GEOHAB 2021

Marine Geological & Biological Mapping

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(All times are given in Australian Eastern Standard Time – UTC +10hrs)

11th May		
10:30-10:35	Daniel Ierodiaconou	Welcome remarks
Session Chair: Kim Picard ***Session Theme: Anthropogenic Pressures***		
10:35 - 10:45	Watson et al.	Anchor drag as a major driver of seafloor habitat degradation
10:45 - 10:55	Ribo et al.	Natural and human-induced factors contributing to habitat suitability of filter-feeder communities in shallow marine environments
10:55 - 11:05	**DISCUSSION**	
Session Chair: Jaya Roperez ***Session Theme: Sonar Techniques***		
11:05 – 11:15	Picard et al.	AusSeabed: Making seabed mapping data easily accessible
11:15 - 11:25	Che Hasan et al.	Multibeam Backscatter using Automatic Pulse Length Mode-Results from Marine Habitat Mapping at Three Marine Protected Areas in Malaysia
11:25 - 11:35	Porskamp et al.	Applying Multibeam Echosounder Water-Column Data to The Benthic Habitat Mapping Workflow
11:35 - 11:50	**DISCUSSION**	
11:50-12:10	**BREAK**	
Session Chair: Alix Post ***Session Theme: Specific Mapping Case Study***		
12:10 - 12:20	Bigham et al.	Benthic community response to habitat alteration caused by an earthquake-triggered turbidity flow in Kaikōura Canyon, Aotearoa/New Zealand
12:20 - 12:30	Johnson et al.	Preliminary interpretation of multibeam bathymetry collected by the R/V Falkor during 2021 in the Tasman and Coral seas
12:30 - 12:40	Puotinen et al.	Locally varying classification accuracy for spatial benthic habitat models in the Arafura Marine Park, northern Australia
12:40 - 12:50	Flores et al.	A possible tectonic control for mesophotic reef growth on the northwestern side of Lingayen Gulf, Philippines
12:50 - 13:15	**DISCUSSION**	
13:15-13:55	**BREAK**	

Session Chair: Sally Watson ***Session Theme: Geology***		
13:55 - 14:05	Niyazi et al.	Mapping the Buried Magmatic Rocks via Seismic Reflection Data - A Case Study from the Offshore Otway Basin
14:05 - 14:15	Bostock et al.	Distribution of surficial sediments in the ocean around New Zealand
14:15 – 14:25	**DISCUSSION**	
Session Chair: Mary Young ***Session Theme: Mapping Strategies***		
14:25 - 14:35	Pucino et al.	Citizen scientists drone mapping coastal erosion at regional scale: data quality, challenges, applications, and future directions
14:35 - 14:45	Shang et al.	Self-adaptive analysis scale determination for terrain features in seafloor substrate classification
14:45 - 14:55	Radford et al.	Making better habitat maps for management with spatially optimised habitat classes and spatial kappa analysis
14:55-15:15	**BREAK**	
15:15 - 15:25	Salleh et al.	Phenomenological Approaches in Correlation between Morphology and Marine Sediment of Seabed Derived from Multibeam Echosounder Data
15:25 - 15:35	Roelfsema et al.	The Mapping and Monitoring the Worlds Coral Reefs: the Allen Coral Atlas
15:35 - 15:45	Giraldo Ospina et al.	Optimizing ground-truthing methods and spatial resolution for deep seagrass mapping
15:45 - 15:55	Goode et al.	Using substrate and seafloor terrain variables to explain benthic community structure
15:55 - 16:05	Thoral et al.	Estimating Benthic Light Availability for Kelp Forests Using Satellite Imagery
16:05 - 16:30	**DISCUSSION**	
16:30 -16:35	**Closing Remarks**	

Anchor drag as a major driver of seafloor habitat degradation

Sally J. Watson[1], Marta Ribó[2], Lorna J. Strachan[2], Sarah Seabrook[1,2] and Rachel Hale[1]

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Shallow marine environments, characterised by complex oceanographic conditions and high ecological diversity and productivity, are the nexus between the land and the deep ocean. This highly important shallow marine realm is also subject to the greatest cumulative impact from humans, being affected by both land- and ocean-based human activities. While the impacts of the global shipping industry on air, water, and noise pollution are well constrained the impact of shipping practices on the seafloor health has received much less attention. Recent high resolution mapping efforts in the Queen Charlotte Sound/Tōtaranui (QCS) located in the Marlborough Sounds, have revealed that the cumulative physical human seafloor footprint represents ~1.5% (6.4 km^2) of the total QCS seafloor area, and is predominantly related to maritime activities (e.g., marine farms, mooring blocks and anchor drags). Spatially, anchor drag marks make up the largest (47.5%) physical human footprint observed in the QCS. In this study, we reveal that anchor drag related to high-tonnage vessels (passenger and cargo) at the Picton Anchorage can excavate the seafloor up to 0.5 m, enough to destroy soft sediment habitats and potentially put seafloor infrastructure at risk. Consistent with other global examples, we found lower proportions of shell fragments, less bioturbation, and higher proportions of fine-grained sediments in collected sediment cores suggesting that repeat anchor drag in this area could be leading to a decline in benthic habitat, and variations of sedimentation patterns. Considering that Picton Anchorage has relatively low maritime congestion compared to other ports, if we extrapolate our findings to a global scale the impact of anchor drag worldwide could represent a major driver of shallow marine habitat degradation. With the increasing trends in global marine traffic predicted in the coming decades, a less destructive method of managing high-tonnage vessels is necessary to mitigate the impact of maritime activities on sensitive shallow marine areas.

Natural and human-induced factors contributing to habitat suitability of filter feeder communities in shallow marine environments.

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The distribution of benthic ecosystems is strongly influenced by the seabed geomorphology. However, the spatial variation of benthic habitats is also affected by near-bottom currents and any changes in light, nutrient concentrations and food quality, associated with increases of turbidity within the water column.

To date, predictive distribution modelling has been derived from geomorphological parameters and usually using spatially limited observations. Detailed predictions of the geographic distribution of filter-feeder species and a deeper understanding of the physical processes influencing their spatial patterns is key for effective management and conservation.

We present a study integrating seabed mapping, oceanographic modelling, hydrographic records, and biological observations to provide high-resolution prediction model of filter-feeder habitat distribution within Queen Charlotte Sound/Tōtaranui (QCS) and Tory Channel/Kura Te Au (TC), South Island, Aotearoa / New Zealand.

In this study we investigate the potential suitable habitat areas for filter-feeders in QCS and TC, in order to inform where habitat restoration management should focus efforts to recover communities such as the horse mussel (Atrina zelandica) or the green-lipped mussel (Perna canaliculus), both of which have high economic impact in New Zealand. Maximum Entropy predictive modelling was used to produce Habitat Suitability maps, using geomorphological parameters and seafloor classification information. Final Habitat Suitability maps incorporate oceanographic and sediment dynamic information and show that filter-feeder habitat distribution is highly influenced by the hydrodynamics and sedimentary processes as well as the seafloor geomorphology and human activities.

Our results confirm that filter-feeder communities inhabit quiescent areas, limited by depth, slope, sediment type, and coincide with regions with low near-bottom currents and low turbidity levels. Regions recognized as suitable for filter-feeder communities in QCS and TC, are also characterised by relatively large anthropogenic footprint related to coastal settlements and infrastructure, the maritime industry, and aquaculture. The outcomes of our research reveal the effects of coastal settlements and major marine traffic routes in limiting the suitable habitats for filter feeder communities.

This study demonstrates that a multidisciplinary approach is crucial to better predict the spatial distribution of benthic communities, with a novel emphasis on the distribution of existing human impact in shallow marine areas. Incorporating a range of environmental factors including local hydrodynamics, seafloor geology and geomorphology and degree of human influence, is key to improve benthic habitat restoration and recovery assessments.

AusSeabed: Making seabed mapping data easily accessible

Kim Picard[1], Robin Beaman, Gareth Davies, Vicki Ferrini, Diana Greenslade, Daniel Ierodiaconou, Natalie Lennard, Aero Leplastrier, Kerry Levett, Joshua Sixmith, Johnathan Smillie and AusSeabed Steering Committee.

Australia's marine jurisdiction, including the Antarctic Territory, covers over 10 million square kilometres and less than 25% of its seafloor has been mapped at high-resolution. In Australia, seafloor mapping is primarily driven by safety of navigation and environmental management requirements. Data acquisition relies on relatively few players from government agencies, universities and industry, but with considerably more end-users. Until recently, there has been limited coordination of the mapping activities which has resulted in duplication of effort, lack of consistency, loss of efficiency and limited use of the data. To address this situation and contribute to the global effort, AusSeabed, a National Seabed Mapping Coordination Program was developed. AusSeabed is a consortium of Australian and New Zealand representatives from federal and state government, universities and industry and is facilitated by Geoscience Australia. Driven by the principle of "collect once, use many times", the consortium developed and published the Australian multibeam guideline, a government priority plan for data acquisition in Australia, an upcoming survey register and a series of resources available on its own website. AusSeabed is now focused on developing a cloud-based data sharing infrastructure to enable better data discoverability and accessibility as well as common seabed mapping tools, such as quality assurance software with automated workflows to assist in the survey planning process. In addition, GA is collaborating nationally and internationally to develop a common geomorphic mapping approach for the interpretation of seabed data and field manuals to standardise marine monitoring practices. This presentation highlights the progress of these initiatives and demonstrates how collaboration is crucial to the development of standards and coordination of mapping efforts.

Multibeam Backscatter using Automatic Pulse Length Mode- Results from Marine Habitat Mapping at Three Marine Protected Areas in Malaysia

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Acquisition of both bathymetry and backscatter data from multibeam echosounder sonar system is vital in any marine habitat mapping programme. Survey campaign must not only aim for full coverage of bathymetry dataset but also need to accommodate in getting good quality of backscatter data. This study discusses the issues and challenges of using automatic setting from multibeam backscatter data acquisition from multibeam system at three different Marine Protected Areas in Malaysia.

The data was collected using Kongsberg EM2040C multibeam sonar system at three different Marine Parks in Malaysia; Labuan Marine Park (2016), Redang Marine Park (2019) and Tioman Marine Park (2020) with collaborations between the local universities, the Department of Fisheries, and the National Hydrographic Centre. Apart for producing marine habitat map, the data (i.e., bathymetry) was also intended to be utilized for the national charting purposes. Therefore, maximizing bathymetry coverage to fit the time and cost are part of the objective of the survey. For this reason, the automatic configuration of backscatter data acquisition mode was selected during the survey (i.e., automatic pulse length selection). The backscatter processing was completed using backscatter processing module in FMGT v7.4 software.

The results show that the automatic pulse length selection does affect the backscatter mosaic quality, for example with sudden changes of water depth. Furthermore, the change of absorption coefficient has also produced inconsistent results such as high differences of backscatter intensity strength values between adjacent lines. This study will also discuss how these artifacts can be reduced and minimized to enhance the final output of backscatter mosaic and to be properly used in habitat mapping and classification modules.

Applying Multibeam Echosounder Water-Column Data to The Benthic Habitat Mapping Workflow

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Macroalgae worldwide are under ever-increasing pressure from anthropogenic impacts including kelp harvesting, pollution, and higher sea surface temperatures due to climate change. Monitoring these communities are key for informing effective policy for marine spatial planning. One common tool used in marine spatial planning is benthic habitat maps. Data needed for creating benthic habitat maps are acquired by multibeam echosounders (MBES), which collect high-resolution bathymetry and backscatter of the seafloor. A product of modern high-resolution MBES is mid-water backscatter data, often termed water-column data, which has been shown to allow detection of kelp extending high above the seafloor, but has been sparsely used in benthic habitat mapping. Our study demonstrates that incorporating water-column data in the benthic habitat mapping workflow can significantly improve the accuracy of these maps, specifically where habitat categories include canopy forming species of macroalgae on shallow subtidal reefs.

The study site, Bunurong Marine National Park, has full-coverage multibeam bathymetry, backscatter and water-column data, as well as a spatially balanced towed video survey, which provided the groundtruth observations. All towed-video observations were classified using a hierarchal marine biotope classification scheme. Water-column data were processed into a mosaic-like product representing the acoustic energy in a layer 0-1m above the seabed. The mosaic-like water-column product was added as a variable along with bathymetric and backscatter derivatives in a supervised random forest classification algorithm to create habitat maps.

Mean decrease accuracy was assessed for all variables and water-column ranked well, and it was retained in all models. The addition of water-column data as a variable increased overall map accuracy by 1.18% and improved producer class accuracies that were defined by canopy forming macroalgae by 2.95%. With a number of pressures on temperate macroalgal communities, this work provides a timely advance for mapping these critical habitats.

Benthic community response to habitat alteration caused by an earthquake-triggered turbidity flow in Kaikōura Canyon, Aotearoa/New Zealand

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Large-scale disturbances, both natural and anthropogenic, can have dramatic impacts on deep-sea benthic communities. One such disturbance are turbidity flows – underwater avalanches – that can transport massive amounts of sediment across large distances. Samples collected before and after a turbidity flow in Kaikōura Canyon, Aotearoa/New Zealand triggered by the 7.8 (Mw) 2016 Kaikōura Earthquake provide a unique opportunity to examine the response of deep-sea benthic communities to a large-scale habitat altering disturbance.

Photographic transects from a towed camera system were collected at the same sites, 10 years before the event as well as 10 weeks, 10 months, and 4 years afterwards. Mega-epibenthic fauna, lebensspuren (feeding and other life traces on the seafloor) and sediment characteristics were recorded from the imagery and compared among these transects. These data were also compared to habitat topographic variables (depth, roughness, aspect, slope etc.) extracted from multibeam bathymetry data acquired before and after the turbidity flow. Results of these analyses revealed that immediately after the turbidity flow event there was little sign of life, although temporary chemosynthetic habitats had developed and changes in the behavior of fish, primarily Macrouridae, were observed. Four years after the event the benthic community is showing signs of having recovered to something similar in structure to the community that existed before the turbidity flow. This recovery is associated with a change in the physical characteristics of the habitat (e.g., sediment and topographic roughness) that have occurred since the turbidity flow drastically altered the habitat in the canyon.

These results, and data for macro-infauna from sediment cores taken at the same time as the photographic transects, form the basis of a wider project which aims to build models predicting rates of benthic community recovery from large disturbances in the deep sea. These models will contribute to better understanding of natural disturbances from turbidity flows and will be useable as proxies for anthropogenic disturbance such as seabed mining.

Preliminary interpretation of multibeam bathymetry collected by the R/V *Falkor* during 2021 in the Tasman and Coral seas

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From 28th December 2020 to 6th March 2021, the Schmidt Ocean Institute's R/V *Falkor* was in operation within the Tasman and Coral seas. The primary objective of these two back-to-back voyages was to collect multibeam bathymetric data in previously unmapped regions of the Coral Sea Marine Park, such as the Coriolis Ridge, Chesterfield Plateau, Cato Trough, around the Fraser and Recorder guyots lying within the Tasman Basin, and coral reefs forming part of the Tasmantid Seamount Chain. The data collected were also part of the Schmidt Ocean Institute's contribution to the Nippon Foundation- GEBCO Seabed 2030 Project, which aims to map the entire ocean floor by 2030. These expeditions were some of the first data collected in 2021 for the start of the UN Decade of Ocean Science for Sustainability (2021-2030).

At the end of the two voyages, the R/V *Falkor* had mapped over 70,000km^2 using the Kongsberg EM302 and EM710 multibeam sonar systems. Preliminary processing and interpretation of the bathymetric data have revealed new details of seafloor morphology. Features of interest include: previously unmapped platform on Coriolis Ridge with significant mass wasting; sediment waves up to 10m tall on Coriolis Ridge; evidence of tectonic activity and faulting along Kenn Reef and Selfridge Bank; mass wasting and deep-water scouring around the Fraser and Recorder Guyots; evidence of terracing on Wreck and Cato reefs; and parasitic cinder cones around Cato Reef.

Further work will combine the new bathymetric data collected by the R/V *Falkor* with pre-existing bathymetric and seismic data in the Tasman and Coral seas to provide insight into the geomorphic history of the region. Specifically, this research will use GIS tools to reconstruct how wave erosion and constructive reef growth may have formed the modern Tasmantid Seamount Chain morphology.

Locally varying classification accuracy for spatial benthic habitat models in the Arafura Marine Park, northern Australia

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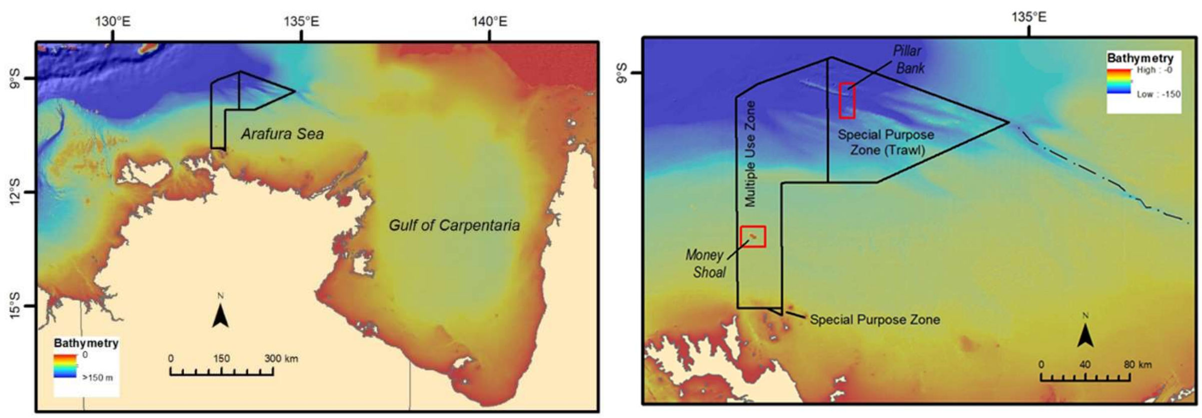
In November 2020, the Australian Institute of Marine Science and Geoscience Australia collaborated to survey two study areas within the largely unexplored Arafura Marine Park in northern Australia. This was done with high resolution multibeam sonar and an array of underwater towed video transects (https://www.nespmarine.edu.au/document/arafura-marine-park-post-survey-report) as part of the National Environmental Science Program Marine Biodiversity Hub. These data were used to build spatial predictive benthic habitat models of the two areas – one centered on a shallow reef (**Money Shoal**) and the other on a much deeper feature (**Pillar Bank**).



For Money Shoal, mixed benthic classes were defined a priori using clustering implemented in R based on a range of lag distances. This was not possible for Pillar Bank given the paucity of classes observed in situ. Models were constructed using Random Forest implemented in Python with two-thirds of the towed video observations, and classification accuracy was assessed using the remaining one-third of the data. Classification accuracy within each study area was also modelled using a locally varying version of kappa. We then explored what insights locally varying classification accuracy mapping brings compared to a single global value, and how this varies with depth.

A possible tectonic control for mesophotic reef growth on the northwestern side of Lingayen Gulf, Philippines

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Lingayen Gulf is a north-facing u-shaped embayment, measuring 40 km wide and 63 km long, along the northwestern coast of Luzon Island [1,2]. An intensive sparker seismic reflection survey was conducted in 1987 by the Mines and Geosciences Bureau and the Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Offshore Areas to look for placer deposits [3]. However, the dataset also provide insights on the possible role of tectonics for coral reef development in general and establishment of mesophotic coral ecosystem in particular on the western side of the gulf. An active fault, identified in the seismic data, occurs as a boundary between the karstic terrane to the west and the fluvio-deltaic deposits to the east. This fault is interpreted as the offshore extension of the East Zambales Fault (EZF), an active left-lateral strike-slip fault. The offshore EZF continues ~64 km into the gulf, following a NNW-trend with an eastward bending that starts at the far-eastern coast of Santiago Island. The eastward bending of EZF results to a compressional region [4] and forms a bathymetric high, herein referred as Pudoc, where mesophotic corals were found. Assessment of the mesophotic window was conducted using a photo-transect method at four sites. Photo-quadrats were then processed in Coral Point Count with Excel extensions using 25 gridded points. The dominant benthic cover is dead coral (54%) followed by sand (22%); while live coral cover is only 18%. This may be due to anthropogenic stress because Pudoc is a rich fishing ground for locals. A total of 37 hard coral genera belonging to 12 families were identified and Porites spp. is the most dominant. The prevalent growth forms across all sites are encrusting, massive, and laminar. Results provide information for comparison on possible role of tectonics for coral reef development in other regions.

References

[1] Mateo, Z.R.P. and Siringan, F.P. (2007). Tectonic control of high-frequency Holocene delta switching and fluvial migration in Lingayen Gulf bayhead, northwestern Philippines. Journal of Coastal Research, pages 182-194.

[2] Mateo, Z.R.P. and Siringan, F.P. (2016). Morphological and sedimentological signatures of late Holocene prodelta lobes in Lingayen Gulf, Philippines. Journal of Coastal Research, pages 182-194

[3] Salas, R.P., Natividad, J.A., and Abarquez, G.G. (1991). Sedimentological stratigraphy of Lingayen Gulf, northwest Luzon, Philippines. In Geological Society of the Philippines 4th Annual Geological Convention.

[4] Sylvester, A.G. (1988). Strike-slip faults. GSA Bulletin, 100(11):1666-1703.

Mapping the Buried Magmatic Rocks via Seismic Reflection Data - A Case Study from the Offshore Otway Basin

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Magmatic rocks are derived from the cooling of molten rocks that ascend from Earth's deep interior and make up 2/3 of the Earth's Crust. While humans are familiar with magmatic systems exposed in the surrounding landscape, ~75% of the Earth's igneous activity occurs in the submarine realm. Active or extinct magmatism on the seafloor can be investigated by multibeam sonar, high-resolution bathymetry, side-scan sonar imagery, and submersible dives. Studies using datasets collected by these methods are capable of observing meter-scale magmatic features on the seabed yet lack the ability to map buried volcanic provinces that over tens of kilometers and may have dramatically impacted the physiography of the paleo-seafloor during their emplacement. Thus, our understanding of the extent, geomorphology, internal architecture, and trigging factors of those magmatic rocks "hidden" underground, although important for evaluating their consequence, are limited compared to subaerial igneous provinces.

Recent advances in geophysical investigation techniques, especially the availability of large volume seismic reflection datasets along passive margin basins, provides a unique tool to study the distribution and emplacement of magmatic systems buried within sedimentary successions. In this study, we present the identification and mapping criteria for the buried magmatic rocks and demonstrate the spatio-temporal distribution of these igneous complexes within the offshore Otway Basin. Our results show that the seismic-based identified buried volcanoes (n= 49) are late Eocene to Early Miocene in age and are distributed mainly along the continental shelf from offshore Portland to the western King Island. Hydrothermal vents (n=27) occur during the late Eocene and are mainly concentrated within the offshore Port Campbell area. Small magmatic sills (n=17) are sporadically identified, which highlights the importance of the dykes for the magmatic plumbing system in the study area.

This study reveals the efficiency and value of seismic reflection data in identifying and mapping buried magmatic features. Considering the close distance to the coastal cities and a long history of exploration seismic reflection data collection, the discovery of these magmatic features, especially those volcanoes in the study area, demonstrates the value of re-examining seismic reflection data in pursuit of new geological knowledge.

Distribution of surficial sediments in the ocean around New Zealand

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New Zealand has a large and geologically complex marine Exclusive Economic Zone (EEZ) and extended continental shelf (ECS). We have developed a series of marine sediment maps of the region to aid the management of the seafloor within the EEZ and ECS. Data from ~150 published, unpublished, national and international collections covering ~30,000 sediment analyses and observations from the 1950s to 2015 were compiled. Most of the legacy data (~80%) were only descriptive, so the dbSEABED software (Jenkins et al. 2008; http://instaar.colorado.edu/~jenkinsc/dbseabed/) was used to convert word-based data in to quantitative data, based on calibrations from datasets where both descriptions and analyses are present on thousands of samples. Descriptions are parsed and meanings and values are attached to the essential terms. For example, a description of "muddy sand" will be assigned as 40% mud and 60% sand. A sample which is described as "pelagic ooze" (a sample made up of carbonate plankton skeletons), a carbonate content of 90% is attributed. The dbSEABED system produces a unified mappable database or the New Zealand region (**nzSEABED**). The database was imported into ArcGIS and the data interpolated using ordinary kriging to develop a series of maps where data was interpolated using a characterising the surficial sediments (% mud. % sand, % gravel, % carbonate). The maps highlight distinct spatial patterns, which can be explained by past and present climate, terrigenous (from the land) sediment flux, tectonics and volcanism, complex bathymetry, oceanography, and diagenesis. The results are published in Bostock et al., (2019a;b) and are already being used to understand benthic habitat distribution of a range of marine organisms, soundscapes for marine fauna, and considered in the potential location of wave energy projects. We are currently building on nzSEABED, by compiling the sedimentation rates for the region and new datasets are being analysed to determine the distribution of elemental concentrations to determine the provenance of the sediments.

Bostock et al., 2019a Distribution of surficial sediments in the ocean around New Zealand/Aotearoa. Part A: continental slope and deep ocean: New Zealand Journal of Geology and Geophysics: Vol 62, No 1 (tandfonline.com)
Bostock et al., 2019b Distribution of surficial sediments in the ocean around New Zealand/Aotearoa. Part B: continental shelf: New Zealand Journal of Geology and Geophysics: Vol 62, No 1 (tandfonline.com)

Citizen scientists drone mapping coastal erosion at regional scale: data quality, challenges, applications, and future directions

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The engagement of (often) non-technical volunteers in coastal data collection campaigns has so far been limited to 2D images. Nowadays, low-cost unoccupied aerial vehicles (UAVs) are being used effectively worldwide to obtain reliable 3D data at very high spatiotemporal resolutions, providing new perspectives on the monitoring of subaerial beach dynamics. However, UAVs are mainly flown by researchers or contractors, raising costs which limit the number or frequency of surveys per location, within a project. Deakin University and The University of Melbourne, in collaboration with the Victorian Department of Environment, Land, Water and Planning, trained and coordinated more than 150 citizen scientists to fly UAVs on 15 erosional hotspots along the coastline of Victoria, Australia, every six weeks for three years. This world first multi-award winning mapping campaign creates a unique dataset of more than 700 datasets between orthophotos and digital surface models, which holds enormous potentials for beach monitoring.

However, what is the vertical accuracy of citizen scientists' data? How do their data compare with the current researchers quality standards? Our first-year results show that they provide data as accurate as professional researchers (or contractors) in similar experimental settings. Moreover, no inter-group bias impacted data quality, meaning that citizen scientists can be considered one reliable mapping asset working coherently at the regional scale. Thanks to this finding, we were able to monitor sediment-only seasonal-scale topographic change, model beachface dynamics with novel indices and evaluate the efficiency of a nourishment program, based on topography timeseries alone. This method and our protocol can be applied worldwide for a variety of scopes, provided that some regulatory or environmental challenges do not fully limit its application.

Our next steps is to implement a full dataset (3-year) raster-based analysis of all locations, using a combination of artificial intelligence and environmental data to better characterize and explain beach dynamics, significantly increasing the understanding of these high priority locations.

Self-adaptive analysis scale determination for terrain features in seafloor substrate classification

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Seafloor substrate mapping has become increasingly important to guide the management of marine ecosystems. Full coverage substrate maps, however, cannot easily be created from point samples (e.g. grabs, videos) as a result of the time required for collection and their discrete spatial extent. Instead, relationships between substrate types and surrogate variables as obtained from bathymetric or backscatter data can be modelled to build predictive substrate maps.

Traditional single scale or multi scale analysis methods can be relatively subjective with regards to scale selection. To improve the objectiveness of seafloor substrate classification process, we propose a novel automatic self-adaptive analysis scale determination approach at each bathymetric point to extract terrain features. To assess the performance of this novel approach, we compare performance metrics to those obtained using traditional single and multi scale analysis methods.

Two testing areas in Newfoundland, Canada, with high-resolution bathymetry and backscatter data available in combination with substrate types interpreted from ground-truth video data, were chosen. The approach developed involved; (i) analysis scale determination based on local seafloor orderliness, (ii) polynomial methods to extract terrain attributes, (iii) object-based image analysis to extract backscatter features, and (iv) Random Forest classification to model the relationship between extracted features and substrate types.

The proposed method demonstrated good performance in terms of both overall (>80%) and per-class accuracies, and tended to slightly outperform other approaches tested. The proposed method additionally avoided the subjective selection of analysis scale, and the untested assumption that a single scale is suitable for all classes. The result is a robust and objective seafloor substrate classification for management and monitoring.

Making better habitat maps for management with spatially optimised habitat classes and spatial kappa analysis

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Habitat maps derived from spatial models are widely used for marine management. Their effectiveness depends on them being a) robust and fit for purpose b) provided with a clear understanding of their limitations. The construction of these maps and models often involves a number of subjective decisions including what habitat classes should be modelled and how these should or should not be combined in a final map. Once final maps our produced, providing map class accuracy is common and give's one indication of robustness however, accuracy will variable at different locations, but this information is rarely calculated or provided.

Using examples from the coastal Kimberly and North West Shelf we present two new methods to increase map and model accuracy, reduce habitat class arbitrary decisions and provide metrics of spatial accuracy of maps. Hierarchical clustering optimised to reduce spatial autocorrelation provides a method to aggregate habitat classes in a non-arbitrary, ecologically meaningful way and greatly increase mapping accuracy. The spatial-kappa statistic can be applied to these maps to show locations where habitat classes are very accurate and where they fail. In combinations these techniques have the potential improve habitat maps and increase their effectiveness for marine management.

Phenomenological Approaches in Correlation between Morphology and Marine Sediment of Seabed Derived from Multibeam Echosounder Data

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The need of identification of seabed morphology and sediment type is becoming indispensableespecially in ecosystem-based management in marine environment. This research aims to determinethe relationship between the structure of seabed and the type of sediment phenomenologically by using bathymetry and backscatter data from multibeam echo sounder (MBES) sonar system. To achieve this task, MBES data using Kongsberg EM2040C system was used to collect acoustic data and to produce bathymetry map and backscatter mosaic at Labuan Marine Park, Malaysia. The data was acquired as part of the marine habitat mapping project at marine protected areas in Malaysia.

Firstly, Benthic Terrain Modeler (BTM) was used to produce a map of different morphological classes using bathymetry map and its derivatives. Secondly, a sediment classification map was produced by using backscatter mosaic and a simple clustering technique (K-Means clustering). Finally, the clustering map was then verified with in-situ ground truth of sediment samplinginformation to assign sediment class to each cluster.

From the morphological and sediment maps, the bigger grain size of sediments seems to dominate on more rugged and steep inclination of terrain while smaller grain size dominating flat areas.

This study concludes that, at Labuan Marine Park, morphology and marine sediment of theseabed are fairly correlated with each other.

The Mapping and Monitoring the Worlds Coral Reefs: the Allen Coral Atlas

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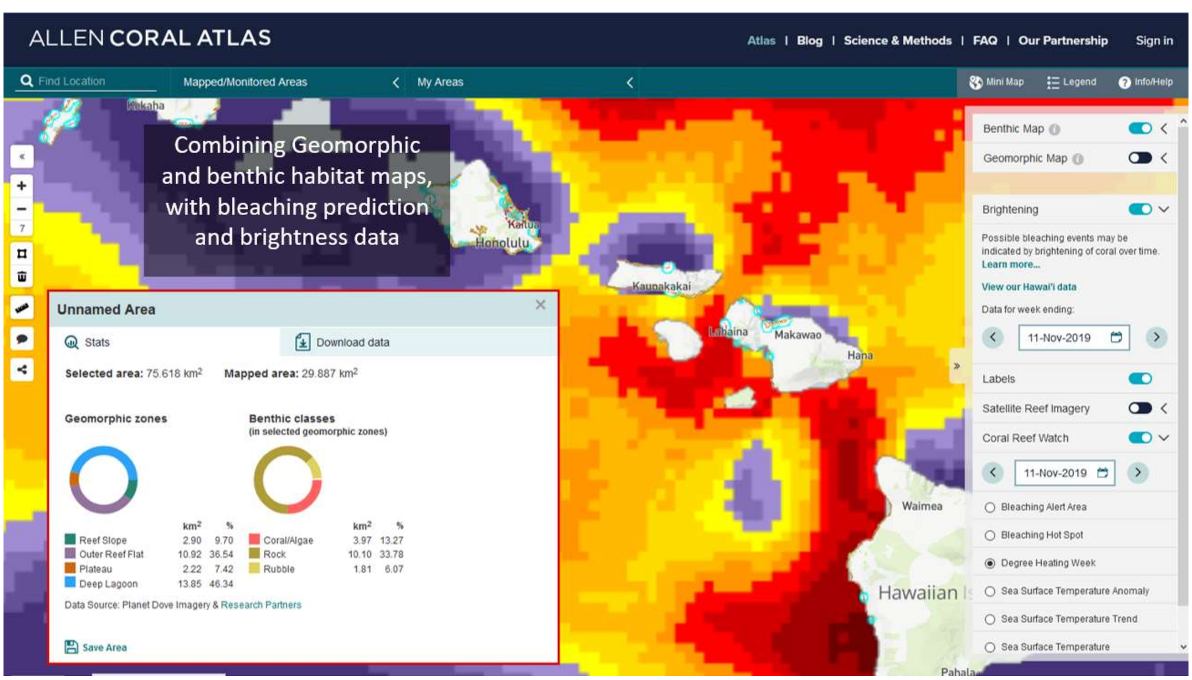
We outline a global coral reef mapping and monitoring effort trough The Allen Coral Atlas (http://allencoralatlas.org) partnership. It combines detailed ecological information and knowledge with high-resolution satellite imagery, to map and monitor the world's coral reefs. This talk will highlight the global coral reef habitat mapping and monitoring methods at high spatial and thematic resolution not published before. The resulting maps provide information on reef geomorphic zonation and benthic cover types in a globally consistent approach, driven by local scale information. The semi-automated mapping approach is based on machine learning and object based clean up using Planet Dove low tide satellite mosaics, Sentinel 2 derived water depth, slope combined existing field data, and spatial modelling algorithms. The Atlas team develops these habitat maps regionally and globally, and dynamic monitoring technology of brightness and turbidity, the initiative's goal is to enable stakeholders to achieve conservation results and improve access to spatial data (e.g., through marine spatial planning or restoration efforts). These products are intended to be the first version of a data set that is updated continually based on input from reef science and management communities globally. By July 2021 99% the world's tropical reefs will be mapped and can be viewed, analyzed and/or downloaded at the www.allencoralatlas.org.



Optimizing ground-truthing methods and spatial resolution for deep seagrass mapping.

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Habitat mapping is a valuable too l for managers in assessing and managing the status of marine ecosystems. The need for sustainable management of marine resources demands habitat information and predictive models based on acoustic remote sensing are the most effective way to address this demand for deep regions where spectral products are inadequate.

Accurate seafloor habitat maps largely rely on adequate ground-truthing data since maps of entire regions are inferred from discrete ground-truthing data and their relationship with environmental variables. In addition, the choice of grid size (resolution) of environmental data, can have significant effects on the performance of modelling and predictions. However, availability of high spatial resolution environmental products is rare, particularly for deep and offshore areas.

Seagrass meadows are a key coastal habitat which sustains marine productivity and biodiversity. In Geographe Bay, Western Australia, seagrass meadows exist up to depths of approximately 45 m. Maps of deep seagrasses (15 – 45 m of depth) were produced for Geographe bay using random forest algorithms, two bathymetry products of different spatial resolution, and four different methods for ground-truthing: Stereo-BRUVs, Autonomous Underwater Vehicles (AUV), forward-facing towed video and downward-facing towed video for a total of eight habitat maps (Fig. 1) (two bathymetry resolutions and four ground-truthing platforms). The resulting maps were compared in their accuracy to represent the distribution of seagrasses, to infer the most appropriate resolution and ground-truthing techniques for mapping deep seagrasses.

Preliminary results indicate that downward-facing ground-truthing methods produce the most accurate maps, with bathymetry resolution having little influence on model performance and forward-facing platforms, generally producing less accurate maps. Each ground-truthing method also produced visually distinct maps, indicating there is an effect, not only of the platform but also the sampling design on the mapping outcome.

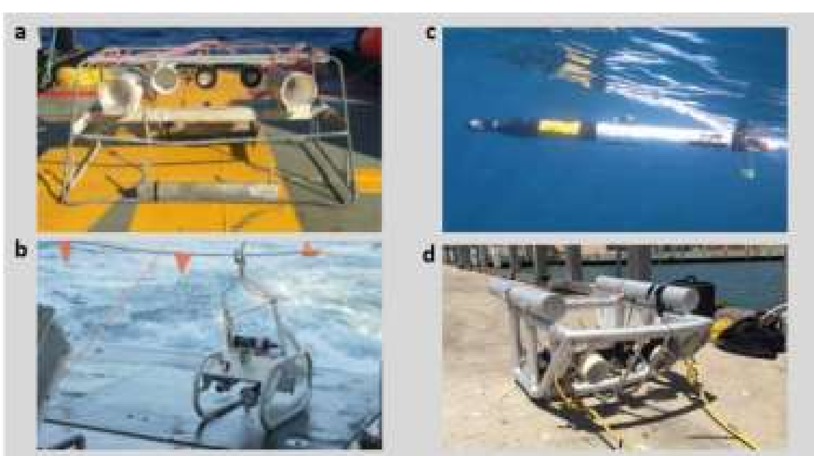

Fig 1. Different ground-truthing platforms used to map deep seagrasses in Geographe Bay: a) Stereo BRUVs, b) forward-facing towed video, c) autonomous underwater vehicle, and d) downward-facing towed video.

Using substrate and seafloor terrain variables to explain benthic community structure and predict community distributions within two New Zealand seamounts

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The ability to predict spatial and temporal patterns in biological communities relies on an understanding of the biotic and abiotic factors related to community assembly processes. Many deep-sea distribution modelling efforts to date have focused on a single species or a small group of similar species, and primarily cold-water corals. However, community-level modelling and mapping (whole or partial species assemblages) may be more useful for habitats characterised by high species richness and many rare records, particularly when being applied in an environmental management context. Seamounts are significant marine habitats, estimated to comprise up to 20 percent of the global seafloor, and vulnerable to disturbances from a variety of human activities, including fishing. These features are highly heterogeneous at a range of spatial scales and can be associated with high abundance and biomass of deep-sea benthic taxa compared to surrounding slopes. It is thus important to understand fine-scale community and patch dynamics, as well as the environmental drivers contributing to assembly patterns on seamounts to improve habitat mapping efforts on these features, inform spatial management, and better assess their potential for recovery from fishing impacts. To address this, we examined two small seamounts on Chatham Rise, a plateau which extends ~1000 km east from South Island, New Zealand to: 1) identify and describe the structure and distribution of mega-epibenthic communities on two unfished New Zealand seamounts; 2) determine which environmental and habitat variables best correlate with variation in community structure and distribution within both seamounts; 3) predict the distribution of the identified communities beyond the sampled areas using a random forest distribution model; and 4) describe the patterns of the predicted spatial distributions of each community, in particular the community patch characteristics.

Estimating Benthic Light Availability for Kelp Forests Using Satellite Imagery

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Kelp Forests support productive and diverse ecological communities worldwide, providing numerous ecosystem services to humans. Increasing evidence shows that these coastal kelp-dominated ecosystems are threatened. Among the stressors affecting kelp, few have focused on the role of light limitation. In New Zealand, there has been no studies on how the quantity and spectral quality of light have changed at a national scale as increasing sediment loads affect coastal water and local Kelp Forests.

Here, we use satellite remote sensing of ocean color to model light availability on the seabed across New Zealand from mid-2002 onwards. By estimating the attenuation coefficient of light in key wavelengths for macroalgae and in the Photosynthetically Active Radiation (PAR) wavelengths using MODIS-AQUA satellite measurements, the quantity and quality of light reaching the seabed was calculated.

Trends were identified, showing regional disparities around the coastline and over rocky reefs. This work is the first step in characterizing the coastal light ‘envelope’ where kelp forests can exist and delineating their spatial extent and temporal variability.
Remote sensing has considerable promise in extending the scale of *in situ* monitoring and is a significant tool in the arsenal of understanding dynamics of coastal reefs on a national scale. Finally, it will help identify areas where critical thresholds of light availability are crossed, thus compromising kelp forest resilience and its associated biodiversity. The method developed here as potential application in any benthic photosynthetic communities such as macroalgae, seagrass or coral reefs systems.