Land Information New Zealand
Toitū te whenua

Understanding the value of Hydrographic Data

March 2021

New Zealand Government

Land Information
New Zealand
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Published in March 2021
by Land Information New Zealand
PO Box 5501, Wellington 6145, New Zealand

This document is available at **www.linz.govt.nz**

Reference documents

Location	Description
https://www.linz.govt.nz/sea/charts/annual-work-programme	HYPLAN
https://www.linz.govt.nz/sea/charts/standards-and-technical-specifications-for-our-chart-and-hydrographic-work	HYSPEC

Revision history

Date	Version	Revision	Description
March 2021	1	0	First Edition

Contents

Executive summary

Land Information New Zealand (LINZ) is the government agency responsible for providing navigational products and services that support safe shipping. These products and services enable New Zealand to meet its United Nations obligations concerning the safety of life at sea.

Some of those products are charts which cover not only New Zealand but also the Sub-Antarctic Islands, Ross Sea and some Pacific Islands as shown in the figure below.

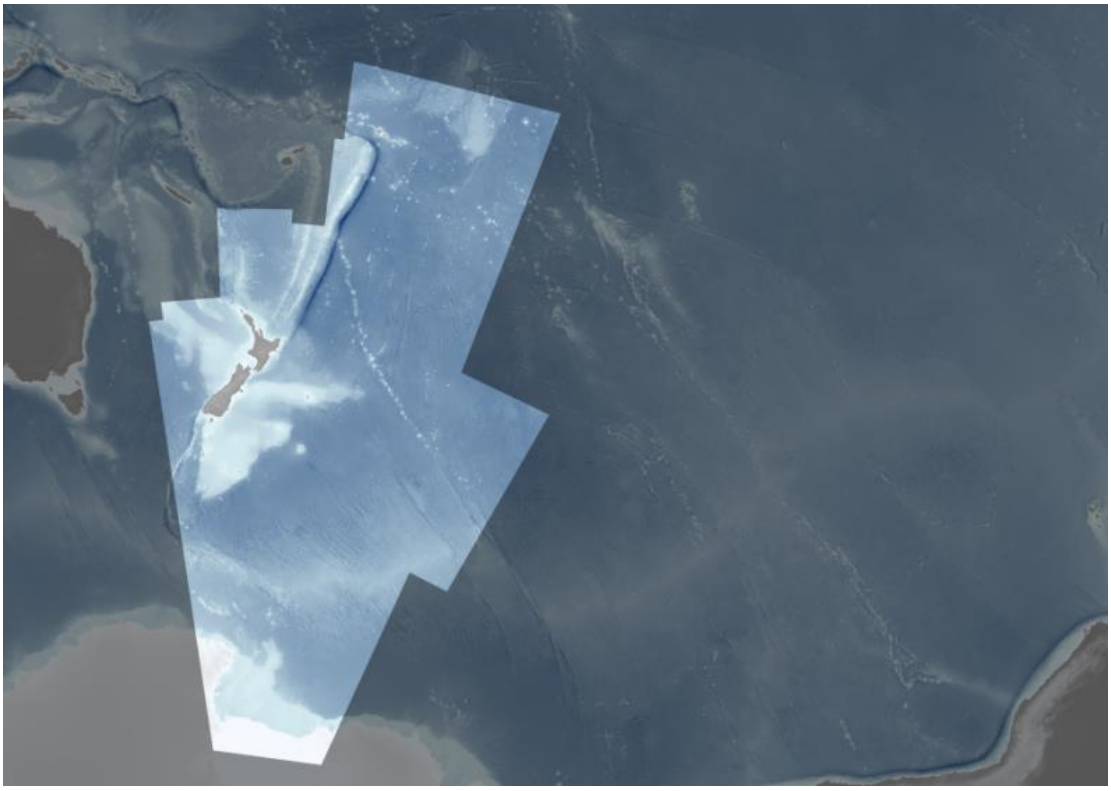

Figure 1 – New Zealands area of charting responsibility

The information underpinning these charts is captured from hydrographic surveys using tools such as sonar technologies, LiDAR, or satellite imagery.

We also collect, manage, and share marine geospatial information to enable a sustainable and thriving blue economy. The wealth of information captured during a hydrographic survey can inform a variety of communities and decision makers in marine research, aquaculture development, flood modelling and much more.

In recent years, joint hydrographic surveys have been conducted with regional councils. This allowed us to update navigation products and provided councils with the information and data required to better understand and manage their valuable coastal and marine resources.

We are looking to partner with other agencies, iwi and stakeholders as we plan our long-term hydrographic survey programme (HYPLAN) to maximise survey opportunities and broader outcomes and benefits for New Zealand.

This document sets out ways to work with us in collecting hydrographic and marine data as well as outlining possibilities of using existing data.

1 Hydrography – building resilience and empowering regional development

1.1 The big picture

71 percent of the Earth's surface is covered by water that has the capacity to absorb heat at a rate 1000 times higher than the atmosphere. As heat is absorbed, oceans will warm, and changes will occur to the physics and chemistry of the oceans.[1] We often refer to these impacts as being of a global nature, hence the term "global warming".

These changes are likely to alter climate, coastlines, habitats, and impact near-water infrastructure.

Climate change

With environmental changes, it is becoming increasingly critical to understand and predict what is happening in our surrounding waters, to ensure our communities remain resilient and our economy strong. Having the data to plan for and attempt to manage these impacts is of utmost importance.

Maritime trade

As an island nation, we are reliant on shipping for imports and exports. We have extensive urbanisation with supporting infrastructure around our coastline and we expect our communities to prosper. It will become increasingly critical for us to understand and predict what is happening in our surrounding waters, to ensure our communities remain resilient, healthy, and strong.

Maritime aquaculture

In 2018 the marine aquaculture industry provided $600 million in sales and employed over 3,000 people in New Zealand communities. The New Zealand Aquaculture Strategy sets the vision to be recognised globally as a world-leader in sustainable and innovative aquaculture management across the value chain, with a goal of $3 billion in annual sales and 6,000 jobs by 2035.[2] Understanding the marine environment is critical to support a sustainable and healthy aquaculture sector.

[1] Rear Adm. Shepard Smith, Director of NOAA's Office of Coast of Survey, Seabed 2030 Summit keynote presentation.

[2] https://www.mpi.govt.nz/fishing-aquaculture/aquaculture-fish-and-shellfish-farming/strategy/#:~:text=About%20the%20aquaculture%20strategy,in%20sustainable%20and%20innovative%20aquaculture.

Our role

Our key role is acquiring quality bathymetry to produce official nautical charts for safe navigation in New Zealand waters and certain areas of Antarctica and the South-West Pacific. We do not gather bathymetry ourselves, but instead contract specialist New Zealand based hydrographic surveying companies through a supplier panel arrangement.

Our long-term priority survey areas are set out in our HYPLAN document. A risk assessment commissioned by us was used to help identify areas of priority. HYPLAN is reviewed regularly and is used to drive annual programs of hydrographic survey work.

1.2 How can we help you?

We believe that the process of understanding our changing maritime environment begins with understanding bathymetry (i.e. the depth and shape of underwater terrain), because the terrain influences how water will move and behave across it.

As part of the process to collect bathymetric information, we also collect other information that may be of use to you, for example backscatter.

And in addition, there are opportunities for other organisations to collaborate with us on our hydrographic surveys to collect additional data. Instead of duplicating efforts and expenses to collect marine data, organisations can leverage from our surveys to collect information required for their own projects as the infographic below illustrates.

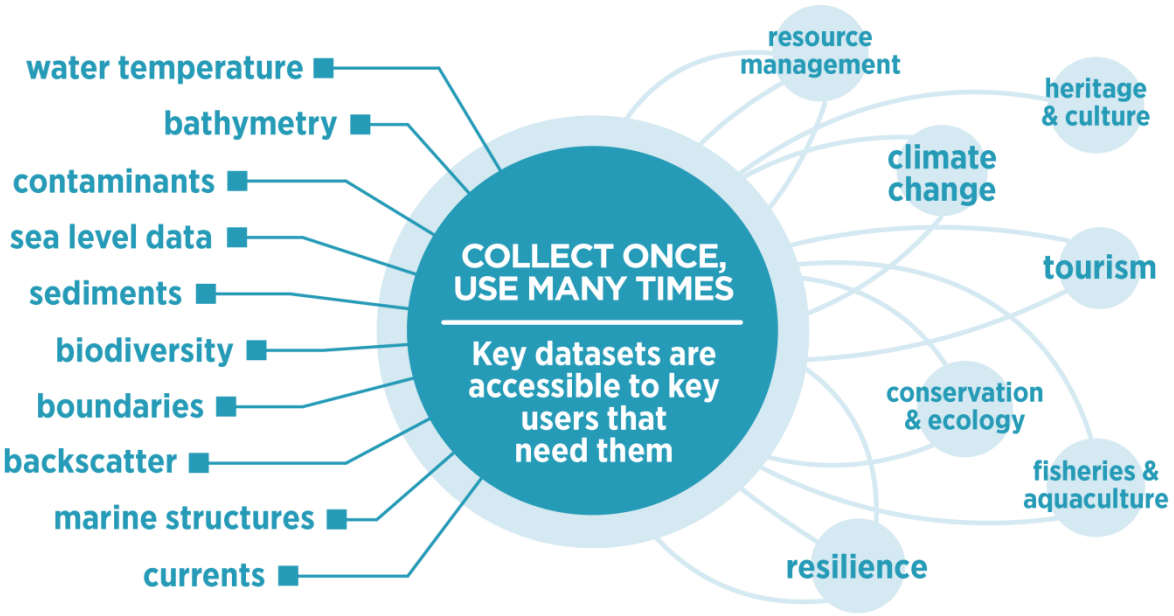

Figure 2 - Infographic of key datasets from hydrographic surveys and uses

The bulk of the cost of a survey occurs during data acquisition. There is therefore benefit for organisations to contact us when you are initially scoping for a coastal project to identify:

- any data previously collected by us in the studied area
- any opportunity to leverage the costs of having vessels and people in the field by collaborating with us.

Other benefits include leveraging our hydrographic expertise. We have extensive experience in commissioning bathymetric surveys. We understand the project complexities and risks and have developed rigorous procurement and project management processes to support this kind of work.

2 What information can be extracted from a comprehensive hydrographic survey?

We collect hydrographic data for charting purposes using our hydrographic standards and technical specifications detailed in HYSPEC. These surveys deliver a wealth of information, but only a small amount of the collected data goes onto our products.

The main dataset is a bathymetric model which shows the topography of the seabed. This model can be used to extract terrain attributes like slope and rugosity. We also collect the strength of the return signal (backscatter) which can give information about the bottom type and is a key dataset for habitat mapping. In addition, the water column reflectance is recorded which can be used to extract features above the seabed like algae, wrecks, gas plumes or fish schools.

The following sections explain in more detail the datasets we collect during a hydrographic survey, including example images from the science deliverables received by us from a joint survey in 2018 with the Ministry of Primary Industries in Kaikōura.[3]

2.1 Bathymetry

Bathymetry is depth data that allows us to visualise the shape of the submerged terrain. This information can be used to:

- help identify navigational hazards
- inform planning of coastal developments
- support monitoring of coastal and inland areas

[3] Surveyed by iXblue and processed for science by NIWA.

- enable modelling and prediction of the effects of water run-up in storm surges or tsunami and in freshwater environments
- calculate volumes of reservoirs and dams.

Bathymetric data is typically depicted as a continuous surface, often coloured from red to blue, where red indicates shallow water. Additionally, the bathymetry can be used to extract terrain attributes like seafloor rugosity, aspect, and slope, all key components in understanding the seabed habitat.

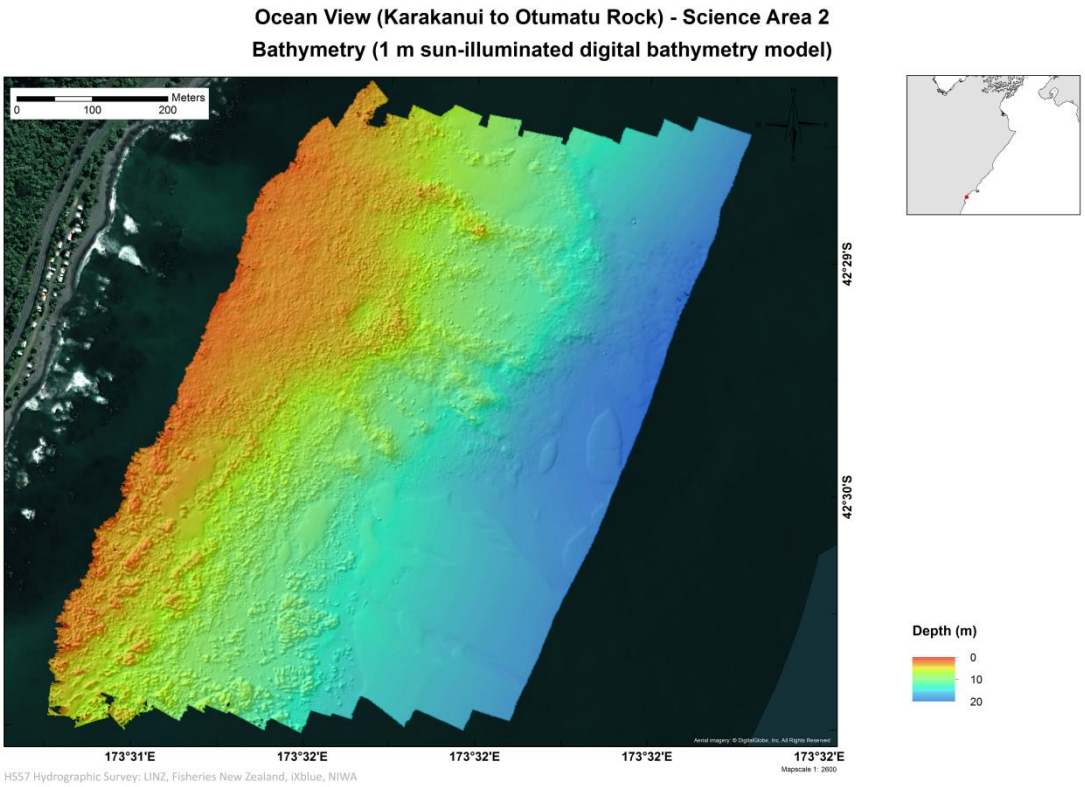

Figure 3: Example of a multibeam sun-illuminated bathymetry model.

2.2 Seafloor backscatter and sampling

As the term suggests, a multibeam echo sounder uses sound to measure the depth of water. The intensity of the reflected sound from the seabed, commonly referred to as backscatter, provides information about the texture of the seafloor. It can give an idea of the granularity of the seabed type and whether it is soft or hard.

The data underpinning this backscatter analysis is collected routinely as part of our hydrographic survey, however, where a science component is identified the multibeam settings are specifically set. Therefore, it is ideal to identify science components prior to the survey planning and acquisition.

Backscatter data is a base dataset for habitat mapping and in combination with seabed sampling the seafloor classification will be more accurate.

Our hydrographic surveys collect seabed samples, although our primary interest is for nautical charting considerations, such as anchor holding areas. Whilst the hydrographic focused seabed samples can be retained for further analysis, the ideal approach is to collect sediment samples and benthic video in locations identified from the backscatter mosaic. This detailed sampling may be required after the initial data collection phase and with dedicated sampling equipment, normally outside of the scope of our hydrographic surveys.

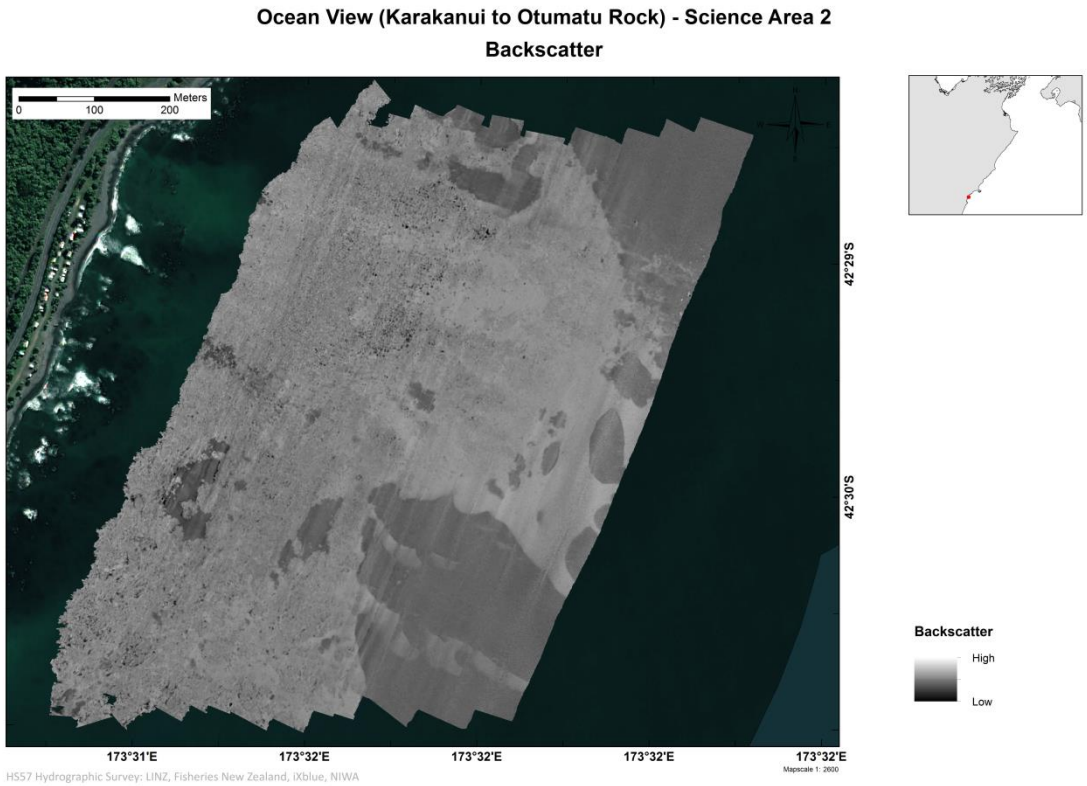

Figure 4: Example of a seafloor reflectance model with lighter colours representing high reflectivity (hard seafloor like gravel or boulders) and darker colours lower reflectivity (softer seafloor like mud or fine sand).

2.3 Water Column Data

Just as the seafloor reflects the sound transmitted by an echo-sounder, so do objects within the water column. This information can be recorded and analysed to identify features sitting above the seafloor like seeps, kelp, fish schools, moorings, shipwrecks, or other features not usually captured in seafloor bathymetry.

Typically, our hydrographic surveyors focus on the water column data to determine the least depth over shipwrecks, obstructions and features and although the data is collected across the survey area it is not processed, or viewed on a project wide scale.

For science purposes, or specific investigations, an initial inspection of the data during collection can provide an indication of types of features present within the dataset. This can be followed by an in-depth review which is time consuming.

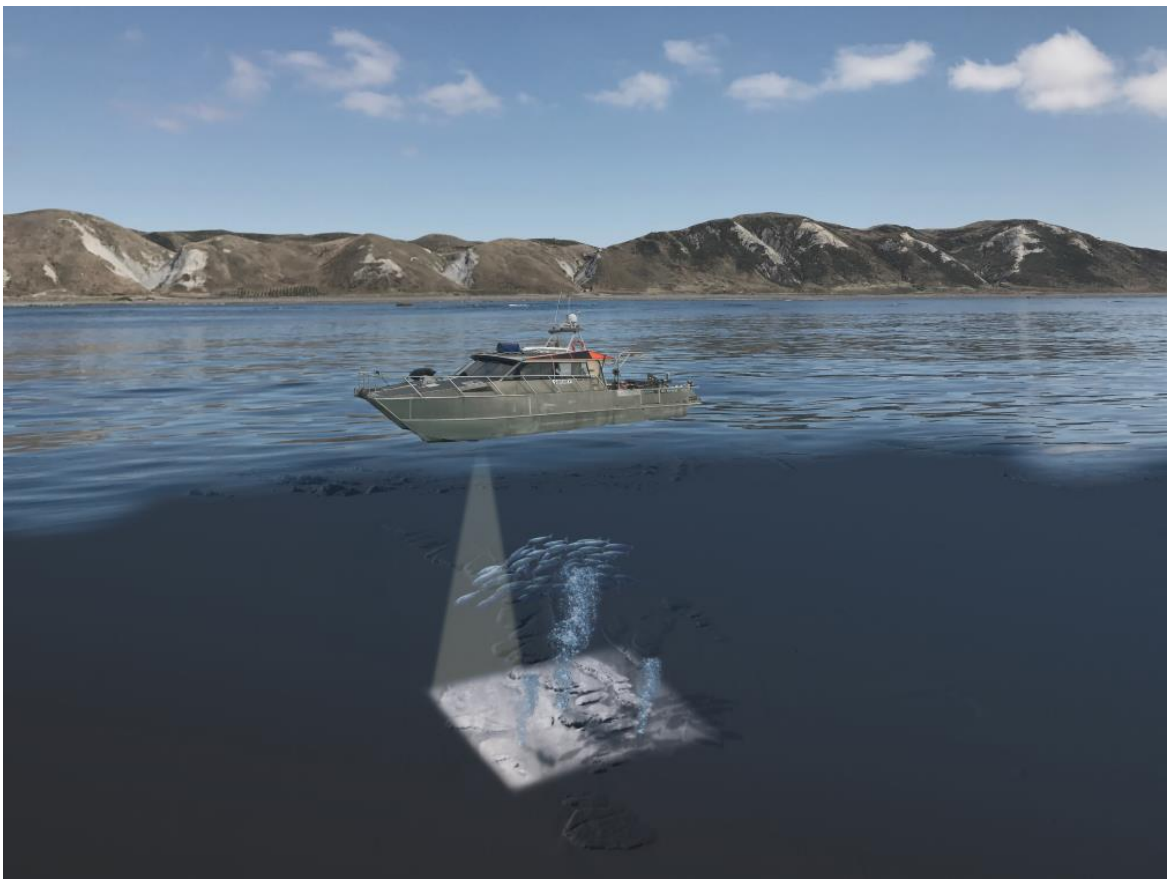

Figure 5: Example of water column reflectance which is best viewed in 3D.

2.4 Terrain attributes

The bathymetric model of the seafloor can be used to highlight terrain attributes like depth ranges, slopes (the gradient of the seafloor), aspect (the direction of the slope) and rugosity (roughness of the seafloor). This analysis is like that conducted over a land based digital terrain model of data.

It is important to note that around coastal New Zealand much of the complex terrain – which is home for most habitats - occurs in shallow depths and may not have been surveyed during our hydrographic projects.

Whilst the exact level of science data processing and analysis may be determined post data collection, these terrain attributes are relatively easy to derive from the bathymetry.

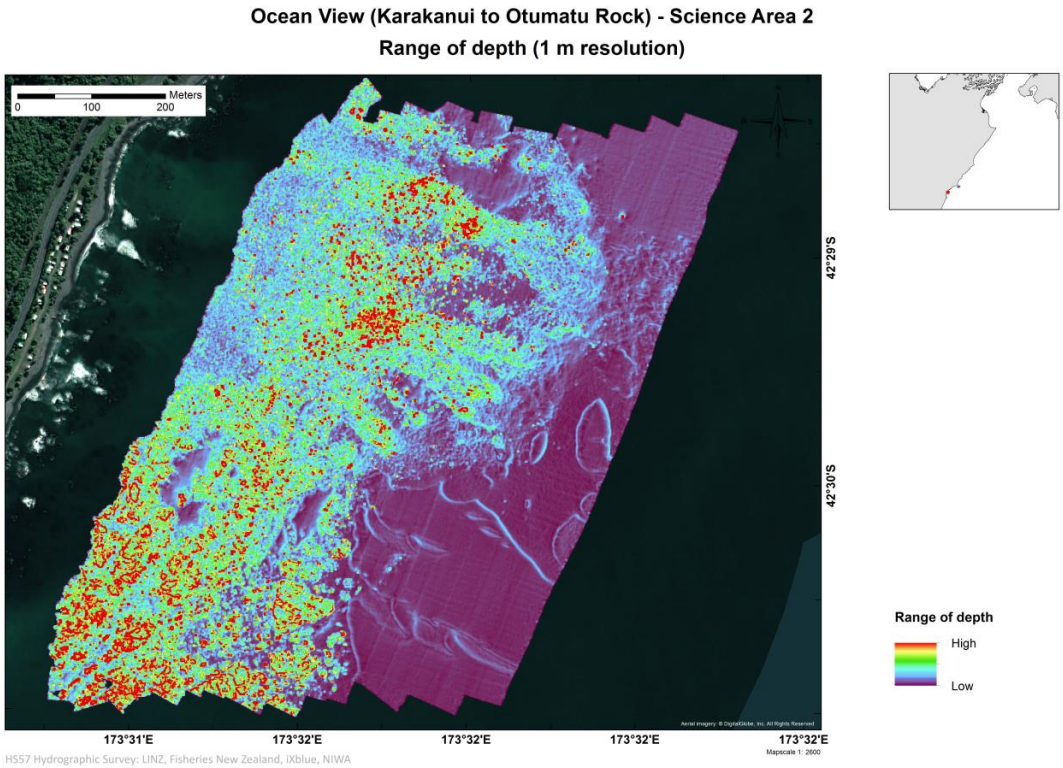

Figure 6: Example of visualising terrain attributes - range of depth.

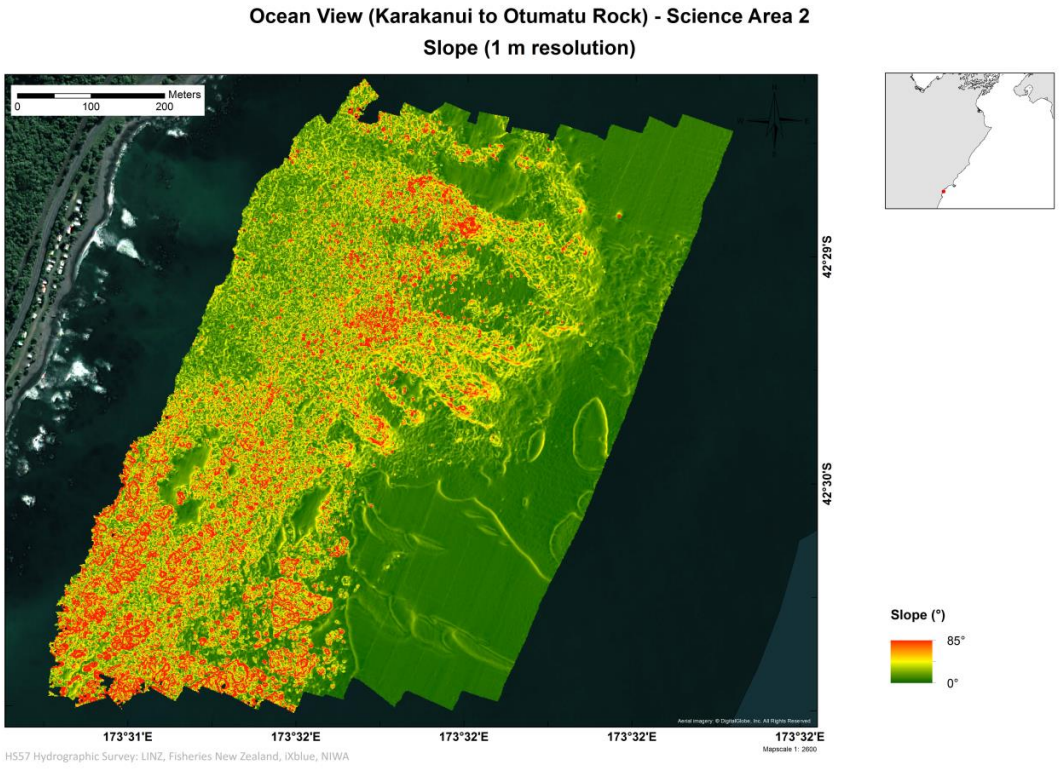

Figure 7: Example of visualising terrain attributes – slope.

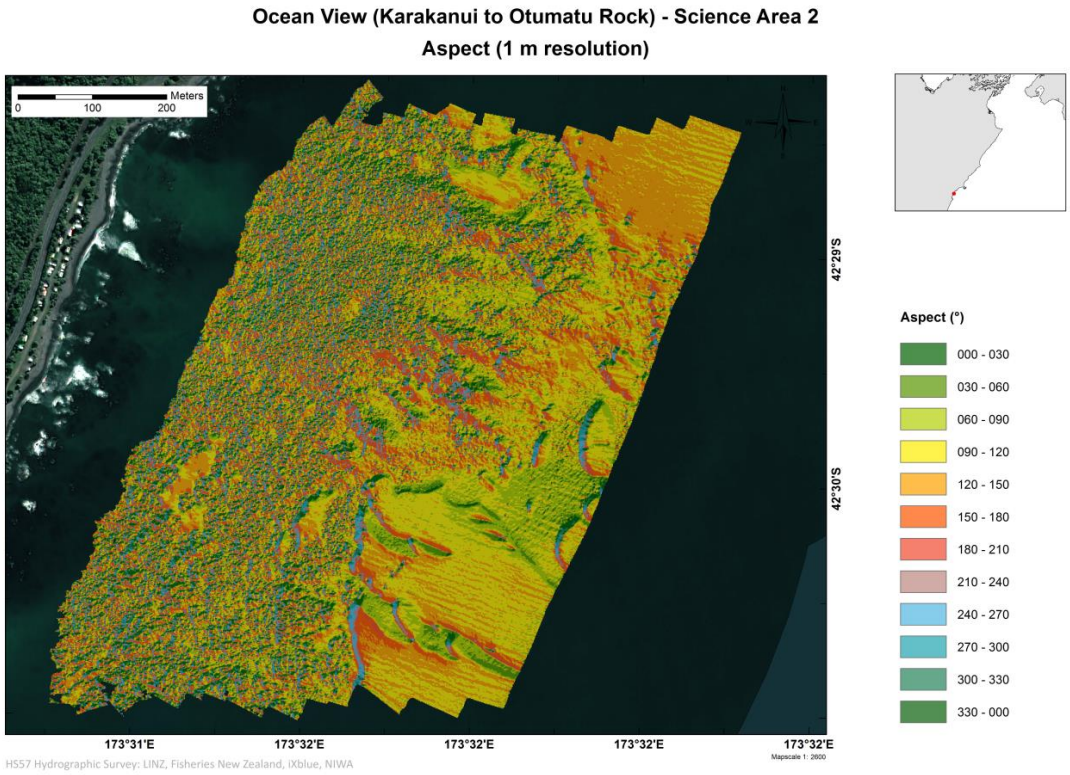

Figure 8: Example of visualising terrain attributes – aspect.

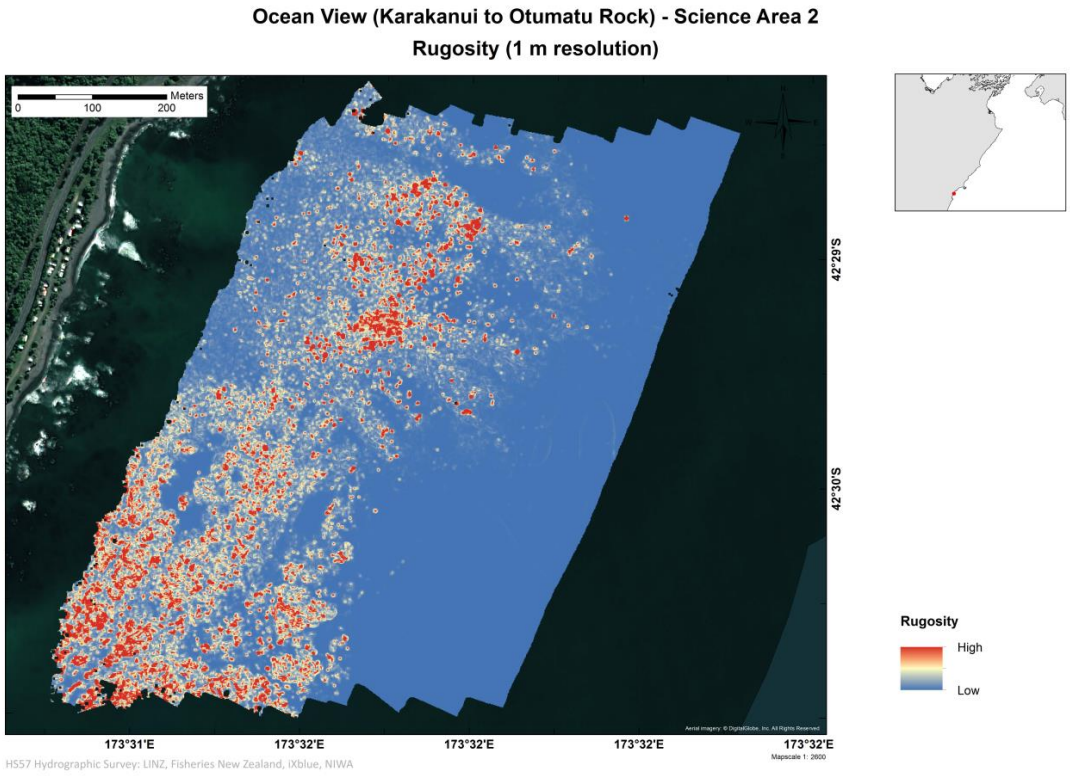

Figure 9: Example of visualising terrain attributes – rugosity.

2.5 Habitat mapping/Benthic terrain moddeling

If a driver is to understand how the seabed supports or not a particular marine habitat, further classification can be conducted. Benthic terrain modelling is a common tool to locate specific habitats by using previously listed datasets like depth, terrain attributes, backscatter and seabed samples as each predicted class has a distinctive environment. Being equipped with a greater understanding of the seabed will allow data-driven decision making in the marine environment.

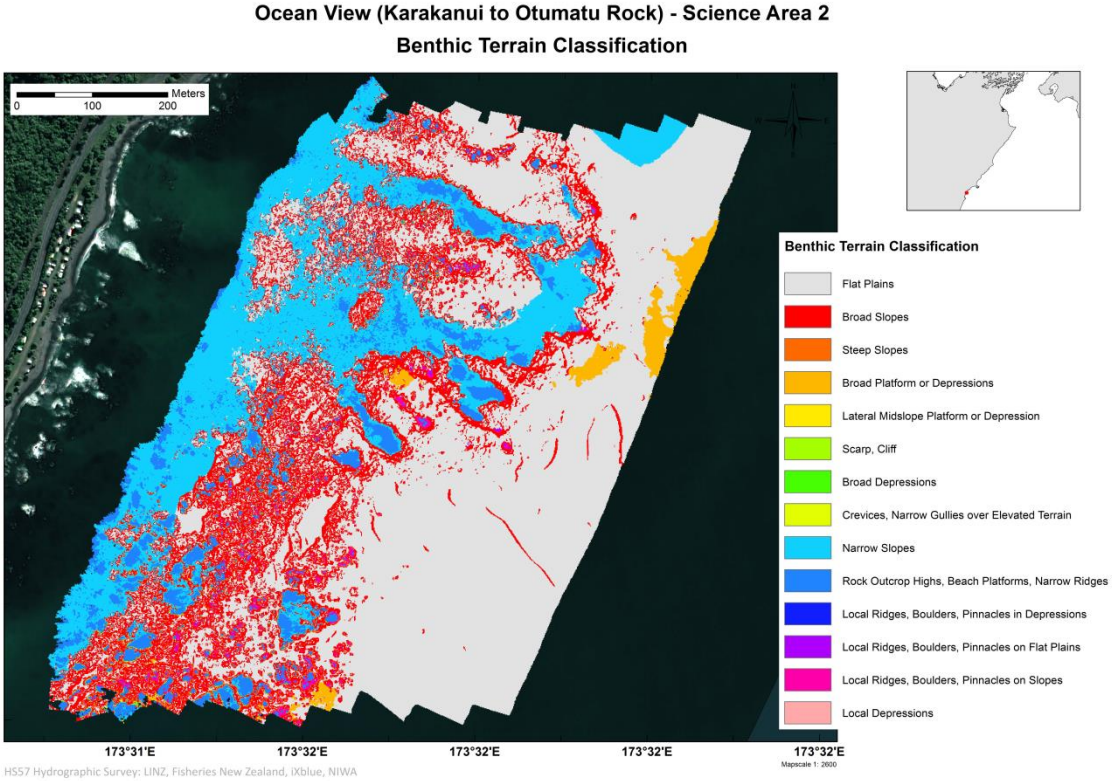

Figure 10: Example of benthic terrain classification.

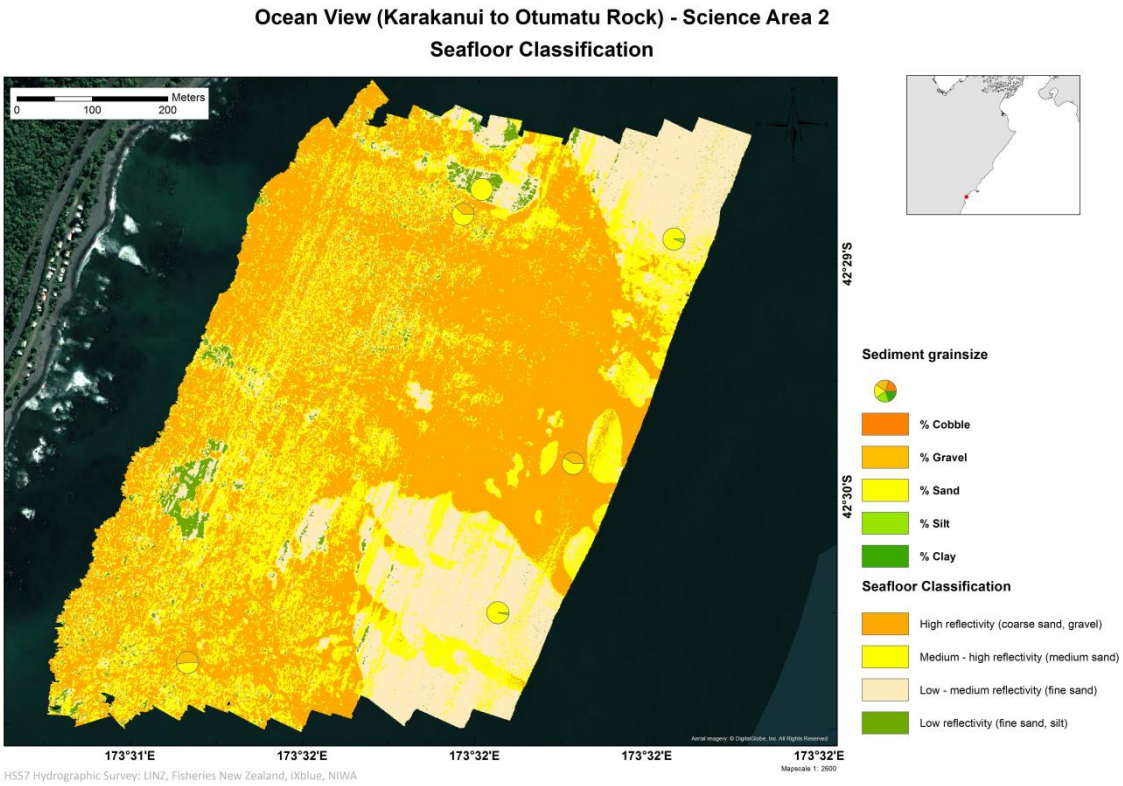

Figure 11: Example of seafloor classification.

2.6 Ancillary Data

There are additional sensors we can deploy that gather information about currents including their direction and strength, as well as water temperatures, acidity levels, and water density. These factors may influence the abundance and viability of sea-life and the safe-passage of vessels.

In recent years, we have used photogrammetry and vessel-based LiDAR (light detection and ranging) sensors to capture coastline data and visualise near-water infrastructure. This data complements the bathymetry datasets, making seamless 3D and 4D visualisation possible and can be easily integrated into a council geographic information system (GIS).

Figure 12: Example of vessel based LiDAR information. Source: Dave Field, iXblue.

During the normal course of a survey, information is gathered about aids to navigation (location and characteristics of buoys and beacons); coastal structures such as wharves, jetties, and marine farms; and the coastline.

Remotely Operated Vehicles (ROVs) can be used to capture HD video of the seabed and water column to assist with ground truthing acoustic datasets or provide further visual tools to assess the full water column. Where seabed samples cannot be taken (perhaps due to the sites being within marine reserves or in areas of cultural significance), video or photos from an ROV's underwater camera can often substitute for a physical sample.

Autonomous vessels and Unmanned Aerial Vehicle (UAV's) are considered on a case by case basis for surveys as are other developing technologies. There is potential for overlap in technologies and efficiencies to be realised if parties work together to define and schedule work packages.

This data and information could be used by you to refine your mooring or anchorage areas, update consents for shoreline infrastructure with accurate positions and imagery or provide a snapshot of coastal erosion for monitoring and planning purposes. You and your teams will have data needs that we are not aware of but may already be collecting, or could collect, with our expertise. Likewise, your teams may have data that supports our projects and frees up resources to investigate other areas.

3 Case studies

Over the last few years hydrographic data collected for charting is increasingly being utilised to answer other questions than the initial objective of the survey.

To give some examples, the following case studies are projects which used the hydrographic survey data collected by us.

3.1 Habitat mapping – Queen Charlotte Sound/Tōtaranui and Tory Channel/Kura Te Au

In 2016 the Marlborough District Council (MDC) completed a harbour risk assessment which identified a need for better hydrographic data in Queen Charlotte Sound/Tōtaranui and Tory Channel/Kura Te Au. Multibeam survey was identified as the most accurate survey method.

Similarly, the Council had recognised multibeam survey data could support effective management of the Coastal Marine Area by:

- revealing the extent and condition of important biogenic habitats
- enabling the development of tailored monitoring programmes
- enhancing an understanding of cumulative effects.

In pursuit of shared navigation safety and environmental objectives, LINZ and MDC established a partnership to undertake New Zealand's largest multidisciplinary survey covering the full extent of Queen Charlotte Sound/Tōtaranui and Tory Channel/Kura Te Au.

The survey delivered a quantum leap in access to data that can assist Council in the sustainable management of coastal resources. Specific projects that have benefited from multibeam data include:

- identification of significant habitats and ecosystems
- provision of a real time tide and current model for the Queen Charlotte Sound/Tōtaranui and Tory Channel/Kura Te Au.
- establishment of environmentally neutral anchorages for ships
- establishment of mooring management areas that address navigation, space efficiency and environmental considerations.

In addition, by making the data open source, it provides a foundation for further science in the regional coastal marine area and has already been used by several other agencies and research institutions. Examples include:

- improving understanding of sediment processes within the survey area
- mapping of ecosystem services

- modelling of species distributions
- quantifying the extent of anthropogenic impact on the seafloor.

The scale and scope of the survey, which was only possible though partnership with LINZ, means the survey data collected will continue to assist decision makers, industry and the community in managing, protecting and enhancing the coastal marine environment for many years to come.

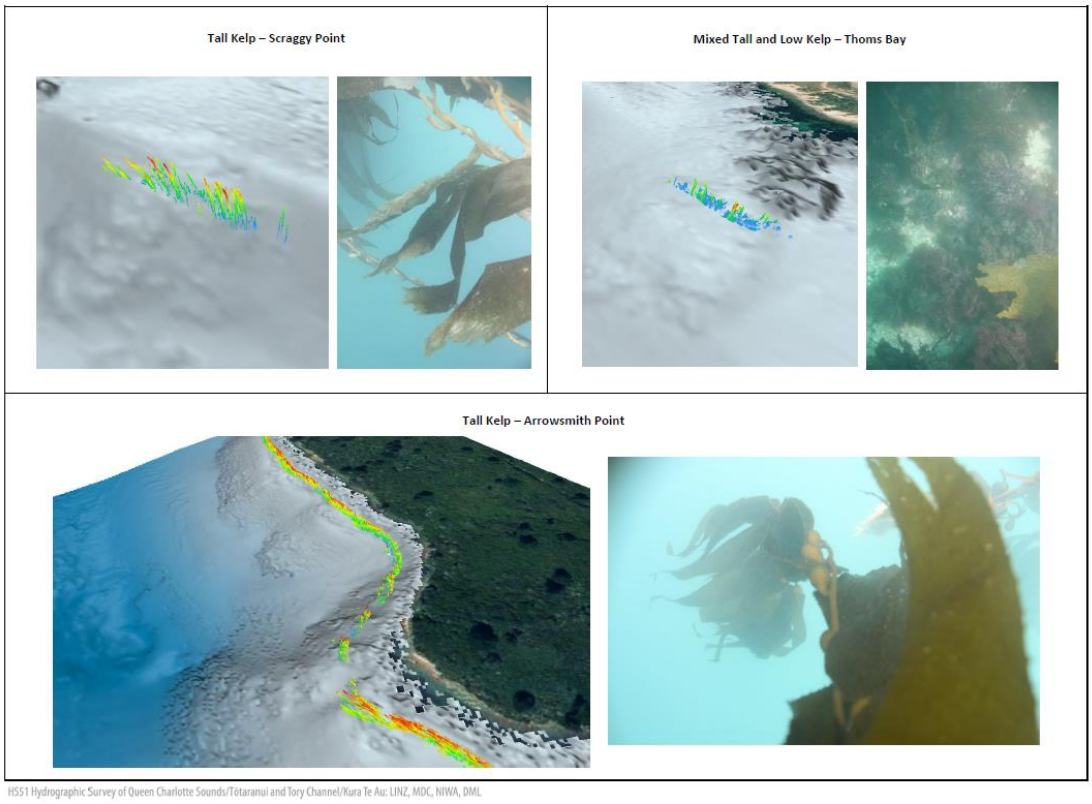

Figure 13: Queen Charlotte Sound/Tōtaranui and Tory Channel/Kura Te Au – Example of kelp water column features, one of many datasets delivered.

Related references:

https://marlborough.maps.arcgis.com/apps/MapSeries/index.html?appid=155a89b0beb74035bd1c4c71f6f36646

https://www.marlborough.govt.nz/your-council/latest-news-notices-and-media-releases/media-releases?item=id:2350c3sx41cxbys4zn42

https://www.marlborough.govt.nz/environment/coastal/seabed-habitat-mapping

Contact:

Luke Grogan, Harbour Master Marlborough Sounds, luke.grogan@marlborough.govt.nz

Oliver Wade, Coastal Scientist Marlborough District Council, oliver.wade@marlborough.gov.nz

3.2 Glaciation – Auckland Islands

In 2015 LINZ completed a survey of the east coast of the Auckland Islands to improve nautical charts in the region. During this remote survey, the survey contractor worked with Department of Conservation (DOC) to gain the necessary permits to operate within their guidelines for this unique part of the world. After LINZ used the data for nautical charting, the processed multibeam bathymetry has been combined with subaerial topography and sub-bottom seismic and coring to evaluate the Quaternary glaciation of the Auckland Islands in a series of papers published by researchers at the University of Otago.

The final datasets revealed information in the context of glaciation during the most recent Ice Age, about 20 thousand years ago, highlighting the effects of glaciation on the land and seafloor. This included classic U-shaped glacial valleys and well-preserved underwater terminal moraines. Knowing the potential of the data it is LINZ' desire to see opportunities are not missed through lack of engagement.

An open access paper published by Otago researchers in 2019 compared the new multibeam dataset with older single beam surveys in the Auckland Islands to demonstrate the usefulness of the new swath system in the context of understanding seabed characteristics such as slope, ruggedness, and aspect (see image following). However, it also highlighted that older single-point data and other information collected for charting – such as seabed type, is useful in a broad-scale understanding of an area, so long as the limitations are carefully considered. Access to past and recent hydrographic data held by LINZ was crucial for this analysis.

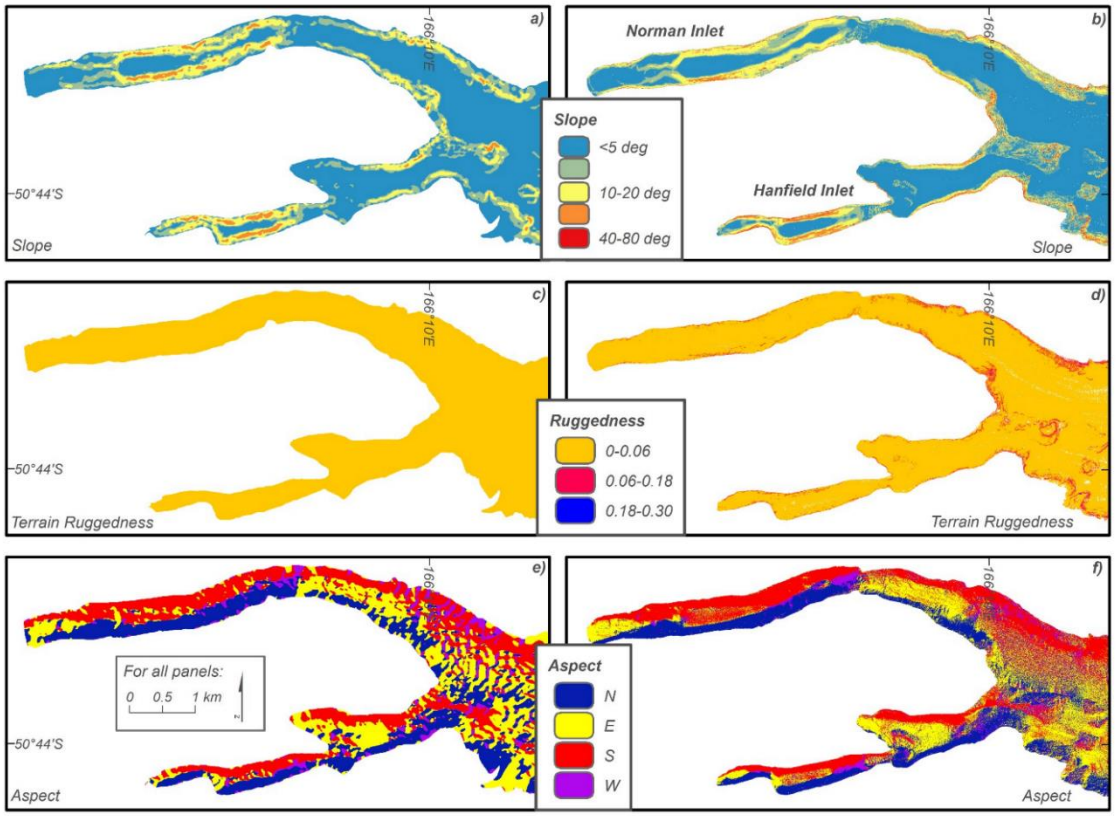

Figure 14: Comparison between singlebeam (pre 2015) and multibeam datatsets (post-2015). (a) Pre-2015 slope; (b) post-2015 slope; (c) pre-2015 terrain ruggedness; (d) post-2015 terrain ruggedness; (e) pre-2015 aspect; (f) post-2015 aspect. (Source:https://www.mdpi.com/2076-3263/9/2/56)

Related references:

https://www.otago.ac.nz/hekitenga/2019/otago731107

https://www.mdpi.com/2076-3263/9/2/56

The following papers can be requested from the contact of this case study:

Tidey, E. J., & Hulbe, C. L. (2018). Bathymetry and glacial geomorphology in the sub-Antarctic Auckland Islands. *Antarctic Science*, *30*(6), 357-370. doi: 10.1017/S0954102018000342

Gilmer, G., Moy, C. M., Riesselman, C. R., Vandergoes, M., Jacobsen, G., Gorman, A. R., Tidey, E. J., & Wilson, G. S. (2021). Late Pleistocene and Holocene climate and environmental evolution of a subantarctic fjord ingression basin in the southwest Pacific. *Quaternary Science Reviews*, *253*, 106698. doi: 10.1016/j.quascirev.2020.106698

Contact:

Emily Tidey, lecturer at the National School of Surveying at the University of Otago, emily.tidey@otago.ac.nz

3.3 Undersea feature naming – Fiordland

From the time New Zealand's coastal sea floor was first mapped, hydrographers have named undersea features on hydrographic charts and bathymetric maps.

One of the functions of Ngā Pou Taunaha o Aotearoa New Zealand Geographic Board (the Board) is to make these existing recorded undersea feature names official. The Board also officially names newly discovered features on the ocean floor. By making undersea feature names official the Board is ensuring that there is one agreed and correct name for use in scientific publications and databases, and on maps and charts. The Board must also ensure that its data is accurate and able to be re-used.

In February 2020, using bathymetric data provided by LINZ, the Board's Undersea Feature Names Committee was able to confirm the existence and extents of a number of undersea basins named on bathymetric maps of Fiordland published in the 1970s and 1980s. Wilmot Basin provides an example of the usefulness of LINZ's bathymetric data for defining and officially naming an undersea feature.

Wilmot Basin, which is near the southern end of Hall Arm in Doubtful Sound / Patea, was first named on Irwin & Main's 1981 Doubtful Sound SE chart. It was likely named in association with Mount Wilmot ~8.5km to the east, which is a prominent land feature.

Using the multibeam echosounder (MBES) data from the HS58 Fiordland survey in 2019, the Undersea Features Names Committee was able to determine a more accurate depth of 91m and that the basin extends further north to the 68m contour and not to the 80m contour as shown on the 1981 chart. This correct extent is now shown in the Board's Gazetteer.

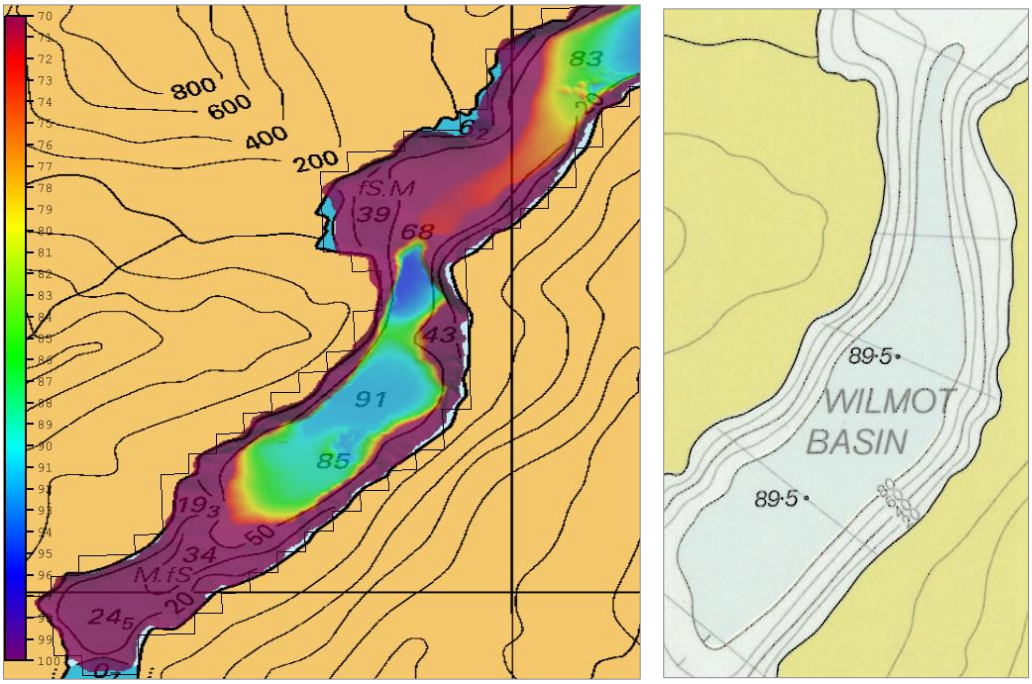

Figure 15: Image on the left: Data provided from the 2019 HS58 Fiordland survey. Image on the right: Doubtful Sound SE chart©, Irwin & Main, 1981.

Related references:

https://gazetteer.linz.govt.nz/place/14940

Contact: Jill Remnant, NZ Geographic Board Advisor, jremnant@linz.govt.nz

3.4 Health management of the seabed – Hauraki Gulf

In 2016, DML and iXBlue were engaged by LINZ to collect hydrographic data in Kawau Bay, Approaches to Auckland and Tamaki Strait. The primary objective of the surveys was to improve navigational safety in the region by collecting modern multibeam echosounder data to LINZ specifications.

Guided by the "capture once, use many" principle, acoustic backscatter data was also collected in all areas, but not processed as part of the charting project. In 2019 Auckland Council requested the backscatter data under the CC BY 4.0 licence and funded a project to process the backscatter data into high resolution mosaics for the three areas. The imagery mosaics along with the accompanying bathymetry will be used to help identify and map habitats of ecological significance throughout the Hauraki Gulf. Auckland Council has already shared the data with NIWA and DOC to aid in their research, such as the location of mussel beds and targeting areas for further investigation.

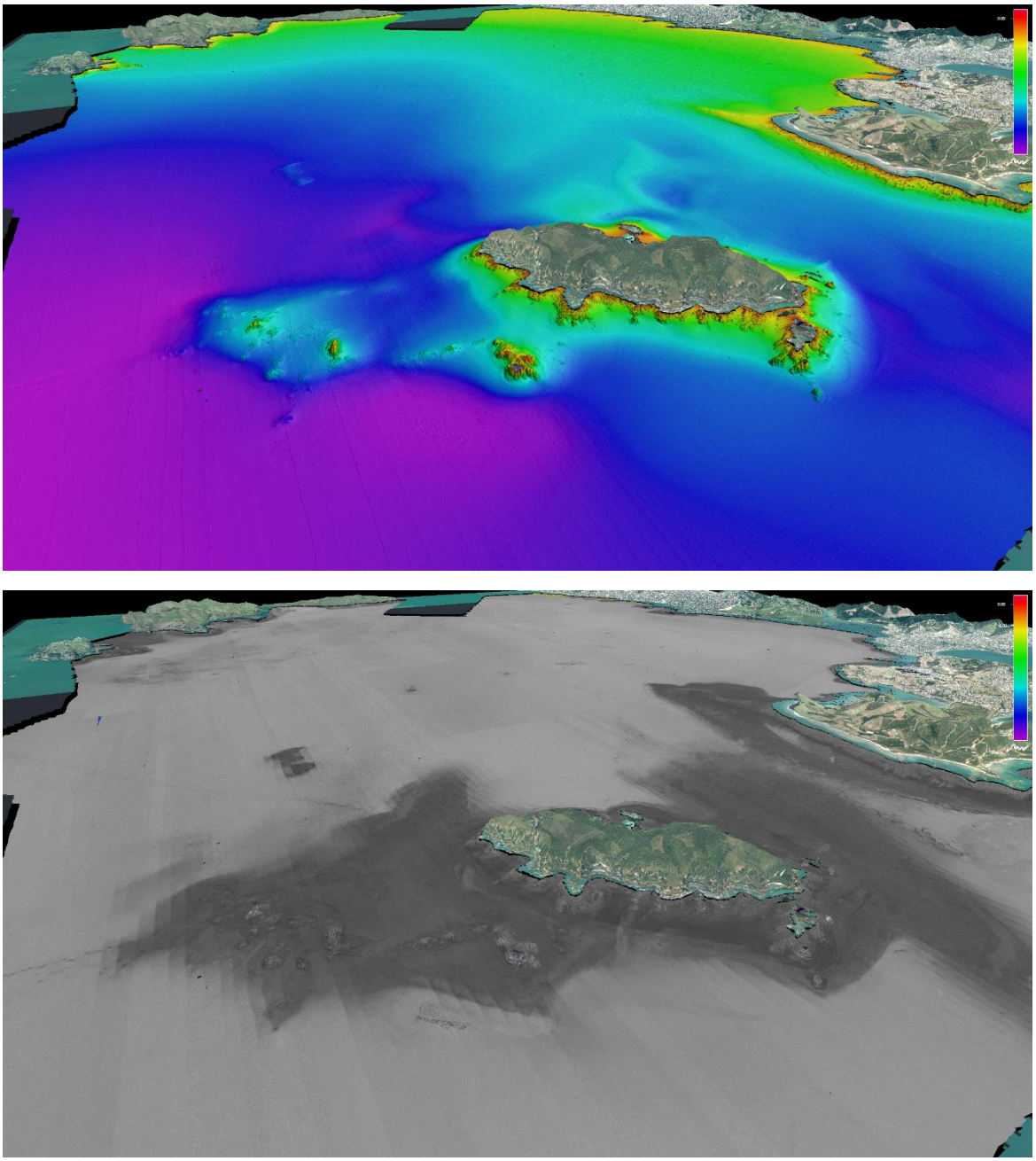

Figure 16: Bathymetry (top) and backscatter (bottom) of HS52 – Approaches to Auckland with lighter colours in the backscatter representing high reflectivity (hard seafloor like gravel or boulders) and darker colours lower reflectivity (softer seafloor like mud or fine sand).

Contact: Dimitri Colella, Auckland Council, dimitri.colella@aucklandcouncil.govt.nz

4 Ways to work with us

4.1 Existing data

Our hydrographic survey data meets the high-quality standards required to produce and update authoritative products, such as nautical charts.

This data can also be used for further analysis to support scientific research into areas such as seabed habitat mapping, anthropogenic impact and monitoring marine aquaculture farms.

The case studies presented in this document show how hydrographic data, collected to improve navigation safety, can be used for other applications and analytical research.

Datasets, including ready to use bathymetric models, are discoverable through the LINZ Data Service and freely available.

4.2 Financial partnership

While data we have collected can be processed at a later stage to answer scientific questions there are benefits in collaborating with us on future data collection. This includes leveraging technical knowledge, procurement and contract management expertise, and cost efficiencies in collecting a wider range of data at the same time.

A good example of a partnership is the survey of Queen Charlotte Sound / Tōtaranui and Tory Channel / Kura Te Au which is listed as a case study. We worked with Marlborough District Council to clearly define the requirements and specifications to meet each organisation's needs. Marlborough District Council funded the collection and processing of data outside our areas of interest, as well as the data analysis to answer their science questions. All data collected was made available to both parties and is now freely available to the public.

Future survey areas are identified and prioritised in HYPLAN which can be found on our website. We encourage you to get in contact with us (hydro@linz.govt.nz) if you are interested in any of the areas listed in HYPLAN. We are open to expanding or re-prioritising areas where possible to fit with partner funding availability. We are constantly reviewing HYPLAN and our priorities and if you have hydrographic survey needs for safety of navigation, please contact us.

4.2.1 Principles

To make sure that our partnerships for gathering hydrographic data work well, we have developed the following principles:

1. **Any survey needs to meet the need for safety of navigation.** First and foremost, survey work will need to be in an area where information is needed for ensuring safety at sea. We have identified these areas by priority in our HYPLAN.

2. **Surveys need to meet our specifications and the data collected will be used for keeping our charts up to date.** The data can be used for other purposes. But it is important that it is up to the right standard for updating our charts and navigation products.

3. **Projects will represent strong value for money.** As a government agency, it is important we are responsible. This means the project works well for both parties – we cannot subsidise other organisations' work.

4. **Data collected will be open data.** We believe that publicly funded data should be open data wherever possible. This means it can be freely used, re-used, and redistributed by anyone. We recognise that in some situations there might be data that is commercially sensitive for our partners. In these cases, we are happy for that to remain confidential, but navigation data would still be made open.

5. **Should have clear benefits to New Zealand.** We are looking for a partnership that will have clear benefits, and if possible, make a difference for New Zealand. A partnership will demonstrate New Zealand's capability being enhanced and maintained in, for example, research, science, or hydrography.

4.2.2 Principles in Practice

If there is potential for working as a partnership, this will be formalised through a 'partnering arrangement.' This will help set expectations, including what is in and out of scope; financial commitments of all parties; and how communications on the project will be handled.

True to principles: the principles we described for assessing potential partnerships will be relevant throughout the partnership, e.g. a partner must allow data to be made available, at the very least for nautical charting; and as much as possible, as open data.

Shared understanding: both partners have a consistent understanding of each other's own business objectives and of what each expects of the supplier of survey services.

Commitment to agreed business outcomes: it is vital we all get the outcomes we agreed.

Respect and trust: each party respects and trusts each other, and each party works actively to maintain that respect and trust.

Communication: is constructive, open, prompt, transparent and honest. We take a 'no surprises' approach so that all public statements about the partnership and its business should be jointly agreed beforehand.

Collaboration: challenges and issues are solved collaboratively and jointly – a 'one team' approach. We will leverage modern work styles and technology to maximize effective collaboration.

Timeliness: the acquisition of bathymetry is complex requiring significant coordination to accommodate operational constraints of working at sea. Project efficiencies can be achieved if parties engage early and expediate key decisions.