AUS SEABED

21 July 2020

AusSeabed Annual Report

2019/20

ausseabed.gov.au

Foreword

Oceans are critical to the health of the Earth's ecosystem, and yet, they are poorly understood relative to the terrestrial environment. Australia presides over one of the three largest exclusive economic zones (EEZ) on the planet[1]; however, our responsibilities extend beyond this, in terms of search, rescue, and research.

In Australia, the value of our marine estate is very large, with contributions of our Blue Economy estimated at $70 billion per annum[2]. With more than 99 per cent of all trade relying on the maritime transport sector[3], and over 85 per cent of Australians living within 50 km of the coast, the well-informed management of our marine estate, through access to adequate knowledge, is essential to our society.

Seabed mapping is critical to activities that underpin sustainable development of Australia's Blue economy, the environmental management of our marine estate and the wellbeing of Australians through safe navigation, coastal and ocean modelling, habitat prediction, fisheries management and marine infrastructure planning. The benefit to cost ratio of seabed mapping has been investigated by a number of studies[4, 5, 6] and estimates give a range of returns, from a conservative 4:1 to an extensive 30:1 on a per dollar basis, depending on the nature of direct and indirect benefits assessed and the particular regional economy.

Despite the significance of seabed data, less than 40 per cent of the Australian seabed is mapped at adequate resolution for these crucial needs and services. These data cost millions of dollars to acquire and have great potential for reuse, yet most are almost inaccessible, existing in disparate holdings and processed to varying standards. Since 2018, AusSeabed is addressing this knowledge gap.

This Annual Report highlights the great progress made in 2019/20, which is a testament to the commitment of the community and the relevance of the program. Personally, it has been a humbling and fulfilling experience to have had the opportunity to help guide the AusSeabed program and work alongside the many passionate and talented people that make up the global and national seabed mapping community. Please enjoy reflecting on the 2019/20 year that was, as I have, and join me in congratulating the AusSeabed community on a stellar performance that has gained national and international recognition.

Ms Kim Picard, Chair of the AusSeabed Steering Committee

Community Value Statement

AusSeabed brings the marine community together to build and promote the value of seabed data, addressing the varied needs of our collaborators: government, academic and industry. This initiative aims to address the connectivity of seabed mapping in the Australian maritime region of responsibility, improving access to data through an open, inclusive network and a centralised Data Hub. Whilst the current value of AusSeabed is recognised as its contribution to establishing a cooperative and supportive cross-sector network and community, including the collaborative development and maintenance of standards and guidelines, the future value will be delivered through data sharing, access and discoverability as the Data Hub becomes fully operational.

Comments from our Stakeholders

"As a marine park management agency, AusSeabed provides us with professional expertise and advice on hand; development of a national system (methods, data management and storage, and visualisation products) to make best use of limited resources and avoid duplication of effort; and an easy way to convey our mapping priorities to the mapping community."

— Dr Cath Samson, Assistant Director Marine Science Program, Parks Australia

"As a marine surveying company, we rely on quality historical data and information to inform our business proposals. AusSeabed's marine data portal provides free and easy access to vital seabed data, which helps us develop informed proposals to work with government tenders around Australia. This valuable service enables us to identify key areas to survey, and plan safe navigation routes - all before we board a vessel. In return, we are able to focus our resources on delivering high-quality marine coastal surveys to support Australia's government and people."

— Dr Elizabeth Johnstone, Marine Geophysicist, iXblue

Contents

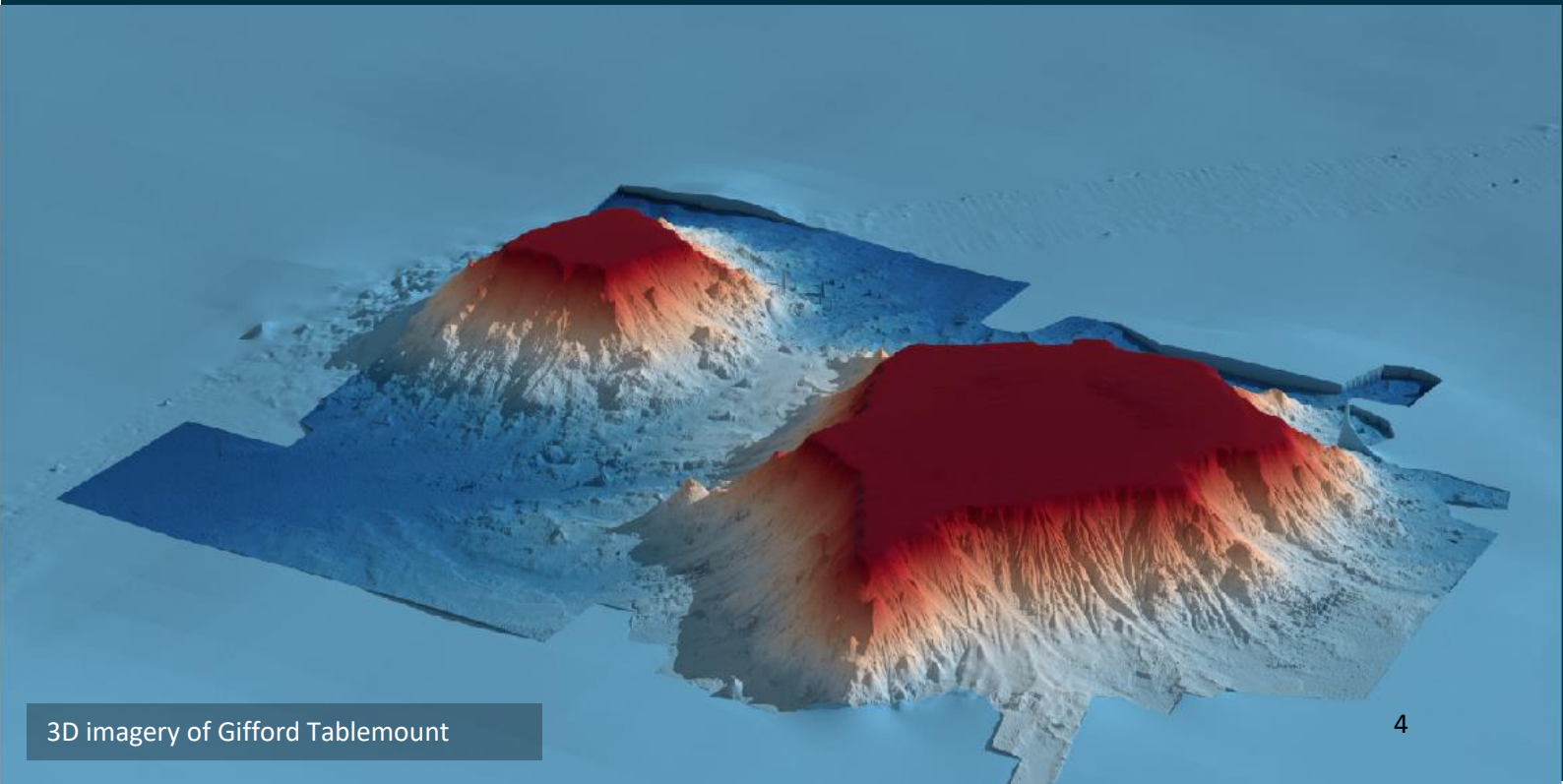
AusSeabed

Our Vision

By 2030, all available seabed mapping data within the Australian Marine Estate will be readily and openly available, and new data acquisition will take into account the needs of a wide range of users. This will facilitate collaborations between government, research institutions and the private sector while contributing to the blue economy and opening up new avenues for scientific investigation.

Our Mission

Improve the awareness, coverage, quality, discoverability and accessibility of seabed mapping data through coordination and collaboration in the Australian region.



3D imagery of Gifford Tablemount

Executive Summary

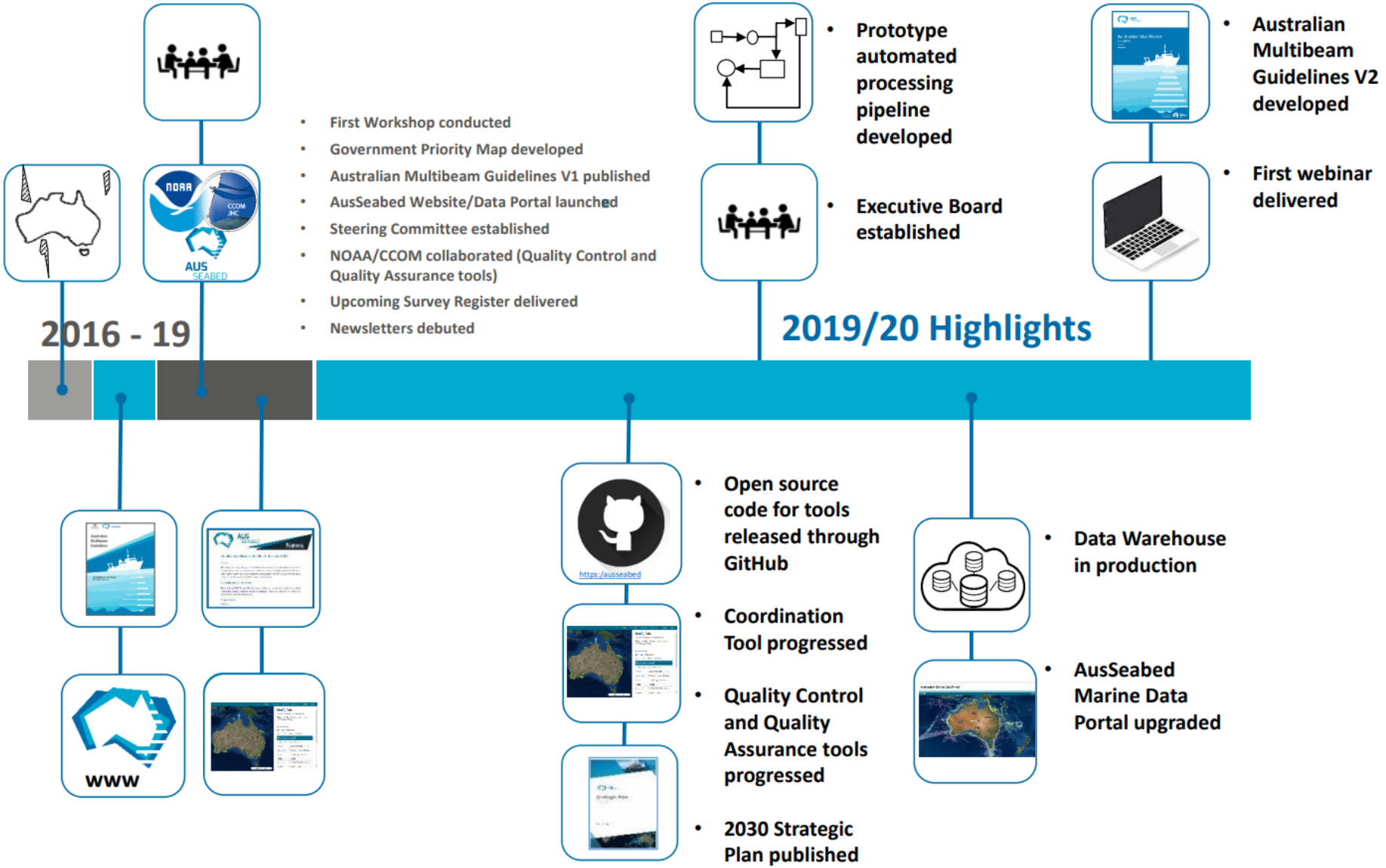
Established officially in late 2018, AusSeabed is the Australian seabed mapping coordination program. It brings together government, academia and the private sectors to facilitate the delivery of all available seabed mapping data within the Australian maritime region of responsibility and ensures that new data acquisition will take into account the needs of a wide range of users.

The AusSeabed Annual Report includes four sections covering the program governance and then cycling through the three program themes: (1) Data Hub, (2) Tools, Guidelines and Standards, (3) Outreach, Education and Training. Each section highlights the main achievements for the theme with more detailed updates being available in the appendices: A, B, C and D. Appendix E contains a summary of the data contributed to the AusSeabed Data Hub this year.

As demonstrated through this Annual Report, the 2019/20 year has been very productive with a considerable shift from program and community building to infrastructure development. The establishment of the AusSeabed Executive Board was the final piece of the governance puzzle initiated in 2018/19, providing a framework to oversee the strategic direction of the program in line with national priorities and actively champion AusSeabed. This year also saw the first renewal of general membership positions on the Steering Committee through a transparent nomination and election process. Both of these achievements are important steps towards ensuring that the AusSeabed program is enduring, and remains relevant and impactful to the nation.

Under the three program themes, we have developed a prototype of the AusSeabed Processing Pipeline and Data Warehouse, upgraded the AusSeabed Marine Data Portal infrastructure, increased our bathymetry data holdings, delivered the AusSeabed Coordination Tool, further developed the Quality Assurance Tool, and published Version 2 of the Australian Multibeam Guidelines, all whilst engaging with successful interstate and international outreach.

The 2019/20 achievements of the program themes are testament to the ongoing commitment from collaborators across sectors and effective community consultation. The progress made this year contributes to catalysing and cementing new working relationships, and amplifies the impact that the AusSeabed program will have on activities occurring in Australia.


2016 - 19
First Workshop conducted
Government Priority Map developed
Australian Multibeam Guidelines V1 published
AusSeabed Website/Data Portal launched
Steering Committee established
NOAA/CCOM collaborated (Quality Control and Quality Assurance tools)
Upcoming Survey Register delivered
Newsletters debuted
2019/20 Highlights
Prototype automated processing pipeline developed
Executive Board established
Australian Multibeam Guidelines V2 developed
First webinar delivered
https://ausseabed
Open source code for tools released through GitHub
Coordination Tool progressed
Quality Control and Quality Assurance tools progressed
2030 Strategic Plan published
Data Warehouse in production
AusSeabed Marine Data Portal upgraded
www

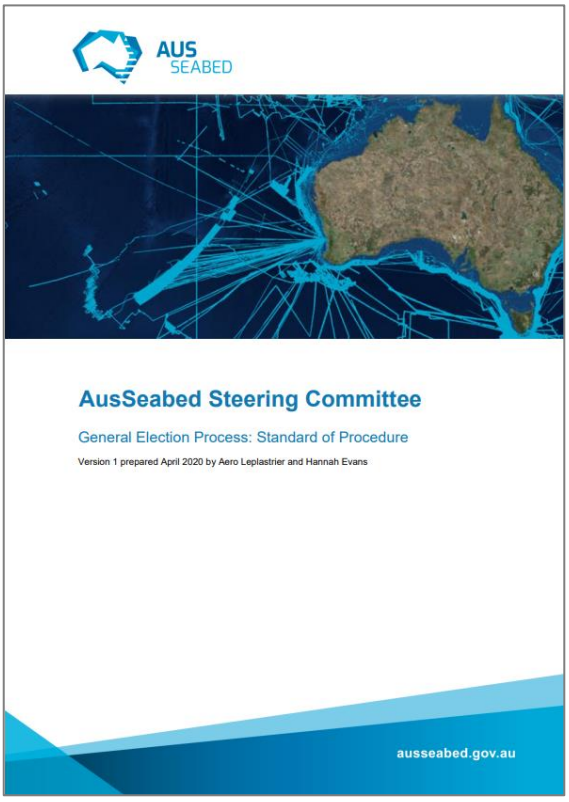
AusSeabed Executive Board Establishment

In 2019/20, AusSeabed saw the establishment of an AusSeabed Executive Board in December 2019 to advise on the development of the AusSeabed strategic agenda. Further, the Board actively champions AusSeabed by communicating, alongside the Steering Committee, the value of seabed mapping and the initiative. The Board, made of five member organisations from the Commonwealth Government, is now progressing the development of a Collaborative Head Agreement (CHA). This aims to formalise the collaboration between partners and their commitment, as well as facilitate the development of future AusSeabed projects and provide an enduring solution.

Steering Committee Diversification through the 2020 Election

This year saw the first elections of the staggered renewal process for the AusSeabed Steering committee take place. Of the ten general memberships that comprise the committee, five positions were up for renewal. The Standard Operating Procedure, established this year, was used to guide the process and ensure transparency. On behalf of the community, we would like to extend our thanks and appreciation to the outgoing representatives who have made considerable contributions to the efficacy of this program:

- Academia: James Cook University and the University of Tasmania
- State Government: New South Wales Department of Planning, Industry and Environment
- Industry: Guardian Geomatics
- Commonwealth Government: Australian Antarctic Division



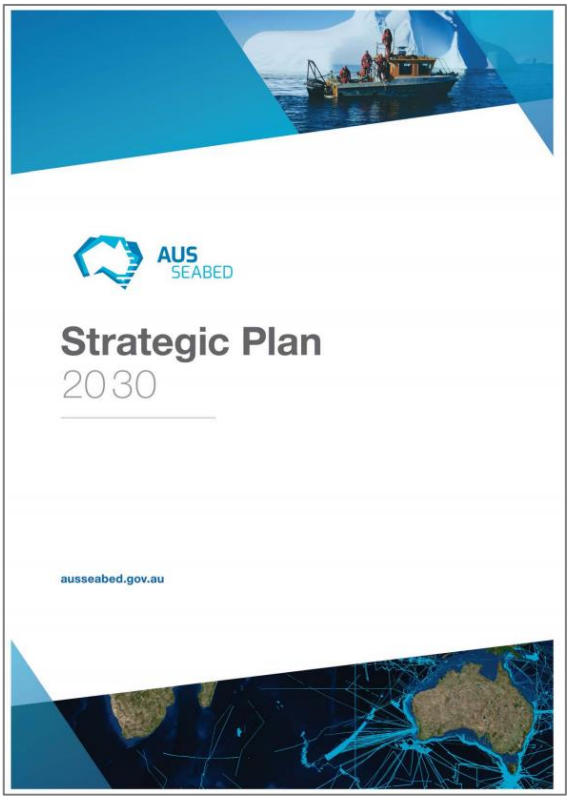
The election process saw eleven worthy nominations for the five available positions, a gesture that shows a continued interest in the work the AusSeabed program is carrying out and its relevance to the Australian seabed mapping community. Our thanks go out to all those who applied and hope to continue our program of work alongside you regardless of the result. We would like to remind everyone that opportunities to serve on the AusSeabed Steering Committee will come around each year.

The following organisations are the incumbent 2020 AusSeabed Steering Committee general representatives. We welcome the new member organisations who will bring great diversity of perspectives to the group during their two years tenure.

- Academia: Curtin University
- State Government: the South Australian Research and Development Institute and New South Wales Department of Planning, Industry and Environment
- Industry: IIC Technologies Australasia
- Commonwealth Government: The Department of Agriculture, Water and Environment

Long-term Vision: Strategic Plan 2030

The 2019/20 year saw the development and publication of the AusSeabed Strategic Plan 2030. The Plan outlines the overall program vision and the mission, as well as the program scope and structure, which is based on three program themes – (1) Data Hub, (2) Tools, Guidelines and Standards, and (3) Outreach, Education and Training. The Plan establishes the role occupied by AusSeabed within the broader Australian marine science community and the niche contribution that the program is positioned to make. Plans to define the ten year work plan is now underway.



2020/21 Work Plan

The AusSeabed 2020/21 work plan, to be published in August 2020, was developed by the Steering Committee and endorsed by the Executive Board in late June. The work plan is bold and targets impactful outcomes for AusSeabed. Four main objectives and strategies, which contribute towards meeting the 2030 fundamental strategic program goals, guide the program of work. While AusSeabed will continue servicing a broad range of Australian and international users next year, the program focuses on securing enduring support to ensure AusSeabed continues to provide value to the community in the future.

by diversifying the Steering Committee membership with end-users representatives *by pro-actively engaging with end-users to co-design infrastructure and services*	*by easing the process to submit data or integrate new 'local hubs'*
by formalising agreements amongst core organisations *developing attractive prototypes and funding proposals*	*through uptake of AusSeabed Coordination Tools* *increased number of stakeholders and end-users using or recommending AusSeabed guidelines*

Work Plan 2020/21 objectives and strategies based on the 2030 strategic program goals (grey area) .

Data Hub

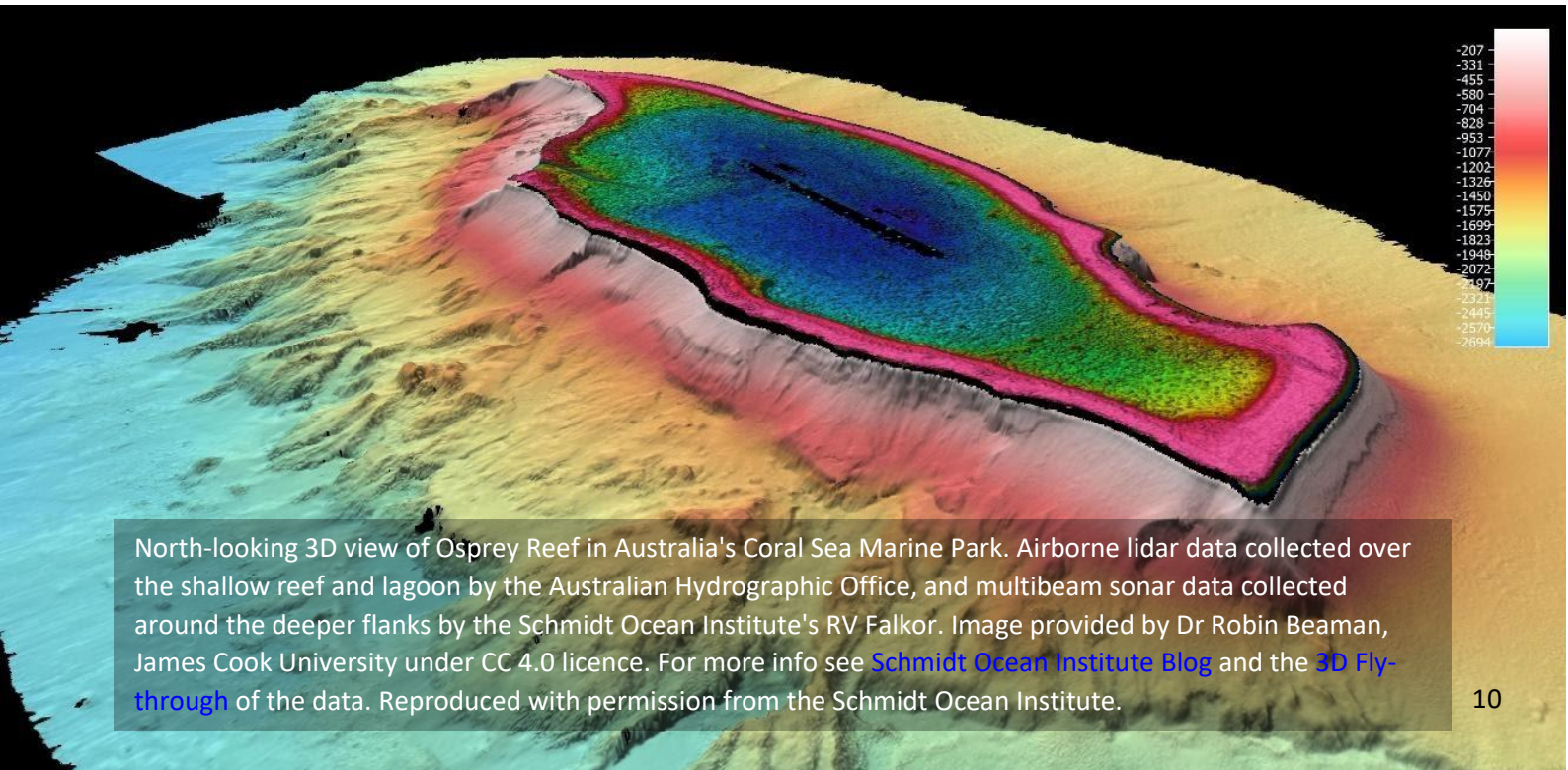
The Data Hub theme aims to develop a centralised system that delivers a standard suite of freely available seabed products while linking data providers to allow for the maintenance of custodianship. The work theme is led by Geoscience Australia.

Semi-automated processing and publication of bathymetry products through prototype AusSeabed Data Hub

A prototype of the AusSeabed Processing Pipeline and Data Warehouse, built in AWS, has allowed a rapid increase in the speed that gridded bathymetry products (as supplied by collaborators) are published online through the AusSeabed Marine Data Portal. The proof of concept was trialled with Deakin University's Apollo Bay survey before being put through its paces with the R/V *Falkor* "Visioning the Coral Sea" survey data. The utilisation of processing standards and the development of the new infrastructure allowed for the publication of data through the AusSeabed Marine Data Portal within two weeks of the vessel returning to port. The process was described by the Schmidt Ocean Institute as the most expeditious public data release that they had seen. This milestone sets a new benchmark for data delivery and is a deliberate step towards developing global best-practice in bathymetric data sharing and efficient data management.

In addition, the AusSeabed Data Warehouse infrastructure allowed CSIRO to deliver a trial dataset through the portal by emulating the structure and delivery conduits utilising a third-party software, meaning that the vision of the AusSeabed Data Hub becoming a federated network of individual data hubs will soon be within reach.

Responsible organisations: GA, CSIRO, Deakin University, Schmidt Ocean Institute, JCU and other collaborators



North-looking 3D view of Osprey Reef in Australia's Coral Sea Marine Park. Airborne lidar data collected over the shallow reef and lagoon by the Australian Hydrographic Office, and multibeam sonar data collected around the deeper flanks by the Schmidt Ocean Institute's RV Falkor. Image provided by Dr Robin Beaman, James Cook University under CC 4.0 licence. For more info see Schmidt Ocean Institute Blog and the 3D Fly-through of the data. Reproduced with permission from the Schmidt Ocean Institute.

Access to Open and FAIR Data

For the second year runnning, the AusSeabed Marine Data Portal has seen an increase in the annual number of individual data access requests (up 47 % from last year), indicating a growing appetite for bathymetry data across the broader community (see *Data Access*). This increase likely stems from growing awareness of the data through sustained engagement activities or may represent a shift in the business workflows that individuals and organisations are using to access data. Both explanations imply that the impact AusSeabed is having is also on the rise and confirm the need for an integrated monitoring and reporting capability to better understand and cater to our user base.

The end of financial year saw the Portal shift over to a new back-end infrastructure with greatly improved reliability and usability alongside a suite of new tools for data visualisation, download and analysis. A demonstration of the new portal was given during the first AusSeabed Webinar and received very positive feedback from participants.

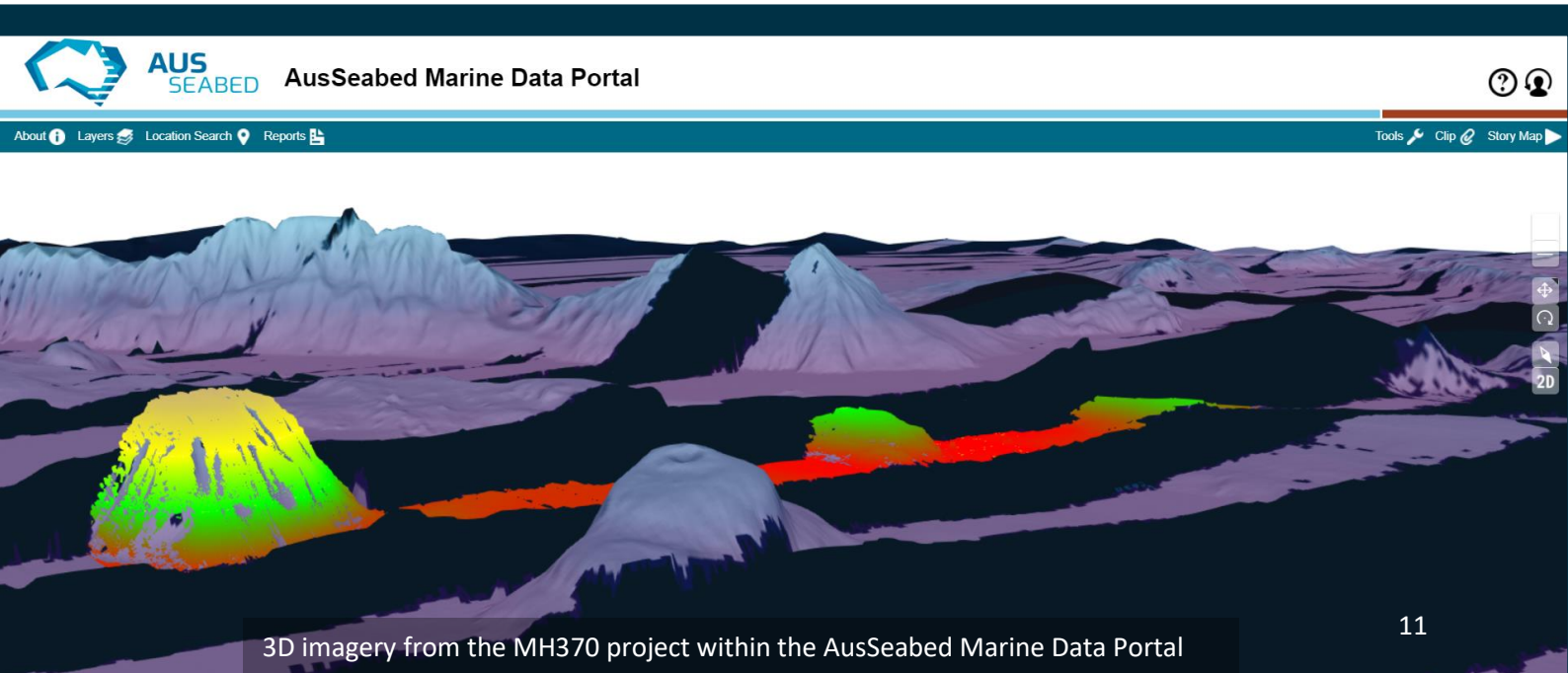
Work continues with user engagement to guide further Portal design and development to ensure that functionality and improvements adequately meet community needs, refine user experience and follows the FAIR (Findable, Accessible, Interoperable, Reusable) data principles.

Responsible organisations: GA

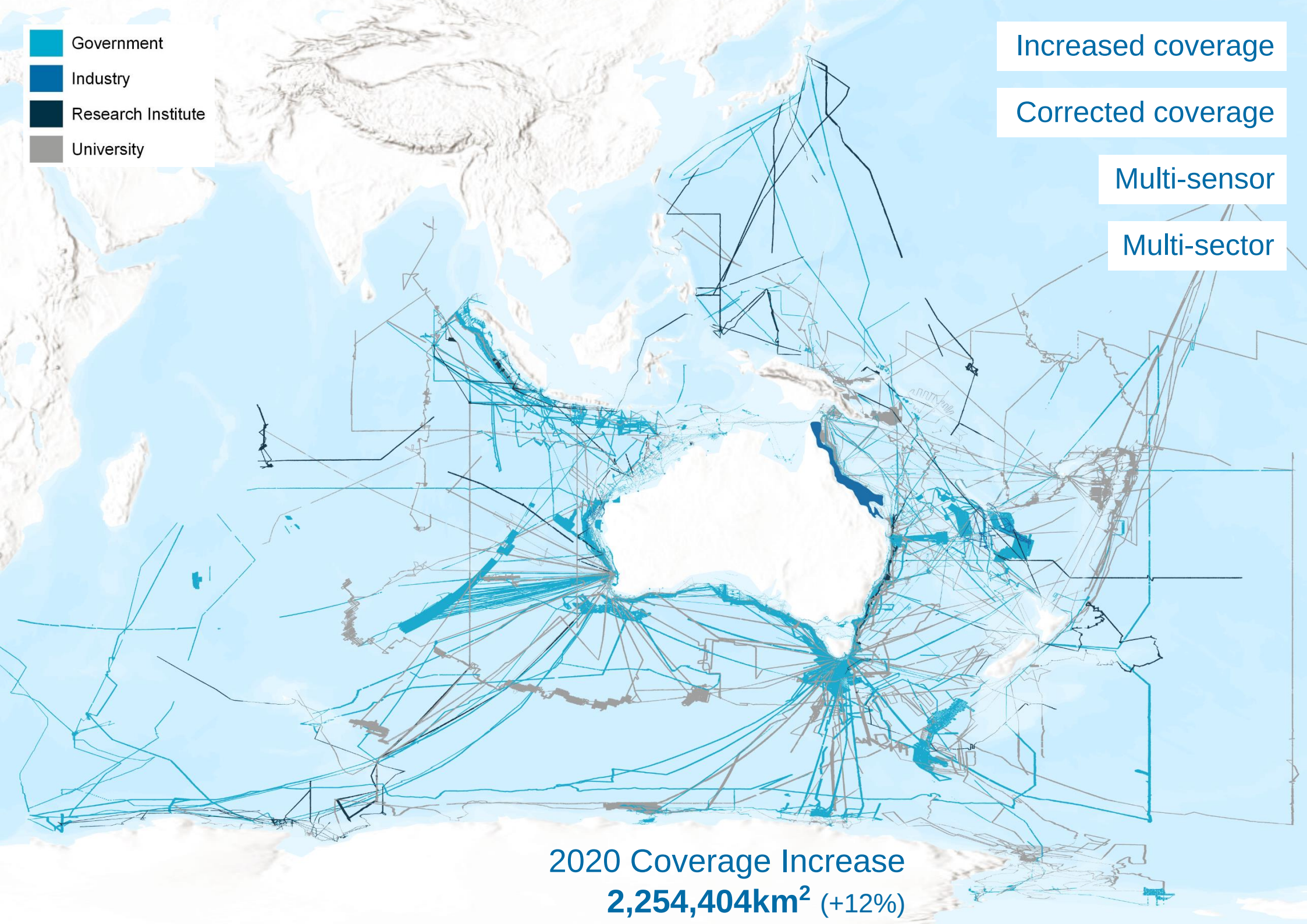
Bathymetry data holdings dramatically increased through the inclusion of information from multi-sectors and sensors

In June, an updated index of bathymetry data holdings was published through the AusSeabed Marine Data Portal. Previously, the data predominantly came from surveys operated by Commonwealth Government organisations (particularly GA and CSIRO). This new update brings state government, academia and private sector data coverage together in one place. Additionally, the data collected are sourced from multiple sensors, increasing the range of coverage. This is another important step in uncovering existing data through the establishment of a one-stop shop and identifying 'true' gaps for future survey planning to fill. This index will be updated on an annual basis, with plans to fully automate the process over the next financial year.

Responsible organisations: GA, CSIRO, NSW DPIE, WA DoT, Deakin University, EOMAP

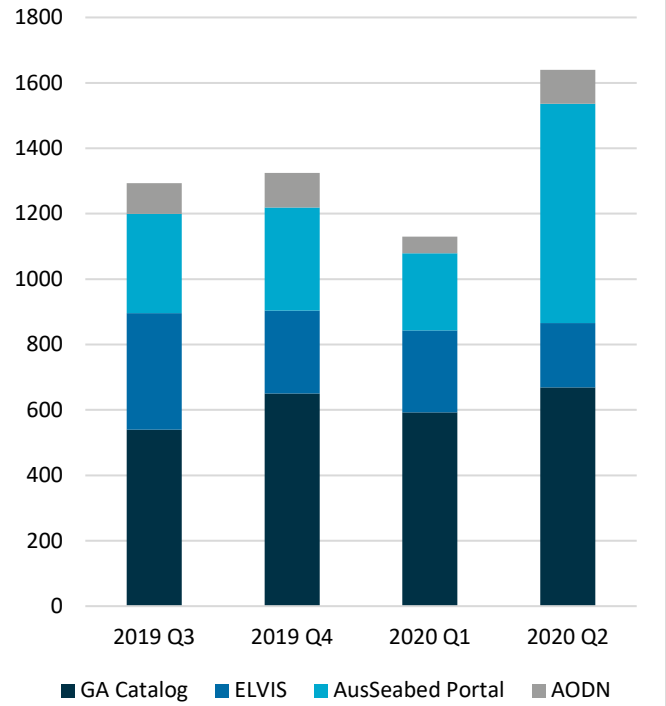


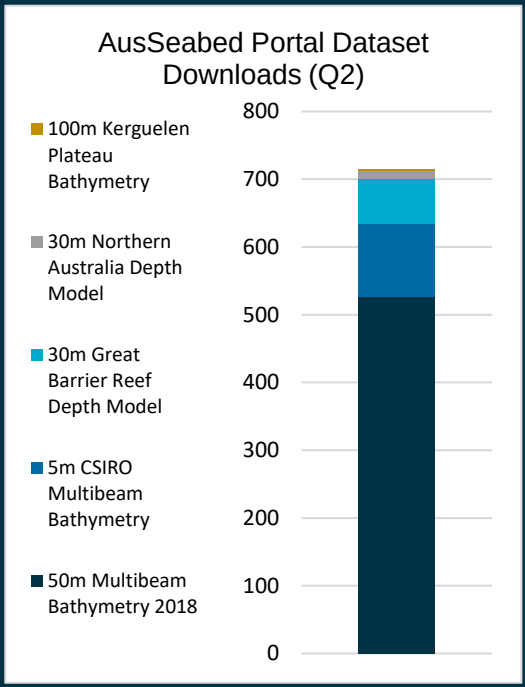
3D imagery from the MH370 project within the AusSeabed Marine Data Portal


Government
Industry
Research Institute
University
Increased coverage
Corrected coverage
Multi-sensor
Multi-sector
2020 Coverage Increase
2,254,404km² (+12%)

The statistics presented in the figures below summarise bathymetry data access for the 2019/20 financial year. Data downloads are showcased as both total number and total size, with acknowledgment of multiple data sources: AusSeabed Marine Data Portal, GA Catalog, ELVIS (ANZLIC) and AODN.

DATA ACCESS





DIRECT CATALOG DOWNLOADS

2451 Jobs

+17% from last FY

AUSSEABED PORTAL DOWNLOADS

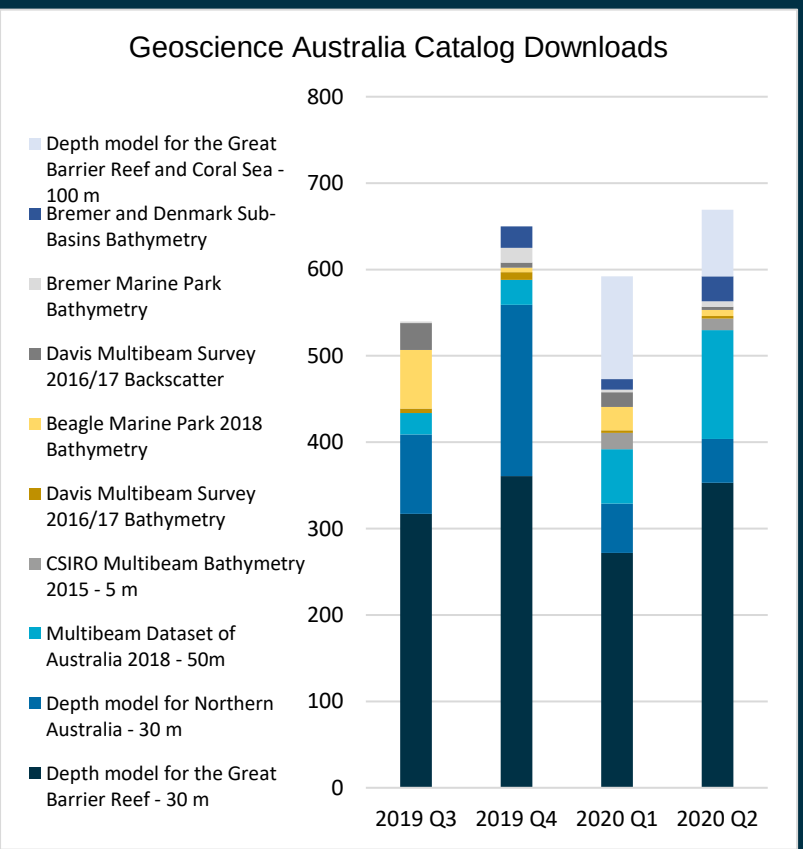
99.6 GB

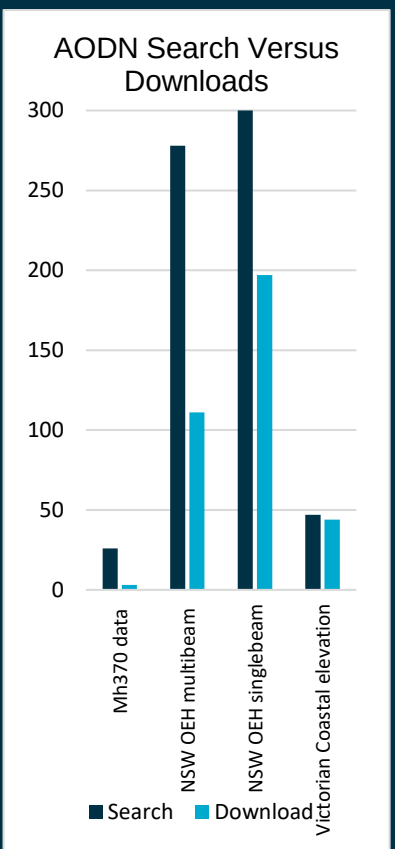
+61% from last FY

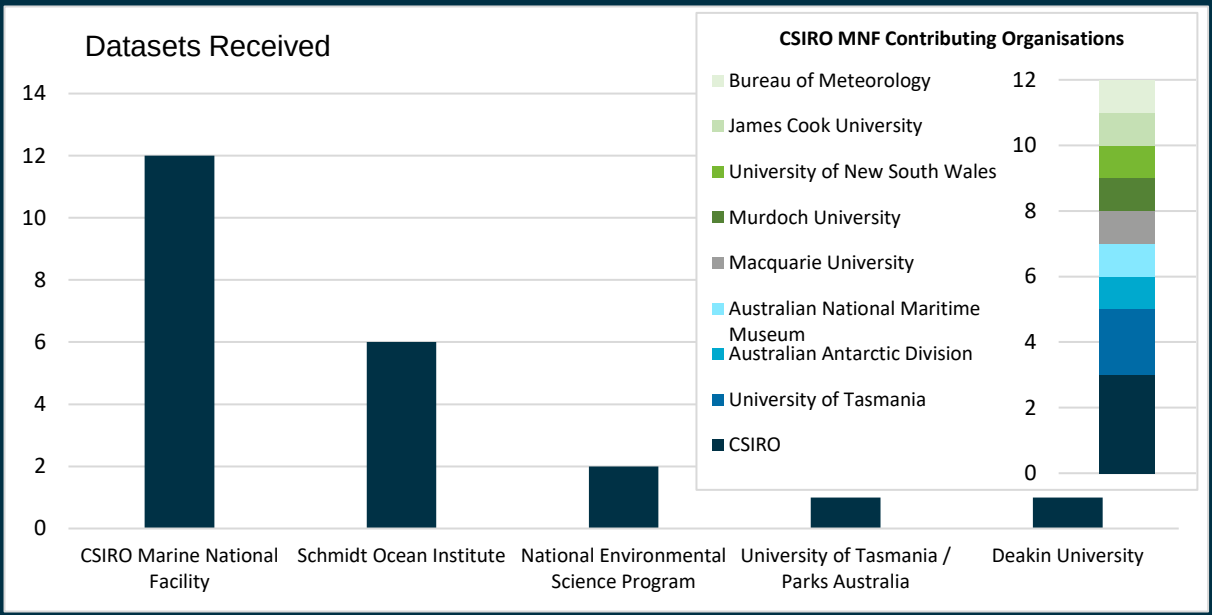
MANUAL REQUEST DOWNLOADS

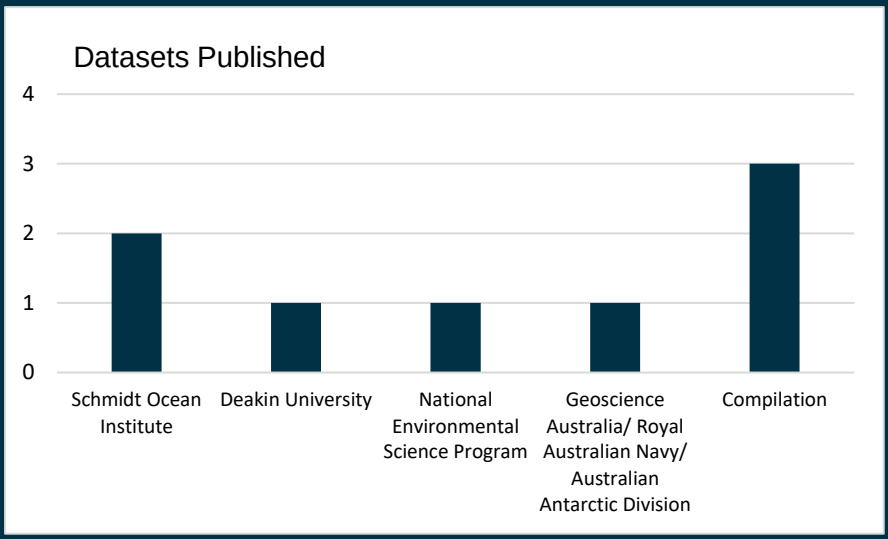
1.2 TB

+ 148% from last FY









Compilation refers to surveys that contribute to a larger dataset. Datasets received represents datasets received in the 2019/20 FY. Comparatively, datasets published includes some legacy data.

Refer to Appendix # for details.

Polygon Coverage Received			
Collecting Entity	**Data Type/s**	**Surveys #**	**Coverage (km², overlapping)**
EOMAP	Satellite Derived Bathymetry	4	229,619
WA Department of Transport	Digitised single beam from Collectors	16	13,641
	Hand Held Lead line	34	13,982
	Laser Scanner	300	83
	RTK level (beach)	174	6,061
	Multibeam	668	1,851
	Single Beam	345	470
	Lidar	12	12,148
	Topographic Lidar	2	251
NSW DPIE	LADS	47	4,361
	Multibeam	80	1,479
	Singlebeam LiDAR and GNSS survey	304	4,491
Deakin Univeristy (VCMP Boxes 6-10)	Multibeam	5	131
2019	LADS	11	19,682
	Multibeam	497	26,536,436

Tools, Guidelines and Standards

The Tools, Guidelines and Standards theme aims to develop community-ready resources that enhance the quality, consistency, and ease of seabed data acquisition, processing, and delivery. Tools, Guidelines and Standards was led by FrontierSI in the 2019/20 financial year and is now led by the Australian Hydrographic Office.

Delivery of the AusSeabed Coordination Tool

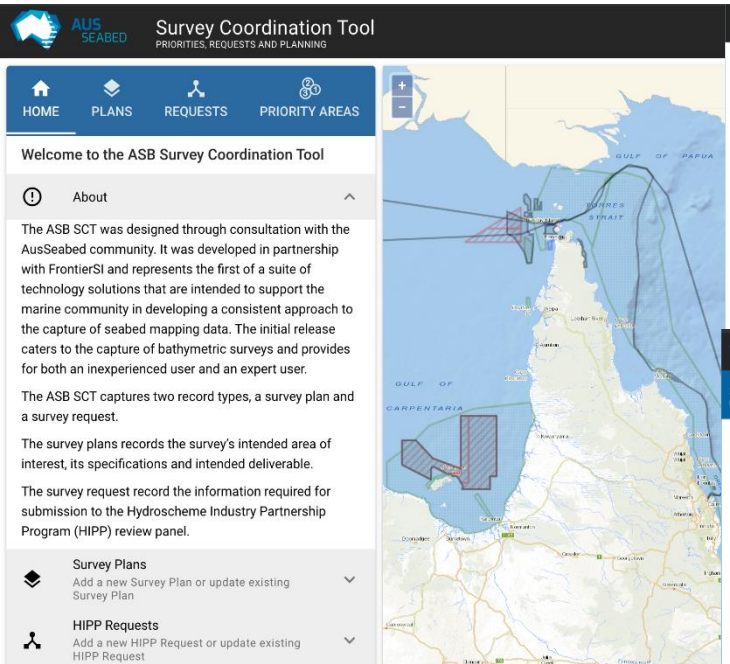
This year we delivered the AusSeabed Coordination Tool. Designed through consultation with the AusSeabed community, the tool includes three functions: upcoming survey registration and planning, demarcation of priority mapping areas, and the capacity to generate survey requests for submission to the Australian Hydrographic Office Hydroscheme Industry Partnership Program. The tool is open-source and the underlying code has been published alongside the other AusSeabed infrastructure in the AusSeabed Git Hub code repository. The Coordination Tool represents the first suite of technological solutions intended to support the marine community in developing a consistent approach to the capture of seabed mapping data.

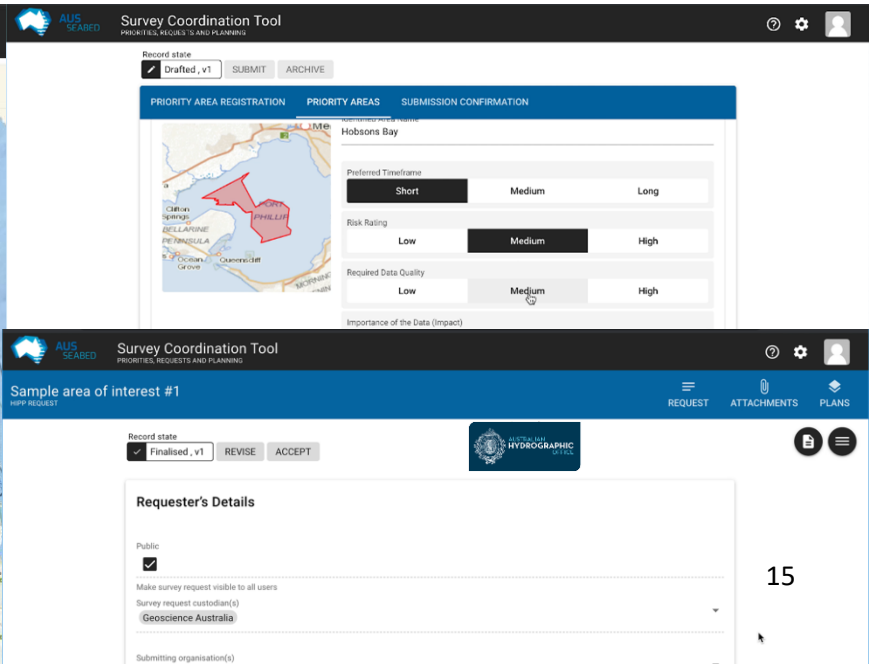
Responsible organisations: GA, FrontierSI, AHO

Development of the AusSeabed Quality Assurance Tool

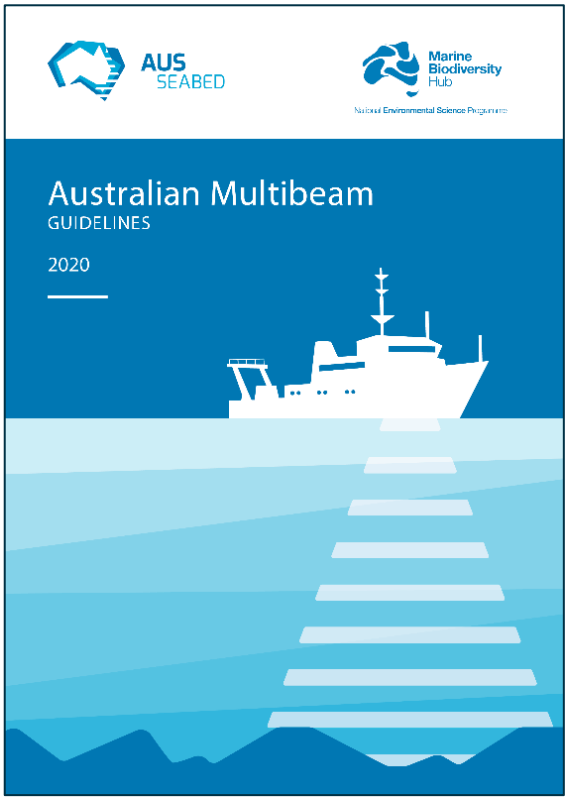
The Quality Assurance (QA) Tool provides an automated workflow that checks Multibeam Echosounder (MBES) vessel surveys against a set of standard specifications. Progress has been made in QA modules for raw and gridded datasets, controlling interface to QA following specific profiles and generation of QA report. Stage 1 was completed in June 2019 with FrontierSI delivering the User Needs report. Stage 2 is underway, with the first beta testing to commence in the second half of 2020.

Responsible organisations: CSIRO, GA, FrontierSI, AHO, NOAA, CCOM-UNH



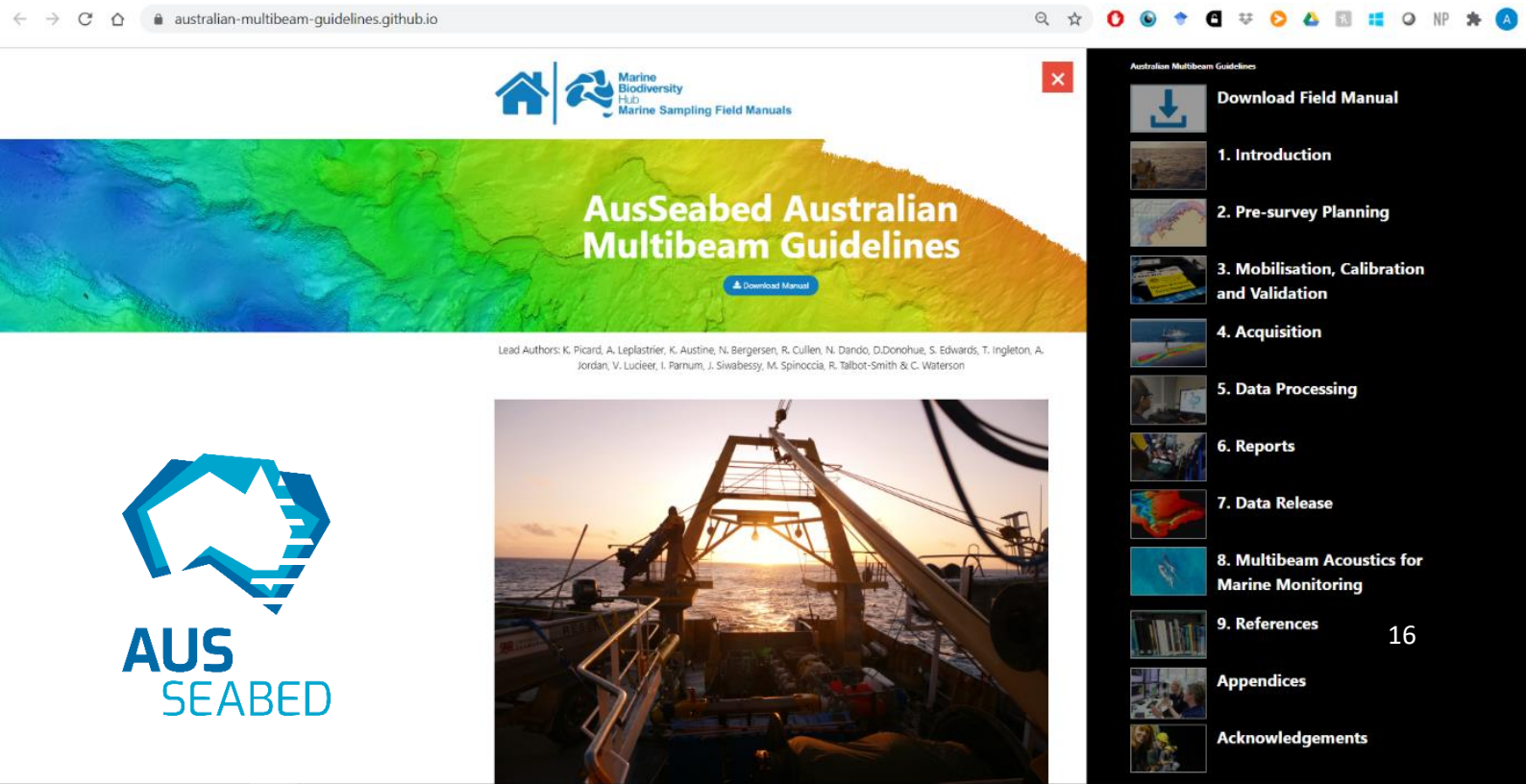


Publication of Australian Multibeam Guideline Version 2



The Australian Multibeam Guidelines, first published in 2018, were revised to version 2. This revision contains an update of data submission requirements for delivery to the AusSeabed Data Hub based on the AusSeabed data standard workshop outcomes (held in 2018/19). Version 2 also contains information previously published in the *Seafloor Mapping Field Manual for Multibeam Sonar* (Lucieer et al., 2018) as section 8 (*Multibeam acoustics for marine monitoring*) and, as such, will succeed the *Seafloor Mapping Field Manual for Multibeam Sonar* as chapter 3 in the second release of the National Environmental Science Program (NESP) *Field manuals for Marine Sampling to Monitor Australian Waters* (Przeslawski and Foster, 2018). The decision to make this extension to the guidelines and inclusion in the NESP suite of Field Manuals was made by AusSeabed and the NESP to allow both initiatives to continue with a single reference document to inform seabed mapping and eliminate the complications and community confusion associated with the maintenance of two reference documents with extensive overlap. The Australian Multibeam Guidelines V2 is available here as both a PDF and an interactive web version hosted by the NESP.

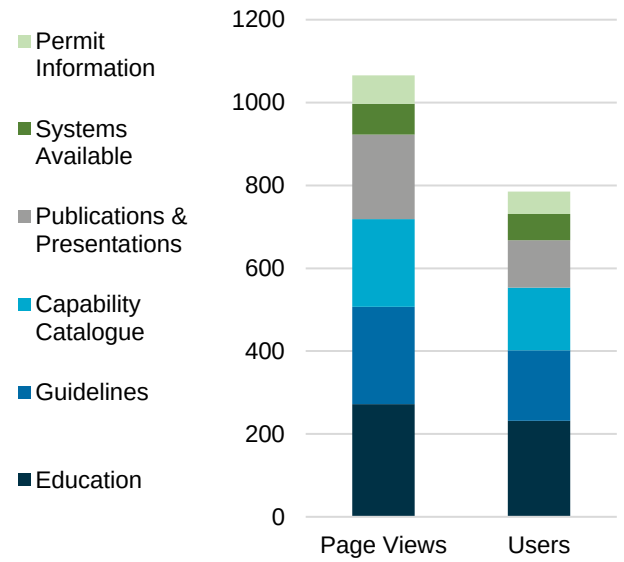
Responsible organisations: GA-led and multiple collaborators



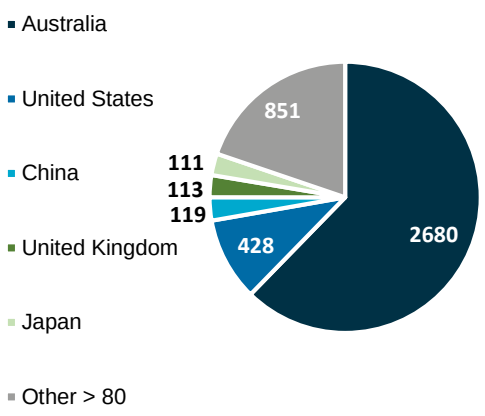
The statistics presented in the figures below summarise AusSeabed website access for the 2019/20 financial year. Data are shown in terms of sessions (number of times the website was accessed), page views (number of times an individual page was accessed) and users (number of unique users to access an individual page/the website).

WEBSITE

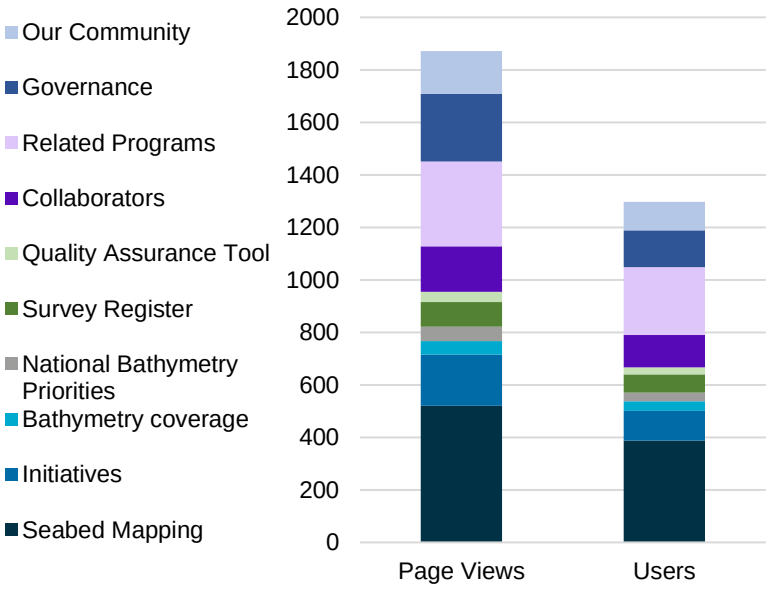
"Resources" Pages Accessed



Sessions by Country



"About" Pages Accessed

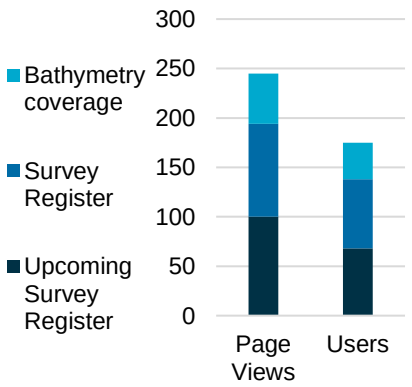


SESSIONS
4,300
+49% from last FY

PAGE VIEWS
9,600
+23% from last FY

USERS
2,900
+55% from last FY

"Tools" Pages Accessed



Top 10 Files Downloaded

Outreach, Education and Training

The Outreach, Education and Training theme aims to raise awareness of the importance of seabed mapping through all levels of society, while building technical capability in the marine sector and facilitating engagement and capacity building through education initiatives. Outreach, Education and Training is led by the Western Australian Department of Transport.

AusSeabed Annual Symposium and Workshop delivered to growing network

In 2019, AusSeabed hosted a one-day symposium (~80 participants) and one-day workshop (~40 participants) during the Australian Marine Science Association (AMSA) 2019 conference. The conference enhanced AusSeabed's impact potential and, especially in WA, elevated industry recognition of the initiative. Gratitude is extended to the WA DoT for providing a base of operations and Fremantle Ports for donating their conference room, IT support and physical assistance. In lieu of AMSA 2020 conference, AusSeabed planned a series of monthly webinars (June-September) that included speed talks, AusSeabed general information and engagement/training workshop sessions. The first webinar was held on 25 June and was a great success with 139 attendees from 85 organisations, 18 countries and all sectors (see Webinar). This outcome demonstrates AusSeabed's continuous growth and impact, both nationally and internationally.

Responsible organisations: WA DoT, Fremantle Ports, GA, Fugro, FrontierSI, NSW OEH & DoE, EGS, NIWA, CSIRO

Successful Engagement with Industry and Government regulation sector

Over the last year we have also begun engaging with the WA Index for Marine Surveys for Assessments (IMSA) initiative, an ideal opportunity that could provide an important stepping stone for AusSeabed's engagement with the Industry sector. Participation in the December 2019 IMSA meeting lead to a reengagement with the Commonwealth Department of Agriculture, Water and Environment (now representing a regulatory collaborator on the AusSeabed Steering Committee). Engagement thus far has included strengthening the connections with the Australian Petroleum Production & Exploration Association (APPEA) and the WA Department of Environment & Energy, both of which have expressed interest in being a part of the AusSeabed Steering Committee in the future.

Responsible organisations: WA DoT, GA, WAMSI, DAWE

AusSeabed used as exemplary case for collaboration

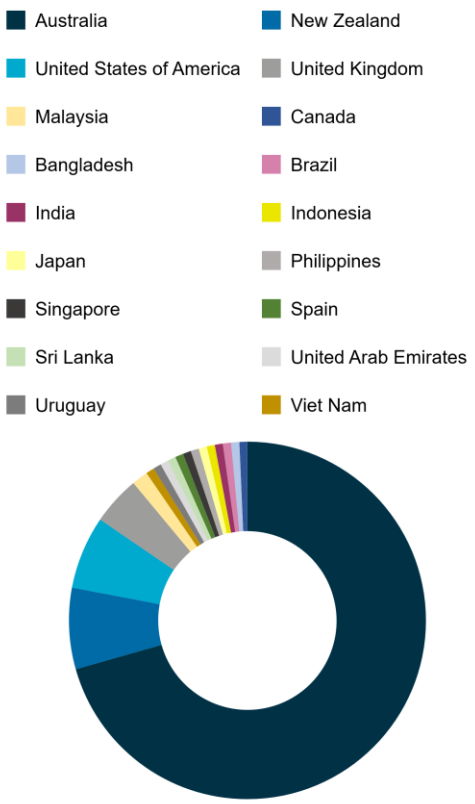
The AusSeabed governance and program growth path has been used as an exemplary model of collaboration and coordination during the establishment of new programs, such as AusHydroid, Australian Coastal Volunteers and the Western Australian Land Information System. In AusSeabed's third year, advancements in seabed mapping collaboration and coordination are evident. The inter-connectivity of data and knowledge enables widespread benefits both immediately and into the future.

Responsible organisations: WA DoT, GA

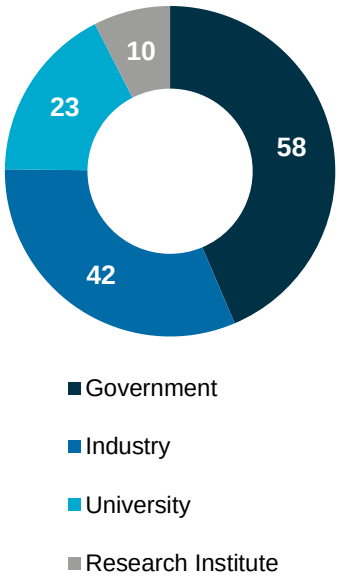
The statistics presented in the figures below summarise the June 2020 webinar, the first of a four part series: “Bringing the seabed to you”. Data are presented in terms of registration (number of people signed up to participate) and participation (number of people who participated). Also included is a summary graph of the overall number and growth of our email list recipients.

WEBINAR

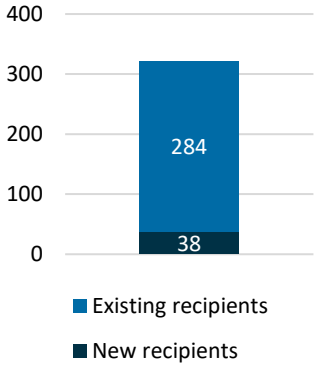
Proportional International Participation



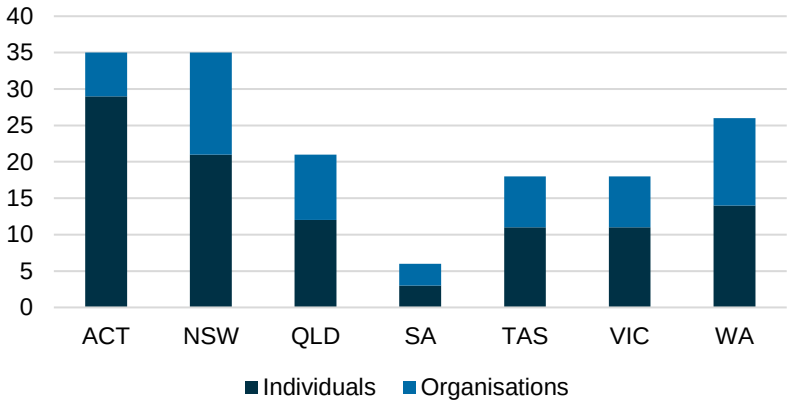
Sector Participation



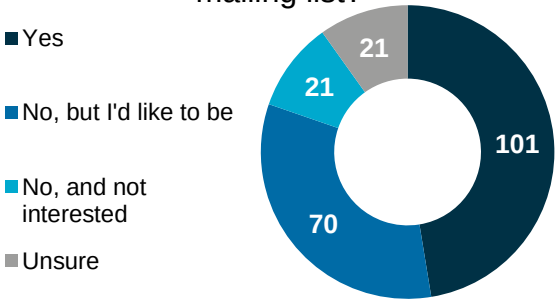
Email Distribution List



Australian State/Territory Participation



Are you on the AusSeabed mailing list?



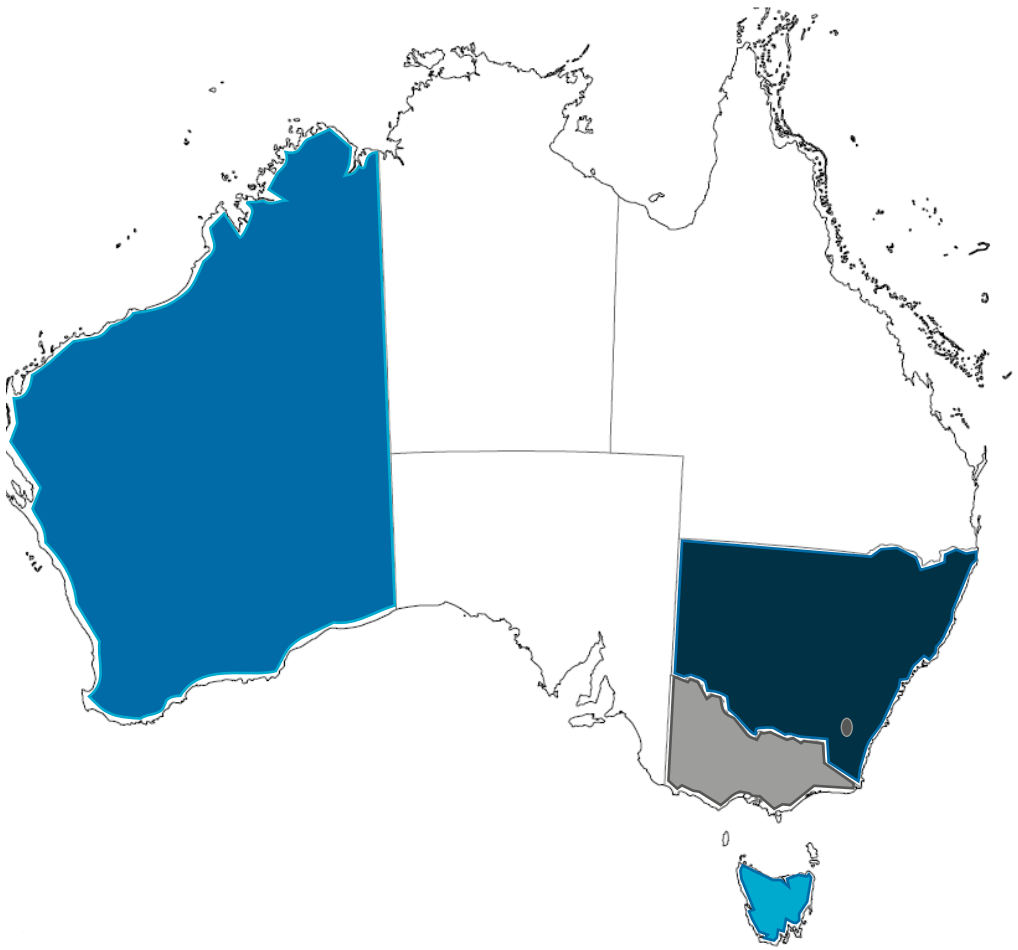
WEBINAR PARTICIPANTS
Individual: **139**
Countries: **18**
Organisations: **85**

WEBINAR REGISTRANTS
Individual: **202**
Countries: **25**
Organisations: **134**

Community Engagement 2019/20

WA Department of Transport Work Experience

"I would like to say thank you with all my heart in helping me to pursuit my career. I met with the team from EGS survey yesterday and I am going to start working with them from next month onwards. I really appreciate the time and effort you have put into helping students, I wouldn't have been able to get my SSSI skill assessment to stay and work in Australia without your help."



- Engineers Australia
- CTCN South Pacific Mapping Project
- NSW Coastal Conference
- AMSA
- International Cable Protection Committee (ICPC)
- WA IMSA Meeting
- NESP Portal Workshop
- Waves Conference
- AusSeabed June Webinar

New Hampshire
GEBCO Annual Meeting

Hawaii
OceanObs

Fiji
Fiji Hydro Day

New Zealand
Seabed2030

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Appendix A: Governance Activities Summary

Table A1: Governance activities summary table

Activity	Activity Description	Participating Organisations	Update
Executive Board (EB)	Establish EB	GA, AHO, AAD, CSIRO, AIMS	Complete, 2019
	Establish a Collaborative Head Agreement (CHA)	GA, AHO, AAD, CSIRO, AIMS	Drafted
	Conduct EB meeting	GA, AHO, AAD, CSIRO, AIMS	Complete (28/04/20)
Steering Committee (SC)	Conduct SC meetings	SC led by Chair organisation (GA)	Complete (10/07/19, 17/12/19, 31/03/20)
	Conduct 2020 general elections	SC led by Chair organisation (GA)	Complete
Resources	Establish 2020/21 Work Plan	SC led by Chair organisation (GA)	Drafted
	Establish Strategic Plan 2030	SC led by Chair organisation (GA)	Complete, published on the AusSeabed website in August 2019.
	Develop 10 Year Work Plan	SC led by Chair organisation (GA)	Drafted
	Establish Community Value Statement	GA, FrontierSI	Complete, endorsed April 2020.
	Establish and document SC election process by developing a Standard Operating Procedure	GA	Complete, published on the AusSeabed website in May 2020.
	Establish Annual Report	SC led by Chair	Drafted

Appendix B: Data Hub Work Plan

Table B1: Data Hub Work Plan 2019/20 (*led by Kim Picard, AusSeabed SC Chair, Geoscience Australia*)

Activity	Activity Description	Participating Organisations	Intended Completion	Update
Automated Processing Pipeline for multibeam bathymetry datasets	Minimum viable product of an automated processing pipeline for MBES bathymetry data that aims to: 1) Reduce delivery time post-survey of open gridded bathymetry product, 2) Improve data quality through consistency and provenance tracking This will be achieved by: 1) implementing a cloud –based (AWS) proprietary geoprocessing software (CARIS) using automated functions 2) utilising built-in monitoring, logging and tracing services. 3) delivering all open source features (automation code) via ASB GitHub organisation 4) delivering all proprietary features as an open configuration where possible.	GA/CSIRO	Apr & June 2020	A proof-of-concept cloud-based automated processing pipeline was delivered in November 2019. The pipeline demonstrated that an L3 product (grid) could be produced from L0 (raw) data using scripted workflows in a cloud environment with minimal operator interactions. The process reduces the time required to manually produce gridded products considerably (from days to hours). The code for all open source features of the pipeline is delivered through the AusSeabed GitHub organisation: https://github.com/ausseabed. Rudimentary AWS monitoring, logging, and tracing services have been utilised but more work is required to fortify the capture and processing of lineage data. Work has begun on individual components of the processing pipeline

	Scoping report providing roadmap and design to ensure efficient and consistent product publishing approaches. This work aims to identify and prioritise: 1) product formats for three end-user types 2) best distribution portals targeting the end-users identified 3) automation of processes associated with publishing datasets The report and the community standards chosen will be published on ASB website.			roadmap, but as yet to be completed and published
Data Warehouse	Prototype of a distributed ASB Data Warehouse involving two local hubs (CSIRO and GA), which aims to demonstrate the benefits of: 1) Consistency and centralised delivery 2) Services that utilises available tools to optimise cost management associated with archiving, storing and accessing while not compromising delivery time for user-needs This will be achieved by: 1) delivering architecture on AWS using cloud native tools for data management 2) publishing an accompanying summary report on the ASB website highlighting business analyses and proposed development	GA/CSIRO/AHO/AAD/AODN	Apr & June 2020	A functioning data warehouse has been built in AWS that allows for fast transfer and delivery of data from the Geoscience Australia Hub. All L0 data that is not subject to embargoes and is presided over by Geoscience Australia has been transferred into the data warehouse. All L3 data produced by or provided to GA and is ready for publication has also been transferred into the AWS data warehouse. An AusSeabed product catalogue has also been developed to assist with the assignment of metadata to the data files, and allow for the assignment of unique identifiers to the data. L3 data hosted in the data warehouse is able to be pushed through a geoserver

	roadmap Prototype of a provenance system aiming to deliver: 1) Defined provenance rules around all data levels & all incoming services of the platform 2) First iteration reporting features to assist data users 3) 360 review of the prototype			instance and read into the staging area of the AusSeabed data portal. Once the visible data has been approved for publication it can be made publicly visible via a request to the portal developers. As mentioned above, the integrated provenance system has not yet been developed, but work has been done on essential components (i.e. the AusSeabed Data Catalogue) and as such this work will continue into the 2020/21 Financial year. Exploratory work with CSIRO to emulate the AWS architecture of the AusSeabed Data Warehouse and push data out through Geoserver using the MinIO platform have been successful. This is the first step towards developing a federated data hub with individual nodes (i.e. a GA and a CSIRO Hub). The submission guidelines for HIPP data are likely to be developed in the first half of the 2020/21 financial year
Analytics and Discovery Portal	Migration of Data Portal to another GA portal aiming to provide efficiencies in terms of resourcing for development, maintenance and operation Scoping report providing a roadmap and implementation plan to enable researchers and broad-range of users to access bathymetry compilation-on-the-fly based on optimal grid	Deakin/GA	Jun 2020	The new portal has been developed, shifted into production, and is delivering much improved functionality compared to the old AusSeabed portal. As such the old portal has been decommissioned. Portal roadmap has been prepared and is currently in review.

	resolution and rule-based decisions. This will be delivered by: 1) hosting for an extended period (3-4 weeks) visiting scientists from Lamont-Doherty Earth Observation (LDEO) who develop and maintain, through NSF grants, the Global Multi-Resolution Topography (GMRT) platform and processes. 2) Hosting a technical workshop to learn all aspects of GMRT and develop collaboratively a forward plan to adopt the platform and to identify iteration and services required			A series of instructional videos have been devised that will help new users familiarise themselves with the portal functions. The COVID-19 pandemic put a hold on the plans to host LDEO scientists and progress the development and integration of the GMRT services. Discussions and planning surrounding this body of work will be postponed until international travel restrictions ease.
Sediment workflow for HIPP				Detailed instructions on the collection, handling and submission of sediment collected during HIPP surveys have been developed and supplied to the AHO (and some of the HIPP partners). These instructions are yet to become a part of the HIPP operating procedures.
Scope other data types BS, SBP				These activities have been tentatively scheduled into the 10 year work plan based on estimates of the maturity of the AusSeabed Data Hub infrastructure, and the capacity of the project team. As such only preliminary scoping discussions have been held on the nature of the tasks and the work that might be required to develop fully integrated solutions.
Update bathy model	*Data layer availability			
Point-cloud expertise to be sought &				

Machine learning (yr2)				

Appendix C: Tools, Guidelines and Standards Work Plan

Table C1: Tools, Guidelines and Standards Work Plan 2019/20 (*led by Nathan Quadros, FrontierSI and Paul Kennedy, Guardian Geomatics*)

Activity (Priority)	Activity Description	Participating Organisations	Intended Completion	Update
Roadmap for each priority/activity	Activity leaders take ownership and provide roadmap; clarity on activity/task definition and leadership	FrontierSI, GA, NIWA, Deakin	Sept 2019	Roadmaps have been drafted but have not yet been published.
Guidelines	Community driven guidelines or suggestion of guidelines by end of year Create template so guidelines are consistent MB, SDB, SBP, Water column, sediments	FrontierSI, GA, NIWA, Deakin	Dec 2019	Version 2 of the Australian Multibeam Guidelines published. The guidelines are now also part of the National Environmental Science Program suite of field manuals and have been implemented as an interactive online document. The guidelines are also available as a PDF from the AusSeabed and NESP websites. Guidelines for SDB and bathymetric LiDAR have been drafted, but completion is on hold and planned for 2020/21
Quality Assurance Tool	QA services associated with MBES data or any gridded bathymetry product to enable: 1) New checks that leverage the incoming survey planning service data to allow new data to be checked against survey specifications and generate a report	GA/FrontierSI/AHO/CSIRO	May 2020	New version of check tool deployed to staging and production that provides an AusSeabed profile and AHO profile that runs designed checks in sequence to give initial indication of quality of the data to these organisation's standards. These checks have been updated since the

	2) New features that allow assessment of existing standardised and consistent data and generate a QA report 3) Delivered via ASB GitHub organisation & synced with CCOM/NOAA public repositories Available for use on AusSeabed			Continuous Integration. QAX installation package now built through an automatic process which includes an automatic upload to GitHub release (saving hours).
Coordination Tool	This milestone will see delivery of: 1) Simple user registration and access through the ASB portal (incl. documentation) 2) Integration with the Quality Assurance & Processing service to enable 'check to specs' 3) A proposed maintenance schedule 4) All code through the ASB GitHub organisation *Line planning tool*	GA/FrontierSI/AHO	Mar 2020	These deliverables were reviewed to ensure that the AusSeabed Coordination Tool met the needs of both AusSeabed and the HIPP going forward. Developments this year include: • A redesigned user interface • Improvements to functionality based on the 2019 AusSeabed workshop • The ability to upload and edit polygons to the National Priority Areas • The ability to generate the HIPP Statement of Requirements and submit this to the HIPP Review Panel • The open release of all code through the AusSeabed GitHub repository

Appendix D: Outreach, Education and Training Work Plan

Table 1 Table D1: Outreach, Education and Training Work Plan 2019/20 (led by Ralph Talbot-Smith, WA Department of Transport)

Activity (Priority)	Activity Description	Participating Organisations	Intended Completion	Update
Seek an outreach 'champion' for each state (1)	Make a call for outreach person in each state; identify appropriate academics/institutions associated with teaching (each state?). Regular presentations or representations at other annual fora	WA DoT / Curtin, NSW DPIE/CSIRO	Oct 2019	Steering Committee representation now includes SA alongside WA, VIC, NSW, TAS, SA, ACT and NZ. QLD and NT are not currently represented on the steering committee, but QLD remains actively engaged with AusSeabed initiatives across sectors. Discussions have not yet been held to discuss the nature of a consistent state-by-state focused outreach approach.
Seek executive champions	Identify CEOs, executives, yacht clubs	WA DoT / Curtin, NSW DPIE/CSIRO	Dec 2019	Engagement delayed.
Regular presentations at state level (1)	Presentations at 1 academic 1 industry and 1 government. State AMSA, AHS, SSSI, Ports. Representation at other forums	WA DoT / Curtin, NSW DPIE/CSIRO and outreach champions	June 2020	AusSeabed webinars (see below) are meeting the desired outcome for this activity.
Presentation/representation at appropriate conferences and forums	Deliver presentations about AusSeabed to a wide range of end-users via a variety of conference opportunity. This aims to raise awareness of AusSeabed	WA DoT / Curtin, NSW DPIE/CSIRO	June 2020	Most conferences in the end of the 2018/19 FY were postponed due to the pandemic. AusSeabed webinars (see below) are fulfilling the desired outcomes of this activity

	and seabed mapping, and increase participation to the program. These conference include: Coasts and Ports Hobart; State Coastal Conferences (Qld; NSW coming up), Forum for Operation Oceanography/Aust. Coastal Ocean Modelling and Observing (IMOS), Waves Workshop (Melb Nov), software conferences Hypack, QPS others?			
Symposium at AMSA 2020 (1)	Develop and submit a seabed mapping symposium and an AusSeabed workshop proposal for AMSA 2020 Commitment to AMSA 2020 Macquarie University; representation on Symposium SC	Theme SC DPIE, AHS, GA, WA DoT, EGS	Aug 2019 Aug 2019	Both proposals for symposium and workshop were accepted by AMSA2020. However, the conference was postponed due to the pandemic. To ensure continuity for AusSeabed, an AusSeabed webinar series was developed with the first webinar taking place on June 25, 2020. The webinars have provided: • the platform to hear from the seabed mapping community about advancements • opportunities to demonstrate upgraded tools and infrastructure and gather feedback from the community. • A more effective way to build and strengthen community engagement. Due to the breakdown of financial and logistical barriers.
Communications	Strategy draft	SC and all	July 2020	Planned as part of the 2020/21 work plan

Appendix E: 2019/20 Data Submissions

Table E1: This table depicts a summary of the survey data received by AusSeabed during the 2019/20 year.

GAID	OTHER ID	SURVEY TITLE	SHIP	COLLECTING ENTITY	LEAD SCIENTIST	START/END DATE	RECEIVED	DATA LEVEL		
								L0	L2	L3
GA-4843	IN2019_V02	Triaxus	INVESTIGATOR	CSIRO (*MNF*)	Prof. Tom Trull	13/03/2019 To 03/04/2019	2019	Yes	Yes	
GA-4844	IN2019_V01	Hydrology	INVESTIGATOR	AAD (*MNF*)	Dr Michael Double	18/01/2019 To 04/03/2019	2019	Yes	Yes	
GA-4845	IN2019_V07	RAN Marine Heritage	INVESTIGATOR	Australian National Maritime Museum (*MNF*)	Emily Jateff	11/04/2019 To 22/04/2019	2019	Yes	Yes	
GA-4846	IN2019_T01	Hobart Fremantle Transit	INVESTIGATOR	Macquarie University (*MNF*)	Dr. April Abbott	28/04/2019 To 08/05/2019	2019	Yes	Yes	
GA-4847	IN2019_V03	Indian Ocean Expedition Line	INVESTIGATOR	Murdoch University (*MNF*)	Prof. Lynnath Beckley	14/05/2019 To 13/06/2019	2019	Yes	Yes	
GA-4849	BF2019_V01	Freycinet Marine Park	BLUEFIN	Marine and Antarctic Studies (UTAS) / Parks Australia	Dr Neville Barrett	08/03/2019 To 21/03/2019	2019	Yes	Yes	
GA-4852	IN2019_E01	Calibration Trials and transit	INVESTIGATOR	CSIRO (*MNF*)	Jason Fazey	27/07/2019 To 01/08/2019	2019	Yes	Yes	
GA-4853	IN2019_V04	Hotspot dynamics in the Coral Sea	INVESTIGATOR	UTAS (*MNF*)	Prof. Joanne Whittake	07/08/2019 To 02/09/2019	2019	Yes	Yes	
GA-4854	IN2019_V05	IMOS EAC	INVESTIGATOR	UNSW (*MNF*)	Dr Bernadette Sloyan, Prof. Iain Suthers	09/09/2019 To 28/09/2019	2019	Yes	Yes	
GA-4855	IN2019_T02	Brisbane Darwin Transit	INVESTIGATOR	JCU (*MNF*)	Dr Robin Beaman	03/10/2019 To 13/10/2019	2019	Yes	Yes	
GA-4856	IN2019_T03	Australian Operational Radar Network	INVESTIGATOR	BOM (*MNF*)	Dr Alain Protat	22/12/2019 To 31/12/2019	2019	Yes	Yes	
GA-4857	IN2019_V06	Timor Sea	INVESTIGATOR	CSIRO (*MNF*)	Dr Alain Protat	19/10/2019 To 28/11/2019	2019	Yes	Yes	
GA-4862	FK191229	Transit to New Caledonia	FALKOR	SOI	Schmidt Ocean Institute	26/01/2020 To 01/02/2020	2020	Yes	No	
GA-4848	N/A	Elizabeth Middleton reefs	BLUEFIN	NESP	Dr Andy Caroll	24/01/2020 To 06/02/2020	2020	Yes	Yes Not Final	

GA-4858	N/A	South West Corner Marine Park Survey	SANTOSHA	NESP	Dr Scott Nichol	14/03/2020 To 21/03/2020	2020	Yes	Yes Not Final	
GA-4860	IN2020V01	Williams Ridge Kerguelen Plateau and Broken Ridge	INVESTIGATOR	UTAS (*MNF*)	Prof. Mike Coffin	07/01/2020 To 05/03/2020	2020	Yes	Yes Not Final	
GA-4863	FK200103	New Caledonia-Sydney transit	FALKOR	SOI	Schmidt Ocean Institute	03/0/2020 To 05/01/2020	2020	Yes	No	
GA-4864	WA FK200110	Transit Sydney to Albany	FALKOR	SOI	Schmidt Ocean Institute	10/01/2020 To 15/01/2020	2020	Yes	No	
GA-4865	FK201026	Bremer, Leeuwin and Perth Canyons	FALKOR	SOI	Dr Julie Trotter	26/01/2020 To 01/02/2020	2020	Yes	No	
GA-4859	FK200308	Submarine Cape Range Canyon	FALKOR	SOI	Dr Nerida Wilson	08/03/2020 To 07/04/2020	2020	Yes	Yes	
GA-4861	FK200429	Visioning the Coral Sea Marine Park	FALKOR	SOI	Dr. Rob Beaman	29/04/2020 To 19/05/2020	2020	Yes	Yes Not Final	
GA-0364		Beagle Marine Park Bathymetry data 2018	BLUEFIN	NESP	Dr Scott Nichol (Scott.Nichol@ga.gov.au)	17/06/2018 To 26/06/2018	2018	Yes	Yes	Yes
GA-0364		Beagle Marine Park Backscatter data 2018	BLUEFIN	NESP	Dr Scott Nichol (Scott.Nichol@ga.gov.au)	17/06/2018 To 26/06/2018	2018	Yes	Yes	Yes
GA-0357	AAP 5093	Davis Multibeam Survey 2016/17, Antarctica (GA-0357/AAP 5093) - High Resolution Backscatter Grid	AAD workboat Howard Burton & Antarctic Survey Vessel (ASV) Wyatt Earp	GA, RAN, AAD	Dr Jodie Smith (Jodie.Smith@ga.gov.au)	10/01/2017 To 06/02/2017	2017	Yes	Yes	Yes
		Apollo Bay	YOLLA	DEAKIN UNIVERSITY	Daniel Ierodiaconou	07/01/2020 To 29/01/2020	2020	No	No	Yes
Compilation		Bremer Marine Park 2018	RV Marion Dufresne, Southern Surveyor, Investigator	GA, Others	Multiple	Multiple	2003-2017	Yes	Yes	Yes
Compilation		Bremer and Denmark Sub-Basins	N/O Latalante, Rv Marion Dufresne, Southern	GA, Others	Multiple	Multiple	1994 to 2019	Yes	Yes	Yes

	bathymetry grids compilation	Surveyor, Melville, Investigator							
Compilation	High-resolution depth model for the Great Barrier Reef and Coral Sea - 100 m	Multiple	JCU, Others	Multiple	Multiple	1971 to 2016	Yes	Yes	Yes

Table E1: This table depicts a summary of the survey data published by AusSeabed during the 2019/20 year.

GAID	OTHER ID	SURVEY TITLE	YEAR OF PUBLICATION	GRID RESOLUTION	GeoCAT#	ECAT PUBLICATION DATE	ECAT CITATION	URL LINK
GA-4859	FK200308	Submarine Cape Range Canyon	2020 (no eCat)					
GA-4861	FK200429	Visioning the Coral Sea Marine Park	2020	64m	eCat140048	23/06/2020	Siwabessy, P.J.W., Duncan, P., Smith, D., Rais, K., Spinoccia, M., Beaman, R. 2020. Visioning the Coral Sea (FK200429). Geoscience Australia, Canberra.	http://pid.geoscience.gov.au/dataset/ga/140048
GA-0364		Beagle Marine Park Bathymetry data 2018	2019	1m	eCat130301	5/08/2019	Siwabessy, J. 2019. Beagle Marine Park bathymetry data 2018. Geoscience Australia, Canberra.	http://pid.geoscience.gov.au/dataset/ga/130301
GA-0364		Beagle Marine Park Backscatter data 2018	2019	1m	eCat130329	1/08/2019	Siwabessy, J. 2019. Beagle Marine Park backscatter data 2018. Geoscience Australia, Canberra.	http://pid.geoscience.gov.au/dataset/ga/130329
GA-0357	AAP 5093	Davis Multibeam Survey 2016/17	2019	2m	eCat130644	12/08/2019	Siwabessy, J. 2019. Davis Multibeam Survey 2016/17, Antarctica (GA-0357/AAP 5093) - High Resolution Backscatter Grid. Geoscience Australia, Canberra.	http://pid.geoscience.gov.au/dataset/ga/130644
		Apollo Bay	2020 (no eCat)	50cm to 2m (Backscatter 1m)				

Compilation	Bremer Marine Park 2018	2019	4X100,50,30 and 20m	eCat130839	30/08/2019	Spinoccia, M. 2011. Bathymetry grids of Carnarvon Shelf. Geoscience Australia, Canberra.	http://pid.geoscience.gov.au/dataset/ga/123889
Compilation	Bremer and Denmark Sub-Basins bathymetry grids compilation	2019	20,50 and 100m	eCat 132281	19/11/2019	Spinoccia, M. 2019. Bremer and Denmark Sub-Basins bathymetry grids compilation. Geoscience Australia, Canberra.	http://pid.geoscience.gov.au/dataset/ga/132281
Compilation	High-resolution depth model for the Great Barrier Reef and Coral Sea - 100 m	2020	100m	eCat 133163	9/01/2020	Beaman, R.J. 2020. High-resolution depth model for the Great Barrier Reef and Coral Sea - 100 m. Geoscience Australia, Canberra.	http://pid.geoscience.gov.au/dataset/ga/133163

AUS SEABED

Australian Government
Geoscience Australia

Australian Government
Australian Maritime Safety Authority

Australian Government

Australian Institute of Marine Science

NSW Government
Office of Environment & Heritage

Australian Hydrographic Office

Australian Government
Great Barrier Reef Marine Park Authority

James Cook University
Australia

CSIRO

Northern Territory Government

Department of Transport

Deakin University

EGS

NIWA
Taihoro Nukurangi

Government of South Australia

Queensland Government

University of Tasmania

IMAS
Institute for Marine & Antarctic Studies

Australian Government
Department of Agriculture, Water and the Environment
Australian Antarctic Division

Curtin University

iXblue

FRONTIER SI

Marine National Facility

Fugro

SOOS
Southern Ocean Observing System

Land Information New Zealand
Toitū te whenua

Australian Government
Parks Australia

Australian Marine Parks

PHS
Precision Hydrographic Services

acoustic imaging

Guardian Geomatics

EOMAP

Victoria State Government
Environment, Land, Water and Planning

IIC Technologies

The AusSeabed program now hosts the logos of more than 34 organisations who have contributed to and made possible the achievements celebrated in this report. We value the diversity of perspective and the strength of a multidisciplinary community, so are always on the lookout for new collaborators. Will you be next?