in-depth

MAPPING THE FLOOR OF OUR OCEANS

Newsletter of The Nippon Foundation-GEBCO Seabed 2030 Project

EDITORIAL

Our oceans, our future

As we enter a new year, we become closer to 2030. There are now just under eight years left to map the remaining 80 per cent of the ocean floor. An objective that becomes increasingly vital with every passing day.

Last month the eruption of the Hunga Tonga-Hunga Ha'apai volcano caused a tsunami that devastated the island and spread throughout the Pacific. The shape of the seabed greatly influenced the speed and size of the tsunami. Waves hit Australia, New Zealand and Japan and even touched the shores of California, Alaska, and Chile.

Tsunami models and warning systems play a critical role in protecting millions of lives but with a limited understanding of the world's ocean and what lies beneath, the effectiveness of these tools is compromised.

A complete map of the sea floor will enable us to better protect humanity, but it will also increase our knowledge of life beneath the ocean surface. A recent example is the remarkable discovery of a rare and giant coral reef in pristine condition off the coast of Tahiti. Increasing our understanding of the ocean will enable us to make informed decisions and consequently promote sustainable practices.

The task ahead may seem ambitious, but it's certainly achievable if we work together on an international scale.

We have now mapped just over 20 per cent of our oceans, with 80 per cent still to go. Earlier this month, Seabed 2030 was given the opportunity to share our mission with the One Ocean Summit. It was at this event that UNESCO called on the international community to strengthen efforts in support of mapping the sea floor.

As we make headway with our goal, we look forward to forming new partnerships and strengthening existing ones. Working collaboratively can greatly help fill in the gaps, and Seabed 2030 is delighted to highlight a major milestone in support of this as Fugro – an early partner of the project who has been one of our biggest supporters from the start – has now contributed over two million km^2 of high-resolution bathymetry to the project.

The clock is ticking, but we are committed to making the most of every day left until the end of the decade. We are committed to mobilising the international community and taking tangible action, and we very much hope you will feel encouraged to play a part in this fundamental endeavour.

Jamie McMichael-Phillips

Seabed 2030 Project Director

FUGRO

Celebrating a major milestone in Fugro's support of Seabed 2030

Back in 2016, Fugro envisioned a super charged crowdsourced bathymetry programme to support the global ocean mapping initiative, The Nippon Foundation-GEBCO Seabed 2030 Project. Five years later, more than two million km² of high-resolution bathymetry acquired by Fugro vessels during transits have now been contributed to the project.

As an early partner of Seabed 2030, Fugro has supported the project in numerous ways, including industry input into the development of the Seabed 2030 Road Map, serving on the Seabed 2030 Establishment Team, and perhaps most notably, developing an in-transit bathymetry programme that enables Fugro vessels to remotely collect valuable, high-resolution multibeam echosounder data for the programme while transiting to and from work sites.

How it started

The International Hydrographic Organization (IHO) defines crowdsourced bathymetry as "the collection of depth measurements from vessels, using standard navigation instruments, while engaged in routine maritime operations". Historically, this concept involved the provision of "passage soundings" to support the updating and improvement of nautical charts.

Fugro operates a global network of Remote Operations Centres (ROCs)
Credit: Fugro

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FUGRO continued

Fugro's David Millar recognised the company's potential to adopt a similar approach for the benefit of Seabed 2030. David is Fugro's Government Accounts Director for the Americas and a current member of the GEBCO Guiding Committee and IHO Crowdsourced Bathymetry Working Group. "We were already using remote command and control technologies to improve safety and efficiency in our offshore operations, so applying these systems and processes to collect valuable bathymetry data during transits that were occurring anyway seemed like an obvious way for Fugro to make a meaningful contribution to the project," David explained.

Edward Saade, then Group Director for Fugro in the Americas agreed, greenlighting a pilot project to test the concept. In September 2016, while transiting in the Atlantic Ocean basin, the *MV Kobi Ruegg*, Fugro successfully acquired 8,500 km^2 of high-resolution multibeam echosounder data where none previously existed. Other transits soon followed and in November 2017 we made our first delivery of in-transit bathymetry data to Seabed 2030 via the IHO Data Centre for Digital Bathymetry (DCDB). That contribution totalled approximately 65,000 km^2 of high-resolution seafloor mapping data.

> *"The ability to manage the data collection remotely without survey crew onboard is critically important to scaling up the programme and continuing to make cost-effective, high-impact contributions that help foster a healthy and understood ocean"*

How it's going

Over time, we have successfully expanded our in-transit bathymetry programme to include nine vessels operating globally, with more planned. "The ability to manage the data collection remotely without survey crew onboard is critically important to scaling up the programme and continuing to make cost-effective, high-impact contributions that help foster a healthy and understood ocean," David said.

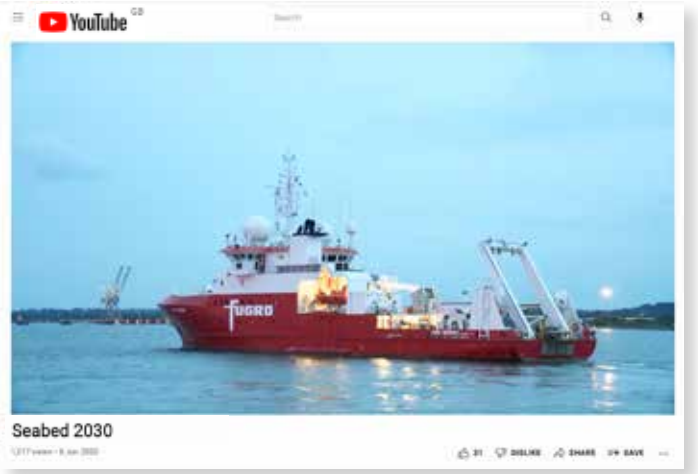
Fugro delivers in-transit bathymetry data to Seabed 2030 approximately twice per year – a frequency that provides a reasonable volume of data to be acquired, uploaded and ingested by the DCDB and regional Seabed 2030 data centers. Our December 2021 submittal represented a major milestone: more than two million km^2 of high-resolution, in-transit bathymetry collected by Fugro vessels has now been delivered to the Seabed 2030 project. Combined, this data coverage is roughly equivalent to the size of Mexico!

Reflecting on this milestone, Jamie McMichael-Phillips, Seabed 2030 Project Director, stated: "We are immensely grateful for the tremendous submission of data by Fugro, who have been one of our biggest supporters from the onset of the project. From participating in our early planning stages to launching their in-transit data campaigns, Fugro has adopted an invaluable and central role in helping Seabed 2030 achieve its aim of a complete map of the world's oceans by 2030. We look forward to continuing this partnership with Fugro in the time remaining for us to achieve our goal."

Furthering the cause

While crowdsourced bathymetry is just one of the ways Seabed 2030 aims to 'map the gaps', it's a strategy with yet untapped potential. As described in a short film co-produced by Fugro and Seabed 2030, multiple other marine industries are also well suited for in-transit data collection. Relatively simple vessel modifications would enable commercial shipping and cruise line companies, for instance, to make meaningful contributions to the project and, by extension, the United Nations Decade of Ocean Science for Sustainable Development.

Ensuring a wholly mapped ocean by 2030 will require cross sectoral, interdisciplinary collaboration and partnerships worldwide. As the world's leading geodata specialist, Fugro is very proud to champion the private sector's support of Seabed 2030.



Seabed 2030 address to the One Ocean Summit

The goal of the One Ocean Summit is to raise the collective level of ambition of the international community on marine issues and to translate our shared responsibility to the ocean into tangible commitments.

> *"I am thrilled to see so many media outlets discuss ocean mapping following the summit. It shows that years of work by the IHO and initiatives like The Nippon Foundation-GEBCO Seabed 2030 Project are having an impact. I am confident that the progress going forwards will be exponential, as new partners join in on the efforts. But this effort cannot be borne by engineers and scientists alone. Policy-makers must understand the compelling need to invest in ocean knowledge and put their words into action."*

Dr Mathias Jonas, Secretary-General, International Hydrographic Organization (IHO)

The Economist's annual World Ocean Summit fosters a global conversation on the greatest challenges facing the seas, inspiring bold thinking, new partnerships and the most effective action to build a sustainable ocean economy.

The ninth annual World Ocean Summit will take place from 1-4 March 2022.

Join Seabed 2030 as we form a panel to discuss key mapping targets on 2 March (16:10 GMT). Project Director Jamie McMichael-Phillips will be joined by Schmidt Ocean Institute Executive Director Jyotika Virmani; Lowri Evans, former Director-General for Fisheries and Maritime Affairs, European Commission; and Catherine Novelli, former Under Secretary of State for Economic Growth, Energy, and the Environment. The panel will be moderated by Charles Goddard, Editorial Director of the Economist Group.

Jamie McMichael-Phillips
Project Director, Seabed 2030

Lowri Evans
Former Director General, Maritime Affairs and Fisheries, European Commission

Jyotika Virmani
Executive Director, Schmidt Ocean Institute

Catherine Novelli
Former US Under Secretary of State for Economic Growth, Energy, and the Environment

BBC NEWS
Science & Environment

Giant pristine coral reef discovered off Tahiti

Marine explorers have discovered a "pristine" 3km (2-mile) coral reef at depths of 30m (100ft) off the coast of Tahiti, French Polynesia. It is one of the largest discovered at that depth, according to UNESCO.

The reef was found in November, during a diving expedition to a depth known as the ocean's "twilight zone".

Coral reefs are among the ocean's most threatened ecosystems – vulnerable to pollution, rising sea temperatures and the change in chemistry caused by carbon-dioxide emissions dissolving in the water.

SEABED 2030 CENTER UPDATES

Seabed 2030 consists of four Regional Centers and a Global Center

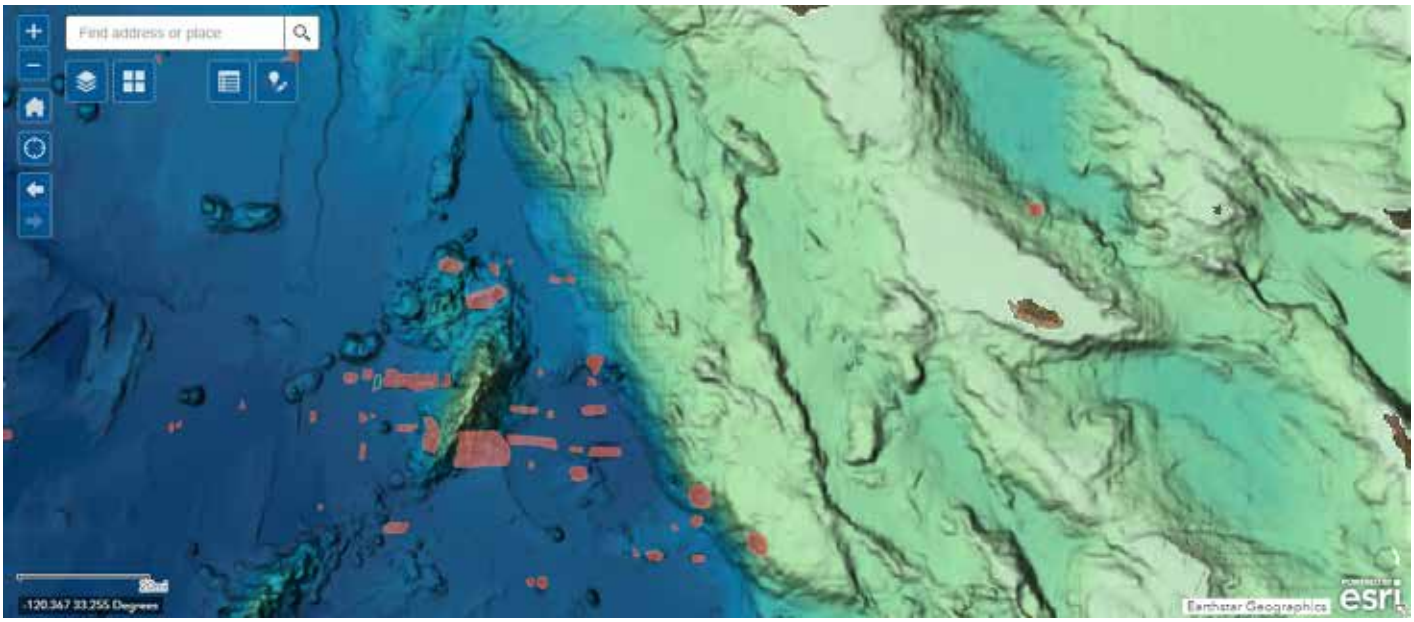
The Regional Centers are responsible for championing mapping activities, assembling and compiling bathymetric information and collaborating with existing mapping initiatives within their regions. The Global Center is responsible for producing and delivering global GEBCO products.

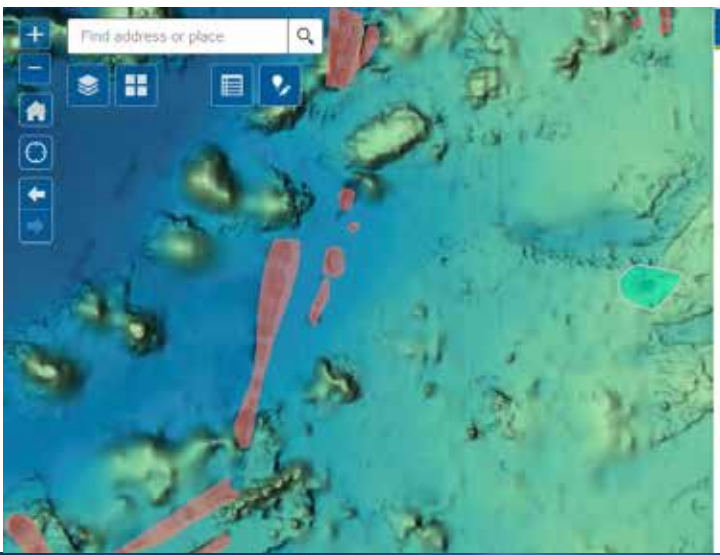
Global Center

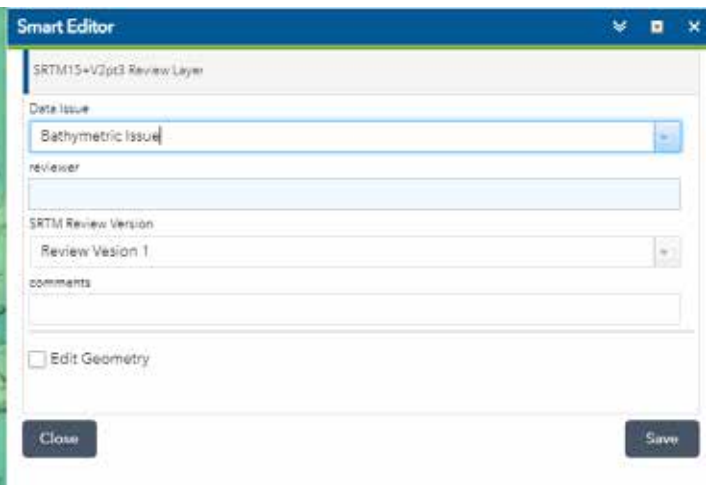
The Seabed 2030 Global Center is hosted by the National Oceanography Centre in the UK, and forms a part of the British Oceanographic Data Centre. As the Global Center, we act as a central hub for the project. Our key priority is generating the annual updates to the global GEBCO grid and providing these to our users.

Reviewing new grids

Generating the global grid is a highly collaborative activity, requiring input from all our Regional Centers, but also coordinating input from one of our important partners – Scripps Institution of Oceanography (SIO) in the US. The SIO group, led by Professor David Sandwell, provide the project with the base grid that allows us to have a continuous global grid. This base grid is generated through a combination of predicted bathymetry (from satellite altimetry) and observations. The SIO group produce regular updates to this grid, to allow us to have the best possible base on which to add observations from the Regional Centers.







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GLOBAL CENTER continued

Each time a new base grid is released, the Global Center team start a review process for the grid. A copy is placed on a GIS server hosted by the North Pacific Regional Center and the full technical team then review this new grid and identify any areas where there seem to be problems. These are often sections where 'bad' data have crept into the computation and caused strange anomalies. The SIO team take the review and revise their computation, before providing a final version to the Global Center.

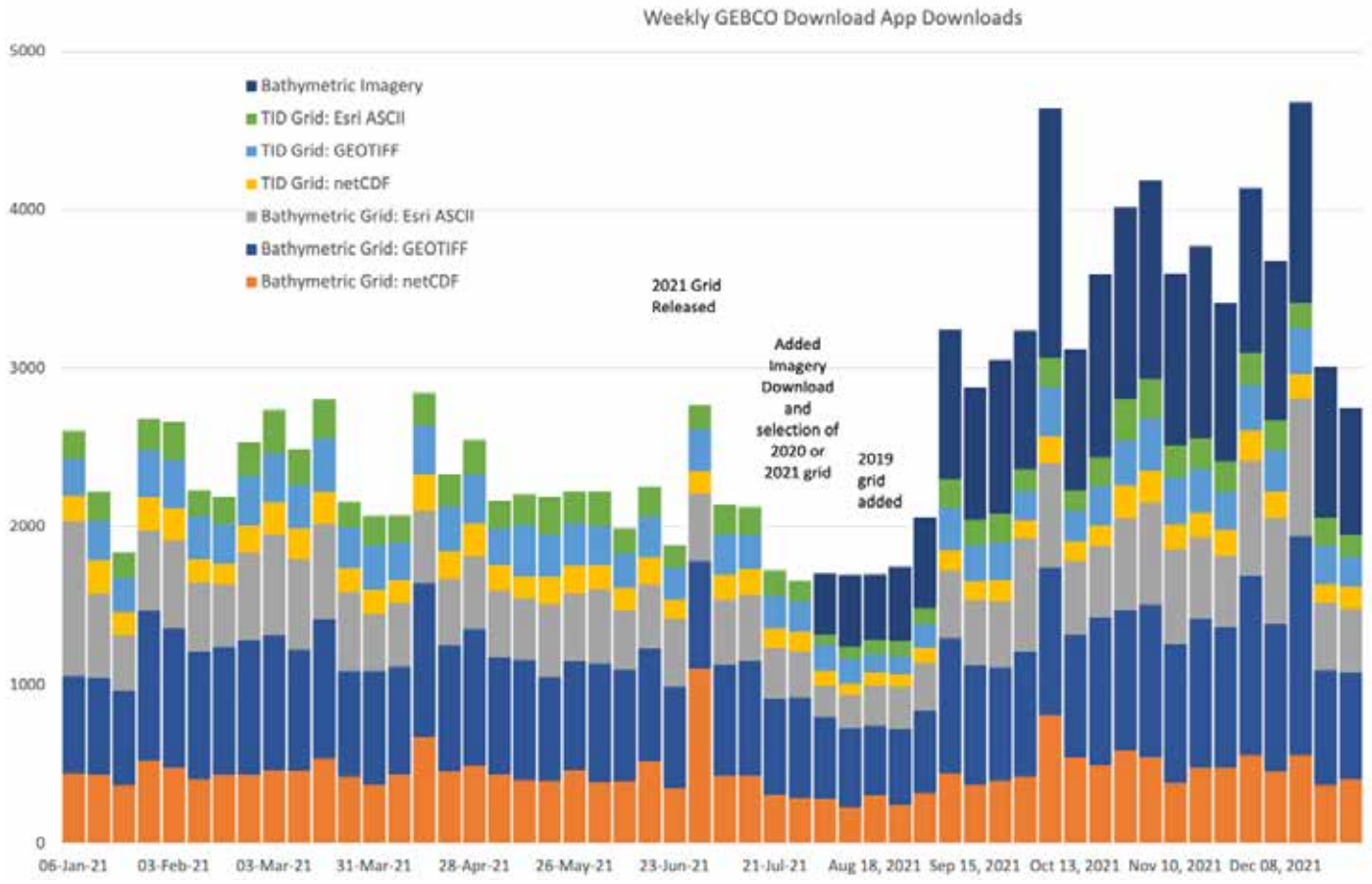
The latest version of the base grid, SRMT_15+ v 2.3, had more than 450 separate edits noted in this process. These will be addressed in v2.4, which will form the base of the 2022 GEBCO release.

The work on the base grid means we now have a version that is closer to our observed data across most of the ocean areas. As a result, we should now be able to provide a much more continuous final product. As we 'stitch in' the Regional Center data, we will be able to see the improvements of higher resolution, with fewer anomalies and false cliff edges.

We use the same method for reviewing a draft version of the GEBCO grid prior to creating the release version. This review includes our full technical team, but also colleagues from the GEBCO sub-committees, in particular from the Technical Sub-Committee on Ocean Mapping (TSCOM) and the Sub-Committee on Regional Undersea Mapping (SCRUM). Their regional knowledge and expertise provides a fantastic input to the process.

Data delivery

As well as generating the grid, we are also continuously improving on the data delivery to our users. In 2021, we provided two different versions of the grid: an under ice version and a surface topography version. For polar ice-covered areas, this gives users the option to look at the ice surface, or the land surface under the ice. These grids are both available to download as single global grids in three standard formats: NetCDF, GeoTiff (as a collection of tiles) and ESRI ASCII format (again, as a collection of tiles).



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GLOBAL CENTER continued

We also provide a download application which allows users to select their area of interest and download only the data they need for that area, in the format of their choice. Over the summer, we put in place a major upgrade to the application that allows users to select which version of the grid they want. So, not only are both versions of the current grid available, but all the previous Seabed 2030 generated products (GEBCO_2019 and GEBCO_2020) can also be used. This is helpful to see the changes between versions of the grid. Downloading and comparing the associated type identifier grids is also an easy way to see where new observations have been added.

Since the upgrade, we are delighted to see that there have been even more downloads from the site and people are obviously making good use of the extra options.

And as an added bonus, users can choose to download the bathymetry for their selected area as an image file in either jpeg or png format. This is a great way to get a desktop image of your favourite area of the ocean, or for quick looks at areas without needing to read and display the data themselves.

With the 2022 release we have more plans to improve the options for polar data, where the geographic grid doesn't work so well and we will also be asking users for their input to help us shape the services we offer in the future.

Credit where credit is due

Another activity that we are working on behind the scenes is making sure that all of our contributors are properly recognised. From the organisations that collect the data, the groups that process the data, to the data centres collating and distributing data, as well as those generating regional gridded datasets that we can incorporate – all these have played a part in the effort to map the world's oceans and should be properly recognised. But finding all that information takes some detective work!

It goes alongside our efforts to understand the data: when were they collected? What type of instruments were used? How were they processed? This metadata (data about data) is all important to understand the accuracy and reliability of the data. All this work will help us be transparent about which data are included and provide services to users to help them in using our products.

Center Head: Dr Helen Snaith | gdacc@seabed2030.org

Atlantic-Indian

The Atlantic-Indian Regional Center recently participated in several virtual events focused on building collaborative relationships with stakeholders throughout the region. In November, this included a virtual round table focused on mapping in the South Atlantic as part of the 17th International Congress of Brazilian Geophysical Society (PGGM), and a webinar organized by MACHC and IOCARIBE focused on different technical solutions for gridding and assembling bathymetry data.

In December, the team was excited to contribute to the successful Map the Gaps Symposium, with team members participating in several sessions. A highlight of this event was facilitating a session focused on Mapping around Africa which focused on the status, needs and opportunities with respect to seafloor mapping. Exciting outcomes of these events include increased cooperation and coordination and the identification of several new datasets that are being incorporated into the GEBCO global map. Finally, in January, our team participated in a series of regional workshops hosted by IOCAFRICA that were focused on developing a strategy for implementing a regional Ocean Decade Action plan. Our participation in this event focused on the Ocean Decade Challenge 8 and included a brief introduction to The Nippon Foundation-GEBCO Seabed 2030 Project, how it can help to address regional challenges (capacity development, data collection and interpretation) and the opportunities mapping the ocean floor around Africa will present for regional stakeholders. Data assembly efforts have been focused on integrating recently shared data and preparations for the regional contribution to the 2022 GEBCO grid.

The team is in the early planning stages of a virtual regional mapping meeting focused on the Indian Ocean – keep an eye on the center web page for details as they are announced.

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

Southern Ocean

This time last year, RV Polarstern set sail to the southern Weddell Sea on a multidisciplinary research expedition to study oceanographic, bio-geochemical and biologic processes of the Filchner Trough. Among a range of monitoring devices, including our efforts as part of AWI bathymetry in seafloor mapping with the ships multibeam, was the Ocean Floor Observation and Bathymetry System (OFOBS). As the lead for the acoustics also on this device, it meant for a busy expedition, especially without the foresight of the events that were to follow.

Towed behind the ship at roughly two meters above the seafloor, the OFOBS captured video footage, still images, sidescan sonar and forward facing sonar. Within the first week of scientific work, under the sea ice of Antarctica, a massive colony of notothenioid icefish (*Neopagetopsis ionah*, Nybelin 1947) was discovered.

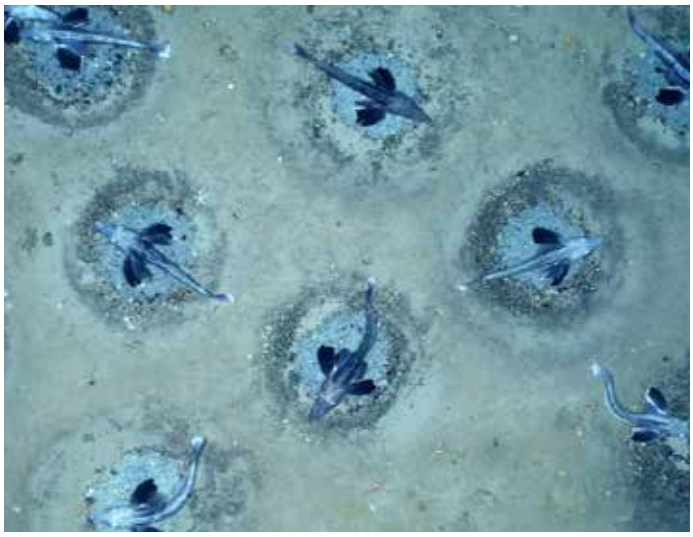
The extent of the discovery was quantifiable due to the combination of camera and acoustic systems. The photos and video confirmed whether or not the nests were active and populated with fish eggs, and the sidescan and forward facing sonar confirmed the indentation of fish nests across a large area. Habitable landscape characteristics could also be resolved from the acoustics, including rugosity, substrate type, slope and aspect. With only a few cross-sectional OFOBS deployments at the site, it was concluded, an area of roughly 40 x 6 km with depths of 535 to 420 m had at least 12,000 active nests and greater than 100,000 mapped nests. Future studies with return visits are required to further assess the sheer volume and habitat of the icefish.

In addition to this very exciting work, we also successfully collected bathymetry data throughout the expedition, thus mapping uncharted seafloor of the Southern Ocean. Imaging the seafloor at various resolutions revealed amazing insights into the ecosystem around Antarctica.

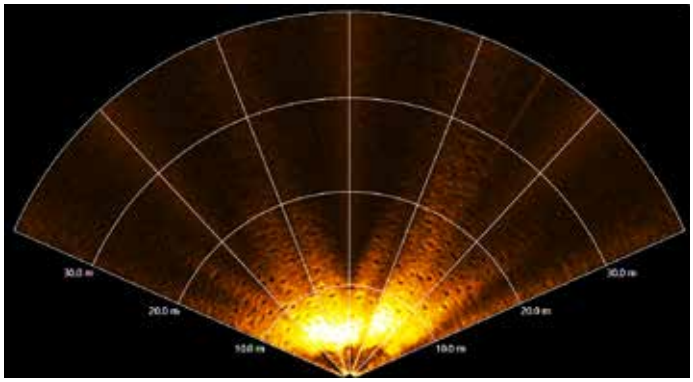
More information on this incredible discovery can be found in this recent publication.

Ms Laura Hehemann
Data Manager and Curator, IBCSO
southern-ocean@seabed2030.org

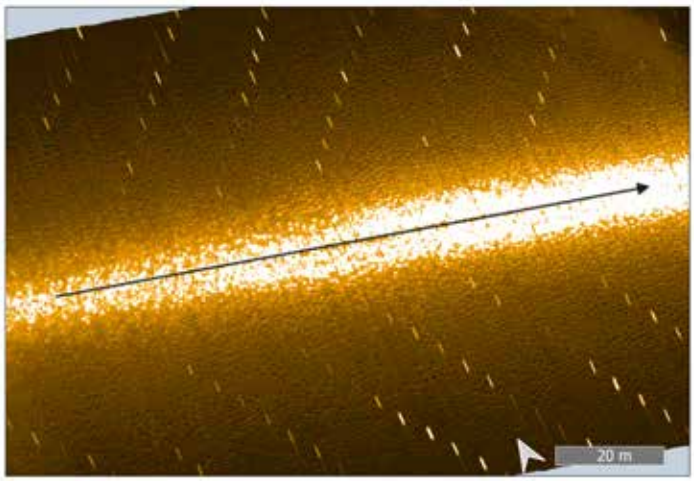
Center Head: Dr Boris Dorschel



Colony of notothenioid icefish



Forward facing sonar



Side scan sonar

Arctic-Pacific

The Arctic and North Pacific Regional Data Center shared by Stockholm University and the University of New Hampshire have worked with Kongsberg Maritime to develop *The Nippon Foundation-GEBCO-Seabed2030/Kongsberg uploader*. A Beta version of the data uploader has been developed and circulated for testing. This version is able to upload bathymetry directly from Kongsberg multibeam systems as well as in the form of processed grid files in tif format. A workshop was hosted by Stockholm University last September, using Stockholm University's research vessel RV Electra.

Statistical routines for calculation of the mapped portion of the world oceans has developed on Amazon Web Services (AWS). These are now operational and provide us with statistics every quarter, including mapped area at the Seabed 2030 decided resolutions at different depth bands, as well as mapped area broken down to different methodologies (multibeam, single beam etc.).

The Center has also successfully demonstrated the viability of autonomous crossings across the Pacific with sail-powered vessel and deep-water multibeam collecting high-quality mapping data.

We have refined and demonstrated low-cost (~$20/each in volume) hardware logging system for volunteer bathy information collection (including cloud-based processing and automatic submission to DCDB).

A team from the North Pacific branch of our Center carried out an expedition with the US icebreaker Healy – North West Passage. About 20,637 sq km of seafloor were mapped during the expedition, including 12,177 sq km of previously unmapped seafloor, a particularly significant number given the remoteness of the region.

Meanwhile, the Arctic branch of our Center took part in a 54-day-long expedition with Swedish icebreaker Oden – The Synoptic Arctic Survey 2021. The expedition went to the central Arctic Ocean and collected multibeam bathymetry from a portion of the North Greenland shelf never visited by surface vessels before.

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

South and West Pacific

Scientists in New Zealand have used satellite technology to chart shallow areas of the Cook Islands' seafloor in never-before-seen detail. The team at NIWA and Toitū Te Whenua Land Information New Zealand (LINZ) have done the work for Seabed 2030's South and West Pacific Ocean Data Centre.

The chart of Suwarrow and Pukupuka in the Cook Islands builds upon decades-old surveys, with more accurate positioning and wider coverage, including information on harder to reach areas such as shallow lagoons.

The images are taken from two commercially owned satellites, World-View-2 and GeoEye-1, which provide extremely high-resolution pictures of the earth's surface.

To measure the depth of the ocean, you would traditionally have to send out a boat with an echosounder, which costs a lot of money and can be dangerous in rough and shallow seas. With satellites, extremely remote locations can be accessed, and it has a lower carbon footprint.

The satellite can see the shallow sea floor in exquisite detail, but to derive the water depth the software needs to get rid of things such as shadows and waves. It strips away the water and uses complex algorithms to produce depth estimations, creating a map with colourings of what the seafloor would look like without any water.

The nautical chart will be published in February and it is hoped to improve ocean safety and scientific knowledge.

Center Head: Mr Kevin Mackay | pacific@seabed2030.org

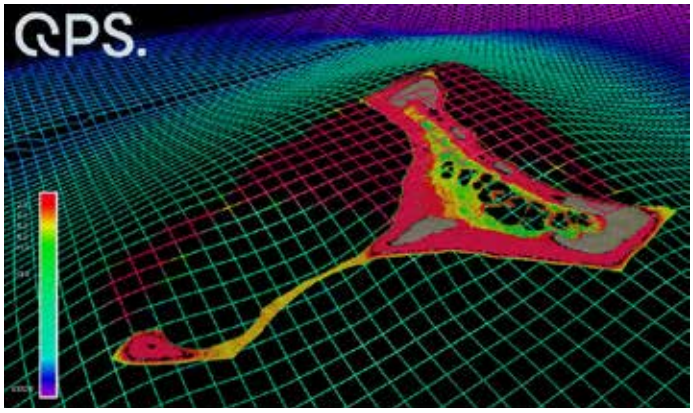


Image shows the Pukapuka Atoll satellite derived bathymetry overlaying pre-existing data in the GEBCO Grid.

Credit: NIWA

NEW PARTNERSHIPS

Global Oceans

A new partnership has been announced between Seabed 2030 and Global Oceans. The two parties will work together to further our understanding of ocean bathymetry and contribute to the global effort to produce the definitive map of the ocean floor.

Based in the US, Global Oceans is a non-profit organisation designed to integrate and mobilise private-sector offshore resources through its MARV™ ship model (Modular Adaptive Research Vessels) to dynamically expand ocean science capacity on regionally deployed manned platforms worldwide. Global Oceans is launching new projects that will utilize MARVs™ and ocean exploration technologies to enable more intensive ocean and atmospheric investigation and greater international scientific collaboration.

Find out more about Global Oceans.

NLA International

A Memorandum of Understanding has also been signed with NLA International.

NLA International champions the implementation of Blue Economy to create sustainable ocean environments. With the ever-increasing awareness of the various ways in which the world's oceans enhance our lives, NLA International is committed to exploring such benefits whilst making sure any solutions are founded on models that ensure growth sustains our ocean environment.

Find out more about NLA International.

SeaKeepers

A further partnership has been announced with the International SeaKeepers Society.

SeaKeepers Society is a non-profit organisation dedicated to facilitating marine research and conservation efforts. SeaKeepers accomplishes its mission by connecting the yachting and boating community with scientific and academic institutions – enabling the yachting community to take full advantage of their unique potential to advance marine sciences.

Find out more about SeaKeepers.

The Fourth Arctic-Antarctic and North Pacific Mapping Meeting

Hosted by Stockholm University, Sweden. 21 – 24 March 2022

This meeting continues the series of mapping meetings organized and hosted by The Nippon Foundation-GEBCO Seabed 2030 Regional Centers which started in 2018.

It is hoped that for this year's Arctic-Antarctic and North Pacific Mapping Meeting we can have a hybrid meeting where there is an option to attend in person in Stockholm, Sweden. If necessary, we will switch to a completely virtual meeting. Further logistical and registration details will be announced soon.

The goals of the meeting are to:

- Review the progress made since the last Seabed 2030 Arctic-Antarctic and North Pacific Mapping Meeting in 2020 – this includes the status of IBCAO and IBCSO
- Identify new bathymetric data sources
- Develop strategies to locate and unlock bathymetric data sets
- Develop strategies to coordinate and promote new mapping activities

For further information, please contact:

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For further information please contact Pegah Souri at pegah@raittorr.co.uk