlier this year to capture the beginning of the melting season. While the expedition had a focus on atmospheric science, Aileen Bohan of Geological Survey Ireland and Julia Muchowski of SU were onboard, supported by Seabed 2030, to operate the installed multibeam echosounder (Figure 1). High-quality bathymetric data were collected from the Fram Strait area, partly while the icebreaker was drifting to acquire atmospheric and oceanographic data.

Center co-Heads Martin Jakobsson and Larry Mayer also authored an article for Hydro International on mapping northern Greenland waters. Martin also penned an article for The Conversation.
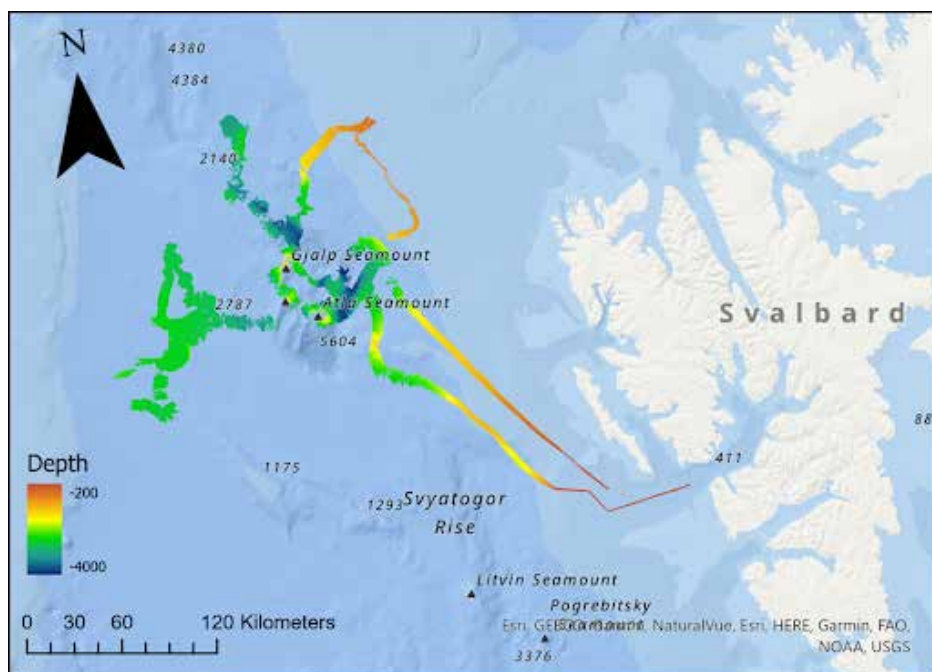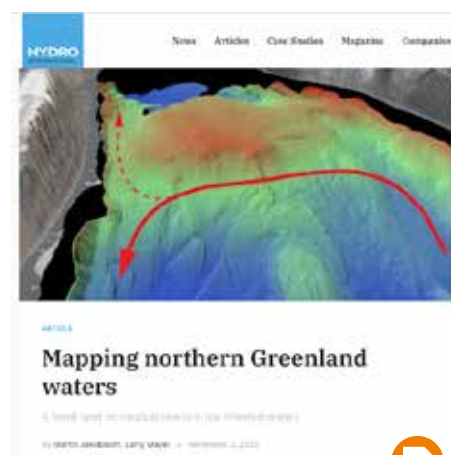

Figure 2. Multibeam bathymetry acquired during the ARTofMELT expedition. *Map provided by Aileen Bohan and Julia Muchowski*

| **Center co-Heads:** |
| **Professor Martin Jakobsson and Professor Larry Mayer** |
| arctic-pacific@seabed2030.org |

Atlantic-Indian Regional Center

Stakeholders from 23 countries participated in the Atlantic and Indian Oceans Regional Mapping Community Meeting earlier this year. The hybrid event, held at the Lamont-Doherty Earth Observatory, offered the opportunity for participants to receive project updates, deliver presentations and engage in discussion. One panel discussion brought together alumni from the Nippon Foundation-GEBCO Training Program to discuss regional perspectives on capacity development. Another panel brought together data managers and coordinators to discuss regional coordination successes and opportunities.

The final session focused on presentations about tools and workflows that can be distributed to empower the global community of ocean mappers to work with bathymetry data. This meeting was held in conjunction with a hybrid working meeting co-organized by the Center team, GEBCO's Technical Sub-Committee for Ocean Mapping, and the IHO Data Center for Digital Bathymetry. Together, these two events provided an opportunity for inclusive exchange among virtual and in-person colleagues to identify and prioritise actions, and to develop a vision for improving discovery and access of bathymetric data.

As part of the team's efforts to build relationships with stakeholders throughout Africa, Data Manager Tinah Martin participated at a virtual event co-organized by the Eduardo Mondlane Geography Department (Mozambique) and the University College of Dublin. Tinah was also recently nominated by colleagues at IOCAfrica to be a member of the UN Ocean Decade Data Strategy Implementation Group. Additionally, in June the team was delighted to welcome Victoria Obura, an Alumna of the Nippon Foundation GEBCO Training Program, for a one-day visit and exchange to better understand challenges and needs linked to data access and mapping initiatives in Kenya.

Other recent activities within the Center have focused on preparing and integrating new data contributions into regional data products. Recent contributions include multibeam data in a variety of forms as well as Crowdsourced Bathymetry (CSB) and Satellite Derived Bathymetry (SDB). We had three data apprentices from The City College of New York joining the team during their academic break, who participated in the preparation and review of these data sets.

Center Head:
Dr Vicki Ferrini
atlantic-indian@seabed2030.org

In-person attendees at the community meetings that were held at the Lamont-Doherty Earth Observatory of Columbia University. *(Photo Credit: Marcus Kwasek, QPS)*

Atlantic-Indian Ocean Regional Center Team members and Data Apprentices welcome Victoria Obura of Kenya to Lamont-Doherty Earth Observatory. (*Photo Credit: LDEO Core Laboratory*)

Pioneering ocean mapping for a better world

"Seabed 2030 was created to act as a catalyst to the long-standing endeavour already underway to chart the ocean – but its mission cannot be achieved alone. It is the result of unwavering collaboration among nations, institutions and corporations alike – and Fugro's unwavering commitment to Seabed 2030 exemplifies the power of private sector involvement in addressing the most pressing global challenges. Through cutting-edge technology, innovation and expertise, Fugro has helped to significantly advance the project's mission, bringing us closer to the day when we will have a complete map of our ocean's depths."

Check out this article in *Hydro International* co-authored by our very own Jamie McMichael-Phillips and Fugro's David Millar. The piece delves into the importance of global collaboration in pursuit of a complete map of the ocean floor.

Pacific Regional Center

The Pacific Regional Center is responsible for 124M km2 of ocean from the west coast of South America to the east coast of Australia and north to Japan, Korea and China. It includes the Exclusive Economic Zones of 39 countries. The Center is hosted at the National Institute of Water and Atmospheric Research in New Zealand (NIWA) and coordinated by a team from NIWA, GNS Science Te Pū Ao and Toitū Te Whenua Land Information New Zealand (LINZ).

In July this year the Center held its first in-person meeting, in Lima, Peru, since the inaugural meeting in Wellington in 2019! Since then, meetings have been online which can be challenging with the range of time zones across the Pacific. The group was hosted by the Peruvian Hydrographic Office (essentially a combination of their Navy and the offshore part of LINZ). This was the first Seabed 2030 meeting of any kind to be held in South America.

In advance of the event, delegates had the privilege of visiting the Peruvian Navy's Antarctic Research Ship, BAP Carrasco. After this visit, the team held two full days of talks, with a mix of in-person and online speakers from around the world. They focused on reviewing the progress to date with the Seabed 2030 project and identifying ways of further collaboration and mapping efforts.

In an effort to eliminate any language barriers, full translation services in English and Spanish were available throughout the sessions.

Overall, the event was considered a big success by the attendees and hosts. The highlights include:

• Over 60 in-person attendees in addition to the online attendees.

• Around half of the attendees were from Peru, joining others from South America and across the world.

• Lots of connections and informal data sharing / collaboration agreements were made with the team.

• In the post-meeting survey, 100 per cent of the people that responded said they learnt something at the workshop, and that it covered topics at a suitable pace.

• The team has confirmation that Fiji will host the event next year.

Center Head:
Mr Kevin Mackay
pacific@seabed2030.org

The bathymetry shown comes from a NIWA project, the link takes the reader to the story map behind the survey.

Group photo for the Seabed 2030 Pacific regional mapping meeting organised by NIWA, GNS, LINZ and Peru Navy held in Lima Peru. 60 delegates in-person plus another 60 joined online from across the Pacific Ocean and around the world.

Running a bathymetry and GIS training workshop in Lima. 50+ in house participants from government, academia, navy, industry from across South America and Pacific.

From left: Kevin Mackay, Pacific Regional Center Head; Belen Jimenez, Data Manager; Jenny Black, GNS Data Technician

The Nippon Foundation – GEBCO Alumni Conference, Tokyo

Over 100 delegates attended the inaugural Nippon Foundation – GEBCO Alumni Conference held in Tokyo, in early August.

With the theme of Connecting Our Oceans, the conference provided an opportunity to discuss problems and solutions to efficiently map the seafloor to scale. It also strengthened the international Alumni network, which is now in its 20th year – the programme has 120 Alumni spanning across 50 countries.

Sessions at the conference covered a range of topics, including the needs of the ocean community, marine education and capacity building for the next generation, and sustainable development.

On the final day of the conference the 2023 New Alumni Projects were introduced by Vicky Maki Honda of The Nippon Foundation, and the winners were announced by our Project Director Jamie McMichael-Phillips! These were a team led by

Amon Kimeli, from Kenya, for a project aiming to enrich our understanding of the Western Indian Ocean by collating and compiling data in this crucial region, and secondly a team led by Evgenia Bazhenova, which is on a mission to discover and share global bathymetric data from the Center for Marine Environmental Sciences, University of Bremen (MARUM).

The Seabed 2030 Podcast:
Revealing hidden depths

We're delighted to have recently launched Seabed 2030's official podcast! Hosted by our very own Head of Partnerships Steve Hall, each month he brings you news about the project, interviews with the ocean mapping community and updates about the latest technology and methods being used.

LISTEN NOW

Seabed 2030 Project Director Jamie McMichael-Phillips delivers an update on Seabed 2030 at the 3rd IHO-Nippon Foundation Alumni Seminar

3rd IHO-Nippon Foundation Alumni Seminar

The UK Hydrographic Office (UKHO) – one of Seabed 2030's partners – hosted the 3rd IHO-Nippon Foundation Alumni Seminar, in London.

For the past fifteen years, The Nippon Foundation has funded international trainees to study nautical cartography at the UKHO. Since 2014, this training has been conducted under the auspices of an agreement between the IHO and The Nippon Foundation known as the IHO-NF Geospatial Marine Analysis and Cartography (GEOMAC) Project.

This event brought together over 50 Alumni and distinguished guests, and provided an opportunity to hear of the Alumni's progress, promote further collaboration and enable the sharing of future aspirations.

Key speakers included representatives from the IHO, Seabed 2030, UKHO, International Board on Standards of Competence for Hydrographic Surveyors and Nautical Cartographers (IBSC), and the International Federation of Surveyors.
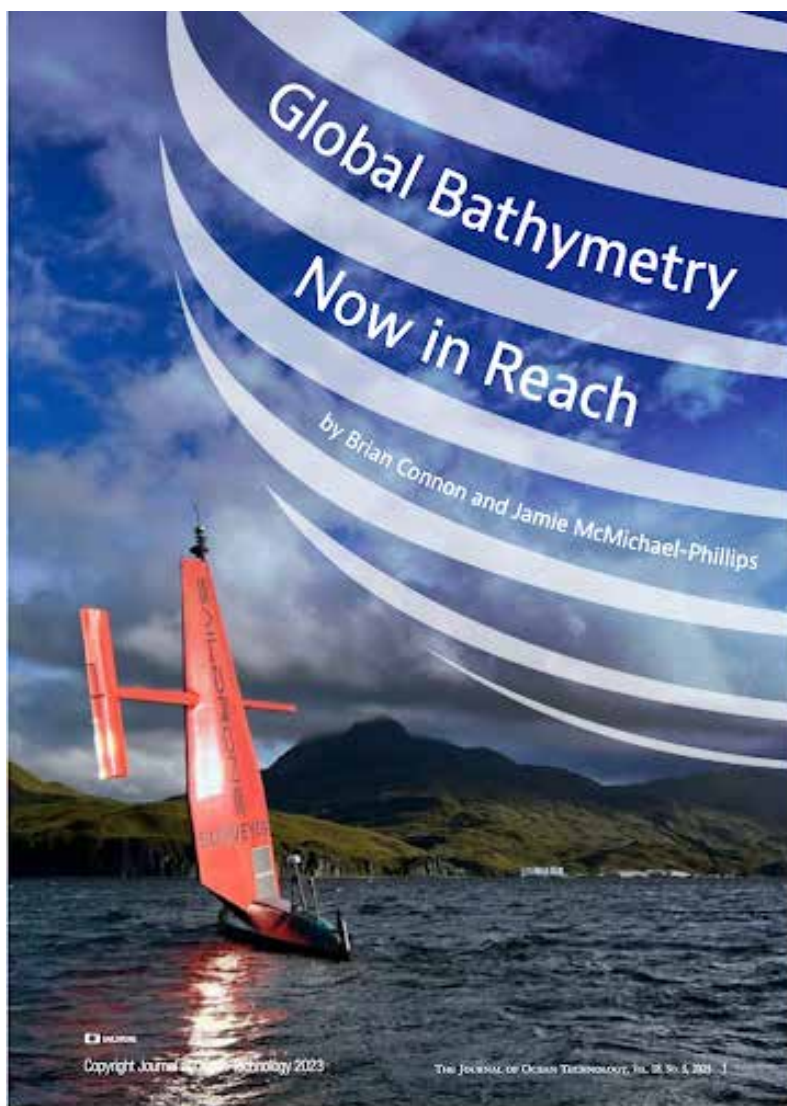
Global bathymetry now in reach

Seabed 2030 contributed a joint article – co-authored with our partner Saildrone – to the Journal of Ocean Technology. The feature article delves deeper into the role of revolutionary technologies, such as those utilised by Saildrone, and the pivotal role they play in helping us map the gaps.

Read it here.

Seabed 2030 named winner of prestigious International Superyacht Society award

Seabed 2030 has been awarded the prestigious Excellence in Improving the Image of Yachting Award at this year's International Superyacht Society (ISS) Design and Leadership Awards!

Founded in 1989, the ISS represents the yachting industry worldwide, and the eminent Design and Leadership Awards were created the following year to call attention to the achievements in the yachting industry.

The Excellence in Improving the Image of Yachting Award recognises Seabed 2030's role in enabling yacht owners to contribute directly to the gathering of essential new knowledge about the ocean, in addition to its role fostering marine conservation and promoting responsible exploration.

Dr Brian Calder of the Center for Coastal & Ocean Mapping / Joint Hydrographic Center at the University of New Hampshire accepted the award on behalf of Seabed 2030. As the lead designer of the next generation of crowd-sourced bathymetry data loggers, Dr Calder has supported the International Hydrographic Organization's (IHO) Crowdsourced Bathymetry Initiative since its inception, which is pivotal to Seabed 2030's success in delivering the GEBCO map.

Dr Brian Calder of the Center for Coastal & Ocean Mapping / Joint Hydrographic Center

Accepting the award, Dr Calder said: **"On behalf of Seabed 2030 and our parent organisations – The Nippon Foundation, GEBCO, IHO and IOC – thank you for this award. It's an honour to be selected, and we'd like to think of this as recognition of the power of partnerships in mapping our ocean world. Because without partnerships, without people actually on the water, people like you in the yachting world, it's going to be a hard haul to get to the 75% of the world ocean that still needs modern mapping. So we're committed to empowering everyone who wants to demonstrate their passion for our ocean by contributing data."**

KONGSBERG

FEMME 2023

Members of the Seabed 2030 team from across the globe were brought together thanks to Kongsberg Maritime's 17th Forum for the Exchange of Mutual Multibeam Experiences (FEMME) conference, held in Edinburgh, UK.

The conference brought together members of the maritime community to exchange experiences, inspire each other and contribute to improved system performance. The forum featured workshops, demos and a range of presentations.

From left: Jennifer Cheveaux, Project Administrator; Christie Reiser, NOAA; Jamie McMichael-Phillips, Project Director; Kevin Mackay, Pacific Regional Center Head; Vicki Ferrini, AIORC Center Head; Boris Dorschel, Southern Ocean Regional Center Head; Helen Snaith; Global Center Head; Steve Hall, Head of Partnerships; Martin Jakobsson; Arctic and North Pacific co-Center Head; Larry Mayer, Arctic and North Pacific co-Center Head

New Partnerships

SMI
Society of Maritime Industries - UK

THE NIPPON FOUNDATION-NEKTON
OCEAN CENSUS

MBON
Marine Biodiversity
Observation Network

MI
MARINE INSTITUTE

SEABER
AUV with confidence

planblue

GeoAcoustics

Seabird

FARSOUNDER

The Maiden Factor

Our partner the International SeaKeepers Society has entered into an exciting partnership with The Maiden Factor in a joint effort to support SeaKeepers' mission of advancing ocean research, conservation, and education.

As part of this collaboration, The Maiden Factor has taken a lead role in one of SeaKeepers' global Citizen Science initiatives, supporting Seabed 2030!

Founder of The Maiden Factor Foundation Tracy Edwards MBE said:

"We are so excited to be part of the Seabed 2030 Project and to assist in this important collection of data of the oceans as Maiden races around the world in the OGR 2023. Maiden's focus on girls' education means that we engage with girls all over the world who are at the forefront of Climate Activism. To actively be part of research, which can inform conservationists and ultimately protect our oceans is an honour."

Find out more about the partnership here

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