Deep-Sea Life

Issue 13, June 2019

We are now into our 7th year of Deep-Sea Life so time for us to enjoy more news from the deep! In the line up for this 13th issue are stories from researchers who have been exploring the deep waters of the Seychelles EEZ, from our Russian fisheries colleagues who have been re-visiting the Emperor Seamounts with interesting results, more news from the Pacific CCZ and from two separate cruises to the Antarctic – one to the Weddell Sea and the other a return visit to the Antarctic Yeti crabs. You can also read about exciting new projects including two from the Atlantic (iAtlantic & CLASS) and the Deep-Sea Coral Initiative off the west coast of USA (NOAA). You can even get the children involved in this issue – an interactive deep-sea trawling game and a children's book on deep seabed mining may inspire!

With updates from DOSI on work to advance deep-sea science in policy, exciting news on the future of deep-sea observations from DOOS and reports from various meetings and workshops from around the globe (e.g. Meroplankton observations, Portugal; Deep-Sea Soundscapes, Japan; Ocean Sustainability, South Africa; Deep-Sea Taxonomy, Germany) you won't want to put it down! Remember to read the last section as there are excellent new publications not to be missed. Start by enjoying this photo of the issue from Steve Long (thank you Steve). A beauty!

Thanks again for all the interesting articles. The editors, Dr Abigail Pattenden (University of Limerick, Ireland), Dr Eva Ramirez-Llodra (now of REV Ocean, Norway – congratulations!), Dr Paris Stefanoudis (University of Oxford / Nekton Foundation, UK), and I all thoroughly enjoyed reading about your work during the editing process.

Coral and sponge garden, 550m, deep-sea benthic sled video image. Credit: Steve Long

Dr Maria Baker
INDEEP/DOSI Co-Lead, University of Southampton, UK

Issue Contents

Cruise News

First Descent – To explore and conserve the Indian Ocean 2019-2022

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We are delighted to share news of our return from the successful launch of First Descent: Indian Ocean 2019-2022, with our first major research expedition in Seychelles, working with, and on behalf of the Government of Seychelles.

Fig. 1. Expedition participants together with members of the Seychelles Government. © Nekton.

Nearly 50 days at sea, covering 2300 nautical miles, with a team of up to 60 (Fig. 1), including crew, on our Mothership, the *Ocean Zephyr* (Fig. 2), we undertook over 300 science deployments, focusing down to 500m depth, across seven key locations in the previously unexplored depths of the Seychelles, helping to provide key data and new skills to inform the protection of 30% of Seychelles Exclusive Economic Zone (equivalent in size to twice the UK). In the process, there were 4,391 different broadcasts about Nekton - first live subsea presidential address (President of Seychelles, Fig. 3) - and 1,863 programming features across 244 media organisations in over 120 countries. Finally, hundreds of thousands of young people engaged including nearly 10,000 school children from 16 countries directly participating in

live link-ups with scientists, engineers and technicians on board the *Ocean Zephyr* over a week during the expedition.

Here are a few snapshots to give you a sense of what we have achieved so far:

- Seychelles Mission Trailer (2mins)
- Seychelles Mission Overview (8mins)

From the dramatic subsea cliffs of Astove and their unbleached healthy coral ecosystems, to abundance of predators around the World Heritage Site of Aldabra and sightings of six-gill sharks at 300 m, early indications suggest some truly remarkable ecosystems and the forms of connectivity across depths and islands. Observations also imply the existence of the Rariphotic Zone in Seychelles from 100+ metres depth. Some representative habitats across different depths are shown in Fig. 4.

Fig. 2. The mothership Ocean Zephyr as seen from the Triton submersible "Kensington Deep". © Nekton.

Back on land, the real challenge begins: the processing, statistical analysis, and interpretation of the collected marine data. This will be a collaborative exercise between a series of networked laboratories from Seychelles, Nekton and participating institutes to develop capacity and accelerate findings. A host of science activities are planned in the coming 12-18 months to ensure we will be able to achieve our science goals:

Fig. 3. A video still of President Danny Faure of the Seychelles, left, speaking inside a submersible 124 m under the Indian Ocean on the 14.04.2019. © Nekton.

- Technical report of expedition activities with summary of all data collected.
- Two AfOx (African Oxford Initiative) fellowships to visit Oxford University in July 2019 and work together with the wider Nekton Team on data collected from the expedition.
- Taxonomic workshop in SAIAB (South African Institute of Aquatic Biodiversity) in July/ August 2019 for participating scientists, joined by world experts, to work through selected samples and specimens from the expedition with the goal of accelerating taxonomic identification, processing, analysing and developing the expertise of local early career researchers. **If you are interested in participating as an expert please let us know as we have a few positions left to fill.**
- Training workshop in Seychelles in Autumn 2019 in order to develop data processing and analysis skills.
- A final workshop in Seychelles in May 2020 with all collaborators to share collective expedition findings to date, agree the datasets and tools to be provided, and determine any further steps towards capacity development or in support of ocean management.

Watch: High Five for Science (scientific deployments)

Read: Indian Ocean Science mission comes to an end

Find more about Nekton on Twitter, Facebook, Instagram, our website.

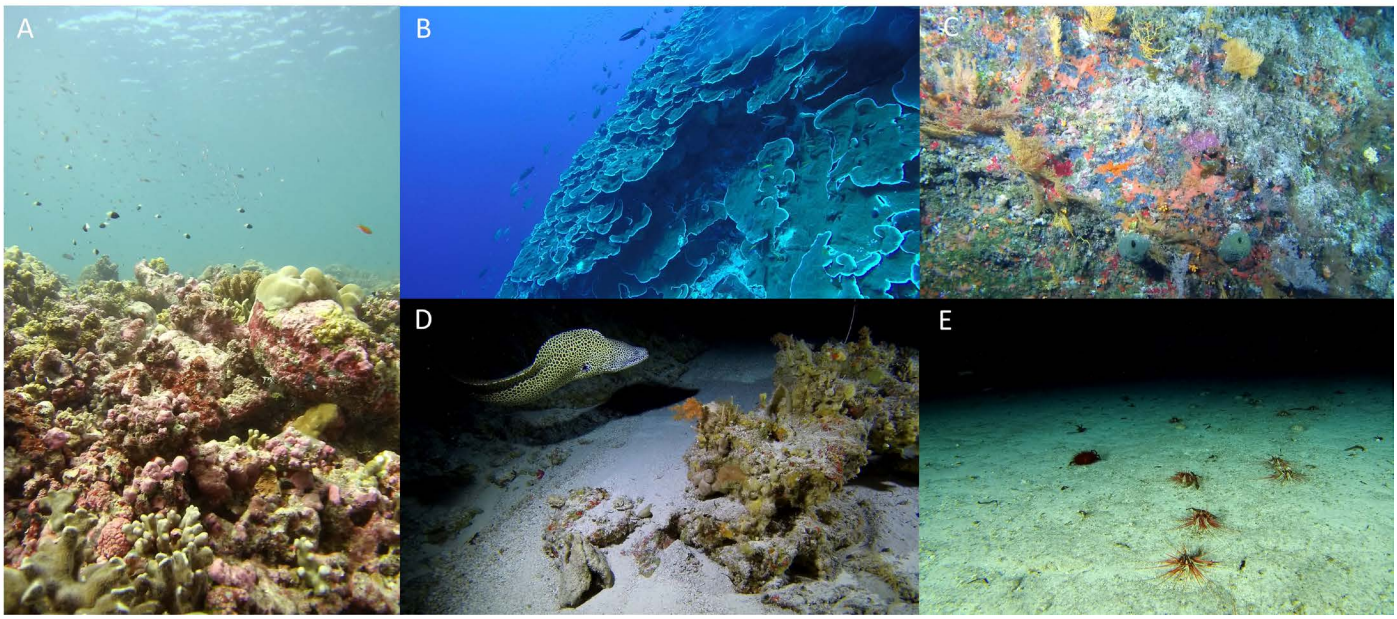

Fig. 4. A) Shallow-coral reefs teeming with life in Alphonse, 10 m, B) Incredible hard coral coverage and fish abundance at reefs in Astove, 30 m, C) Diverse benthic assemblages observed in Astove, 60 m, D) A moray eel spotted in Aldabra, 120 m, E) Sea urchins populating the deeper sedimented habitats in Desroches, 250 m © Nekton.

Research in Emperor Seamounts area in April 2019

Somov, A.A., Kanzeparova, A.N., Orlova, S.Yu., Kurnosov, D.S., Zuev, M.A., Orlov, A.M

Russian fisheries research on the Emperor Seamounts began in the 1960s. Despite long-term observations, the ichthyofauna of this area has not been fully studied, even at the level of species composition. Ecosystems of seamounts in general, and those of Emperor Seamounts (Fig. 1) in particular, are highly productive. However, being localized and isolated, these ecosystems are very vulnerable, especially commercially important species such as pelagic armorhead (*Pseudopentaceros wheeleri*) and alfonsinos (*Beryx splendens* and *B. decadactilus*). Heavy commercial exploitation of their resources in the 1970s and 1980s caused significant restructuring of fish communities.

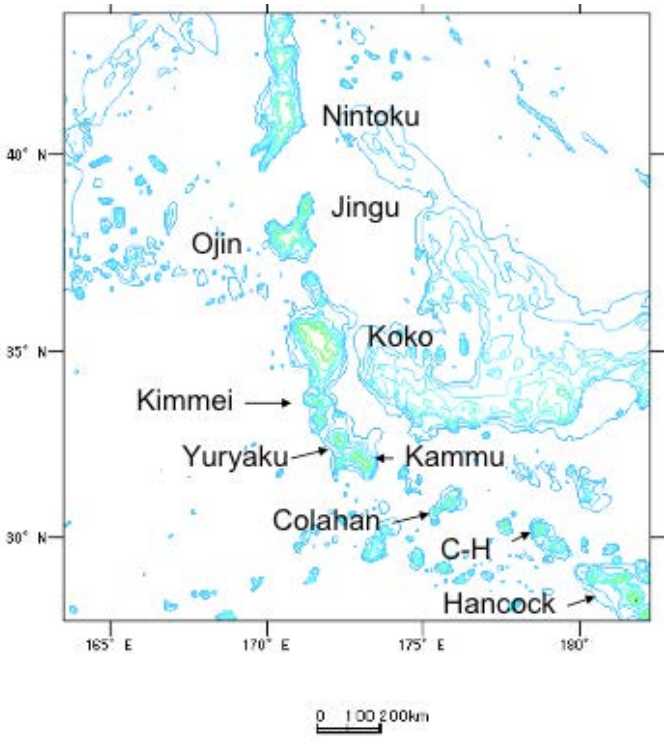

Fig. 1. Map indicating the location of the Emperor Seamounts.

In April 2019, research on board Russian research vessel *Professor Kaganovsky* (Pacific Branch of the Russian Federal Research Institute of Fisheries and Oceanography - TINRO, Vladivostok, Fig. 2) on Koko, Lira, Ojin and Jingu seamounts (Fig. 3) was conducted. Trawlings were carried out using bottom trawl at depths ranging from 291 to 1030 m. Thirty six species of demersal and benthopelagic fishes, including meso - and epipelagic fish (Fig. 4), and another six species of cephalopods were registered in the catches, of which 11 species were not observed in a previous Russian survey in this area in 2010. Among benthopelagic species at least six (*Congriscus megastomus, Meadia abyssalis, Nettastoma parviceps, Embassichthys bathybius, Icelus sp., Elassodiscus sp.*) were not observed in this area earlier (Borets, 1980; Novikov et al., 1981). It can be concluded that the real species richness of benthic and pelagic ichthyofauna of the Emperor Seamounts are much higher as compared with those from

Fig. 2. RV Professor Kaganovsky in Nanaimo (BC, Canada) harbor.

published literature and known from previous cruise reports.

In addition, the distributional shift of some fish species from the southern seamounts to the northern ones should also be noted. The pencil cardinal (*Epigonus denticulatus*) became the most abundant species (Fig. 5, left) on Koko seamount (central part of the area) recently. In the 1970-80s, this species was observed on Milwaukee seamounts (southernmost part of the area) and on Hawaiian Ridge and was not found on Koko seamount (Borets, 1986). As surveys in 2010 and 2019 showed, the range of pencil cardinal has been extended northward considerably. In addition to this species, catches of the Japanese codling *Physiculus japonicus* and *Paraulopus oblongus* composed significant portions of the catches while in the past they occurred in this area in insignificant amounts. In the 1960s and 1970s, pelagic armorhead (Fig. 4, right) was the dominant species in catches, accounting for up to 93.3% of catches, while since the 2010s it it accounts for 2-7%. The opposite pattern is observed in pencil cardinal. Previously, the catches accounted for less than 1% while in the 2010s it increased to 69-81% (Fig. 6).

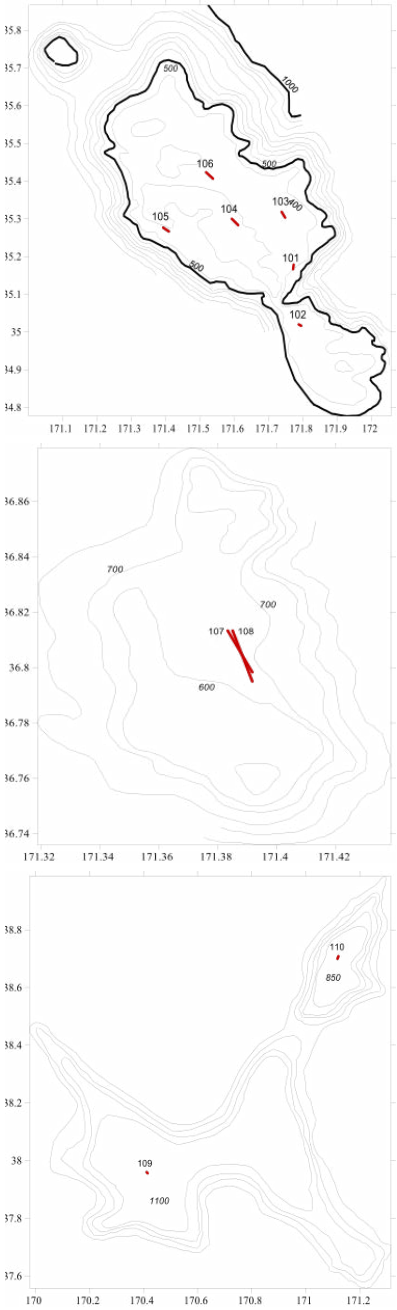

Fig. 3. (right): Positions of trawlings (in red) made on Koko (top), Lira (center), and Ojin and Jingu (bottom) seamounts; numbers are isobaths (italic) and haul numbers (regular).

Fig. 4. (above): Example catches of mesopelagic fishes.

*Fig. 5 (Left): A collected specimen of a pencil cardinal (*Epigonus denticulatus*); (Right): A collected specimen of a pelagic armorhead (*Pseudopentaceros wheeleri*).*

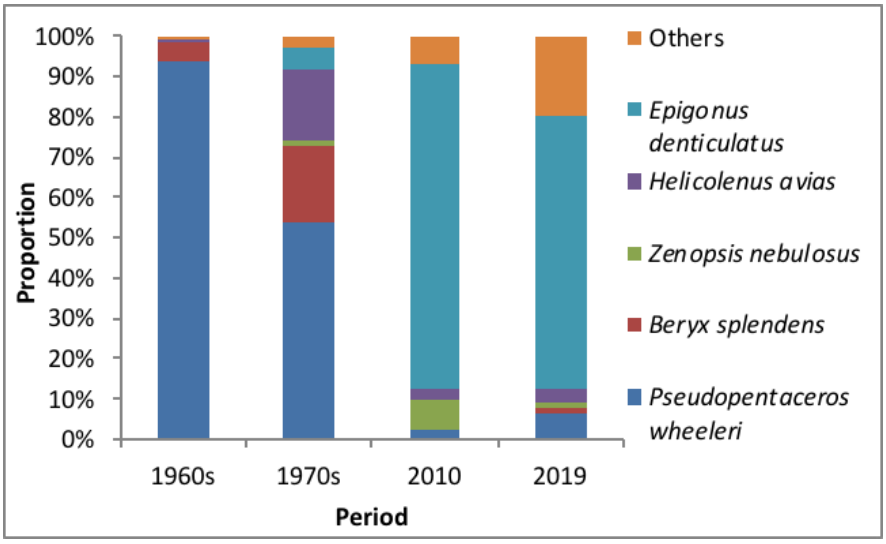

Fig. 6. Composition of bottom trawl catches on Koko seamount.

Fig. 7. The scientific team of RV Professor Kaganovsky (left to right: M. Zuev, S. Orlova, I. Shurpa, A. Ivanov, A. Slabinsky, A. Khleborodov, A. Vazhova, A. Somov, A. Orlov, D. Kurnosov, A. Kanzeparova).

The return to the Antarctic yeti crab

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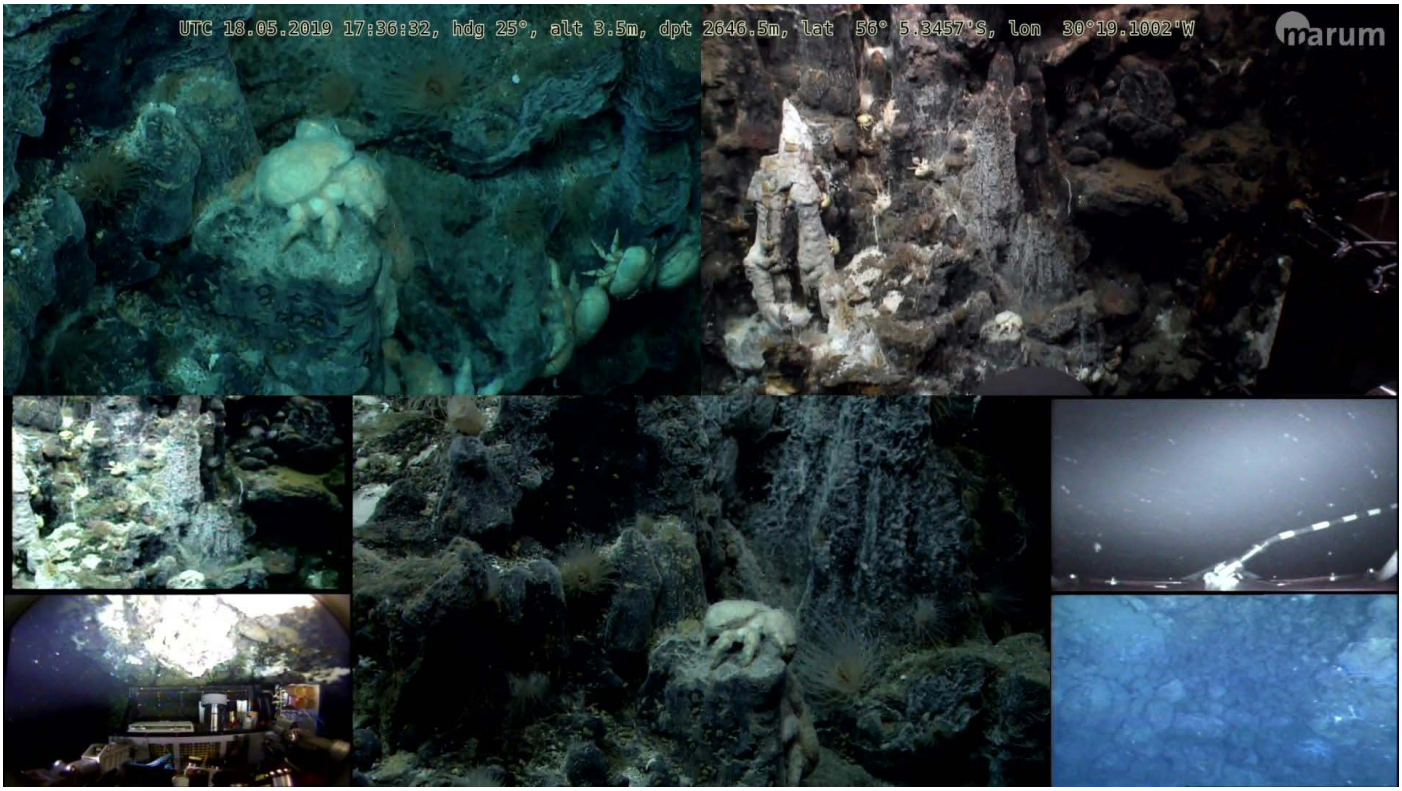
The hydrothermal vent fields on the East Scotia Ridge (ESR) were one of the earliest photographed vent fields – with photos taken during the RV *Eltanin* Cruise 22 on 17th Feb. 1966 at 2377 m depth off the South Sandwich Islands (60 03'S, 29 58'W) – but the importance was not recognised until more than four decades later. Those original photos showed actinostolid anemones, stalked barnacles (*Neolepas scotiaensis*) and individual white brachyuran crabs (*Kiwa tyleri*). In 2009, after the UK's ChEsSO consortium filmed black smokers and their surroundings with SHRIMP, a towed camera system, it became clear that *Eltanin* had photographed a diffuse flow field. The ChEsSO consortium had two successful ROV expeditions in 2010 and 2012 to the visited the ESR vents, but no expedition has returned although almost another decade has passed.

Professor Gerhard Bohrmann's (MARUM, Germany) expedition PS119 "South Sandwich Venting II" from 13th April to 31st May 2019 set out to study seeps and vents from the trench to the back-arc of the South Sandwich microplate, focussing on fluid and gas circulation. Our invitation to join this cruise on RV *Polarstern* enabled us to further study the



biodiversity, ecology and physiology of animals at black and white smokers in hydrothermal vent ecosystems at ESR segment E2 and the Kemp Caldera.

MARUM's ROV *QUEST* was our workhorse for sampling target species for respiration experiments on board: the peltospirid gastropod *Gigantopelta chessoia* and a vesicomyid clam, and we had three temperature-controlled lab containers on hand for live animal experiments. Coming back to a slow-spreading vent field, after more than seven years, also enabled the German-UK-USA expedition team to study the changes in the chimney structures in their geology, and geochemistry and their faunal assemblages.

Exploration of deep-habitats of the Weddell Sea on *SA Agulhas II*

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At the start of January 2019, an international and multidisciplinary group of explorers and researchers were congregating at Penguin Bukta, Antarctica. All coming together to participate on the Weddell Sea Expedition 2019 (WSE, the "Expedition") during a window of opportunity delivered by a particularly mild austral summer.

Fig. 1: SA Agulhas II *and floes near Larsen C, Antarctica 2019; image courtesy of ©Julien Trincali*

The WSE was supported by the Flotilla Foundation. The Expedition had two main objectives: (1) scientific study of the Weddell Sea including, by example, environments of the Larsen C ice shelf on the eastern coast of the Antarctic Peninsula (AP) and where iceberg calving is active; and (2) deep-sea exploration in search of Sir Ernest Shackleton's ship, *Endurance*, used in the Imperial Trans-Antarctic Expedition (1914-1916) and last seen November 1915.

The Weddell Sea is a harsh and foreboding environment with changing sea-ice and strong floes dominating western and central areas; the South African icebreaker and research vessel *SA Agulhas II* (Fig. 1) was chartered.

Captain Knowledge Bengu was the ship's Master and Captain Freddie Ligthelm Ice Pilot. Heading up the WSE were Dr

Figure 2: ROV Lassie*, CDT and AUV, and Claire Samuel Martin (Deep Ocean Search); images courtesy of ©Julien Trincali*

John Shears (Leader), Mensun Bound (Director of Exploration), Holly Ewart (Project Manager), Claire Samuel Martin (Offshore Manager) and Professor Julian Dowdeswell (Chief Scientist); overall leading some 45 *in situ* WSE members composed of explorers, scientists, technologists, and documentary-makers.

Examples of scientific reach on the WSE included ice mechanics, sea ice investigations, submarine and aerial glacier evaluations, oceanographic and meteorological research, sediment boring, CDT, sampling for microorganisms, and wildlife assessments.

Authors herein formed the WSE Marine Biology Team (MBT). Our main aim was to explore environments and document communities near the Larsen C ice shelf and site of the July 2017 calving of iceberg A-68. Critical to advancing our work, and both Expedition objectives, was the deployment of submarine capabilities to survey at depth and distance. Autonomous underwater vehicles (AUVs) and a remotely operated vehicle (ROV – "*Lassie*") were supplied and operated by Ocean Infinity and Eclipse Group, respectively, and with ultra-deep, marine-survey specialists from Deep Ocean Search (see Fig. 2).

After 7 days passage to the AP, *Agulhas II* arrived at Larsen C. Coring work, CTD measurements, AUV and *Lassie* trials ensued amongst other activities. Regarding submarine image-data capture, the MBT selected dive sites by differing timelines of ice shelf coverage.

On the 14th January, employing *Lassie*, the first transects of seafloor close to Larsen C were completed. Further transects were conducted from 20th-23rd January. Lines were all ~750 m long and depths were either ~250 m or ~400 m. Challenges to video surveying varied between locations due to sea ice, icebergs, floes, marine snow, and currents. One site showed evidence of iceberg scouring, some 2-3 m in depth and 5-8 m wide. All sites studied by the MBT showed evidence of deep-sea life. Examples (indicative) are given in Fig. 3.

On the 22nd February 2019 the Expedition came to an end. Scientists and further WSE members were demobilised from Wolf's Fang to Cape Town. It remains just a short interval since, and the MBT is continuing to work data and samples. Expectations are for the MBT to share findings on the deep-sea life of the Weddell Sea, and publish on all aspects of its work there in due course.

The authors would like to thank all those involved in the WSE 2019 (especially Prof. Alex Rogers), and the NERC DTP.

Figure 3: Example images from transects January 2019 (a) Siphonophore; (b) Sea pig; (c) Nemertean

Project Focus

iAtlantic project about to set sail

Murray Roberts

University of Edinburgh, UK

On 1 June 2019 a new international 4-year project begins work to carry out an integrated ecosystem assessment of Atlantic deep and open ocean ecosystems in space and time. iAtlantic is funded through a €10.6M European Horizon2020 grant bringing together 33 partners from Europe, Argentina, Brazil, South Africa, Canada and the USA plus a wider network of associated partners.

iAtlantic takes an interdisciplinary scientific approach to unifying efforts to better inform sustainable management and enhance human and observational capacity throughout the Atlantic. By integrating ecosystem data with major circulation pathways connecting North and South Atlantic and linking climatic data and forecasts, iAtlantic will give a new systematic approach to jointly assess and tackle policy challenges.

Ocean physics and ecosystem connectivity will enable high-resolution oceanographic hindcasts and forecasts of future circulation together with ground-truthing genomic data. Advances in eDNA genomics, machine learning and autonomous underwater robotics will be combined with existing data to provide step-changes in predictive habitat mapping approaches to expand species and biodiversity observations from local to basin scales. Ecological timeseries, including innovative palaeoceanographic and genomic reconstructions, will provide an unprecedented view of the impacts of climate change on Atlantic ecosystems. Assessment of the impact of multiple stressors will identify key drivers of ecosystem change and tipping points.

iAtlantic uses 12 Atlantic regions in the deep sea and open ocean that are of international conservation significance and of interest to Blue Economy and Blue Growth sectors. Innovative and efficient data handling and data publishing approaches will establish a better integrated Atlantic Ocean observation data community. Capacity and cooperation between science, industry and policymakers bordering the Atlantic will be boosted by joint multi-disciplinary research cruises, enhanced S Atlantic monitoring arrays, scientific training events, iAtlantic Fellowships and industry focused workshops. Results will be used to stimulate dialogue with stakeholders and critically assess current ocean governance frameworks generating increased capacity for Marine Spatial Planning and enabling Blue Growth scenarios to be rapidly evaluated.

iAtlantic is coordinated by Murray Roberts at the University of Edinburgh, UK.

For more information please contact i-atlantic@ed.ac.uk

THE GLOBAL SEAMOUNTS PROJECT

Proposed Global Seamounts Project Working Group on Geomorphic Proxies for Benthic Biodiversity

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The Global Seamounts Project proposes to mount 18 deep-sea expeditions over the next five years to conduct intensive, standardized surveys of representative seamount ecosystems in the Atlantic, Pacific and Indian Ocean basins (an updated proposal is available at https://osf.io/8b5yt/). Teams of ecosystem modelers will concurrently populate several leading ecosystem models with expedition data as it is generated and will collaborate on the development of a new integrative model of complex ecosystem function for seamounts. The utilization of geomorphic proxies to estimate benthic biodiversity and biomass is proposed here as a component of the project.

The development and use of biophysical proxies to estimate deep-sea benthic biodiversity and structure has made initial progress as a method for investigating these habitats at a larger geographic scale (Anderson, et al, 2011; Roff, et al, 2003). Exploring the utility of this approach for the Global Seamounts Project (GSP) becomes relevant when thinking about how to estimate seamount system-wide benthic biodiversity and biomass for use in populating ecosystem models. A separate GSP Working Group on geomorphic proxies is therefore proposed to assess the value of using this approach for the project; to develop appropriate field methods; and to develop strategies for data analysis, including with the use of statistical machine learning approaches.

Through evolutionary history, organisms have adapted to their surroundings, and these adaptations influence the distribution and abundance of organisms today. Seafloor characteristics, such as sediment composition, geomorphology, substrata type and complexity, and topographic relief, are just a few examples of physical variables which are known to influence the structure of the benthic biological community (Jennings et al. 1996; Levin et al. 2001; Curley et al. 2002; Thrush et al. 2005; Anderson et al. 2009).

Studies that investigate these complex biophysical relationships are often performed at a fine spatial scale to explore relationships between physical drivers and the biological community. Sampling strategies often consist of collecting video and still image data and can also contain sediment samples and biological samples. These data sources can be used to relate and classify specific environmental and biological variables based on common appearance.

However, the vast sources of data also pose a challenge: incorporating direct and indirect measurements of the environment to predict biological indicators. For the Global Seamounts Project, we propose to utilize a statistical machine learning approach to enable classification tools to predict the composition of benthic biological communities (e.g. biodiversity and biomass) based on analysis of wide-area high-resolution video and photographic transects of selected seamount terrain. Representative benthic core samples will be processed for biological analysis to create a set of training data for supervised analysis of geomorphic proxies. A deep-neural network is proposed to relate biophysical proxies to biological indicators.

This approach is proposed as a method for estimating benthic biodiversity and biomass on surveyed seamounts, correlated with mapped habitats, that will feed into multiple ecosystem models developed for the project.

Deep-neural networks, also known as perceptron, allow incorporating vast data types without any ad-hoc manipulation, thus reducing the subjectivity. Workflows utilizing deep neural networks also possess the flexibility for computational scale-up, allowing characterizing vast extents of area at a fine scale in a feasible amount of time (Lary et al., 2016). Such methods can be optimized on a cloud topology for mass training and prediction for large areas. In addition, the decoupled training and prediction processes allow cloud-based training to explore relationships and enabling an optimized model using an edge computing device that can be installed on-board on AUVs for real-time classification of biological indicators.

As biophysical relationships are known from the fine-spatial studies, a general-purpose classifier enables generalizing these relationships to larger areas. Effective characterization is achieved by mapping the ocean floor at an adequate resolution to preserve physical heterogeneity in the model to be model realistic biophysical relationships.

Currently, acoustic technologies are improving at an unprecedented rate, and large areas of the ocean floor can now be mapped to a much higher resolution to create habitat maps allowing for the testing of biophysical relationships at a much larger spatial scale. Complementary high-resolution video and photographic survey data of selected benthic terrain will be used in this project as the primary basis for correlating environmental variables with estimates of biological composition. State-of-the-art process-based models for validating analytical tools are limited. Thus, we use neural networks to capture patterns between physical and biological indicators. Neural networks allow modeling uncertainty in the biological indicators as well. In this study, both epistemic and measurement-based uncertainty exist.

Secondly, the quality of the data source measuring the physical environment can cause uncertainty, and sources of uncertainty are not independent. For example, visual data resolution can determine whether a physical variable is picked up or not, and whether the variation in this variable is adequate to discriminate between different niches; in other words, whether a classification is possible. A physical variable that appears to work well as a predictor may require further validation to assess the degree of correlation with specific fine-scale heterogeneity, which may not have been picked up in the visual photographic information, to ensure the physical variable is not masking the true relationship between biology and the environment.

Thus, a neural network approach is proposed to rigorously learn relationships, both weak and strong, and account for dependence between predictors. Proposed deep-neural network will be tested against field data and calibration cores to quantify accuracy. In addition, we propose to use a stochastic network topology to account for uncertainty in data. We propose to map the semblance of the neural network to quantify the local importance of every physical predictor. The semblance analysis (i.e. which local variables are most important for representing local biological variables) will guide further data collection and reveal uncertainty in predictions.

The tests and validation of biophysical proxies require substantial data volume, which is provided by data from videos and still images. These can take a long time to analyse, however as classification algorithms are optimized and project datasets are expanded these analytical tools should become more effective as biological predictors. The proposed method is naturally scalable and fault resilient. In addition, the method we propose to use lends itself to offline classification via edge-computing, enabling real-time prediction in situ.

We are currently seeking expressions of interest in participating in this GSP Working Group and are interested in comments and ideas for assessing and developing the application of this methodology for the Global Seamounts Project.

References

Anderson, T.J., Syms, C., Roberts, D.A. and Howard, D.F., 2009. Multi-scale fish–habitat associations and the use of habitat surrogates to predict the organisation and abundance of deep-water fish assemblages. Journal of Experimental Marine Biology and Ecology, 379(1-2), pp.34-42.

Anderson, T.J., Nichol, S.L., Syms, C., Przeslawski, R. and Harris, P.T., 2011. Deep-sea bio-physical variables as surrogates for biological assemblages, an example from the Lord Howe Rise. Deep Sea Research Part II: Topical Studies in Oceanography, 58(7-8), pp.979-991.

Curley, B.G., Kingsford, M.J. and Gillanders, B.M., 2002. Spatial and habitat-related patterns of temperate reef fish assemblages: implications for the design of Marine Protected Areas. Marine and Freshwater Research, 53(8), pp.1197-1210.

Jennings, S. and Polunin, N.V.C., 1996. Effects of fishing effort and catch rate upon the structure and biomass of Fijian reef fish communities. Journal of Applied Ecology, pp.400-412.

Lary, D.J., Alavi, A.H., Gandomi, A.H. and Walker, A.L., 2016. Machine learning in geosciences and remote sensing. Geoscience Frontiers, 7(1), pp.3-10.

Levin, L.A., Etter, R.J., Rex, M.A., Gooday, A.J., Smith, C.R., Pineda, J., Stuart, C.T., Hessler, R.R. and Pawson, D., 2001. Environmental influences on regional deep-sea species diversity. Annual review of ecology and systematics, 32(1), pp.51-93.

Roff, J.C., Taylor, M.E. and Laughren, J., 2003. Geophysical approaches to the classification, delineation and monitoring of marine habitats and their communities. Aquatic Conservation: Marine and freshwater ecosystems, 13(1), pp.77-90.

Thrush, S.F., Hewitt, J.E., Herman, P.M. and Ysebaert, T., 2005. Multi-scale analysis of species–environment relationships. Marine Ecology Progress Series, 302, pp.13-26.

West Coast Deep-Sea Coral Initiative: Successful first year of deep-sea coral research and exploration

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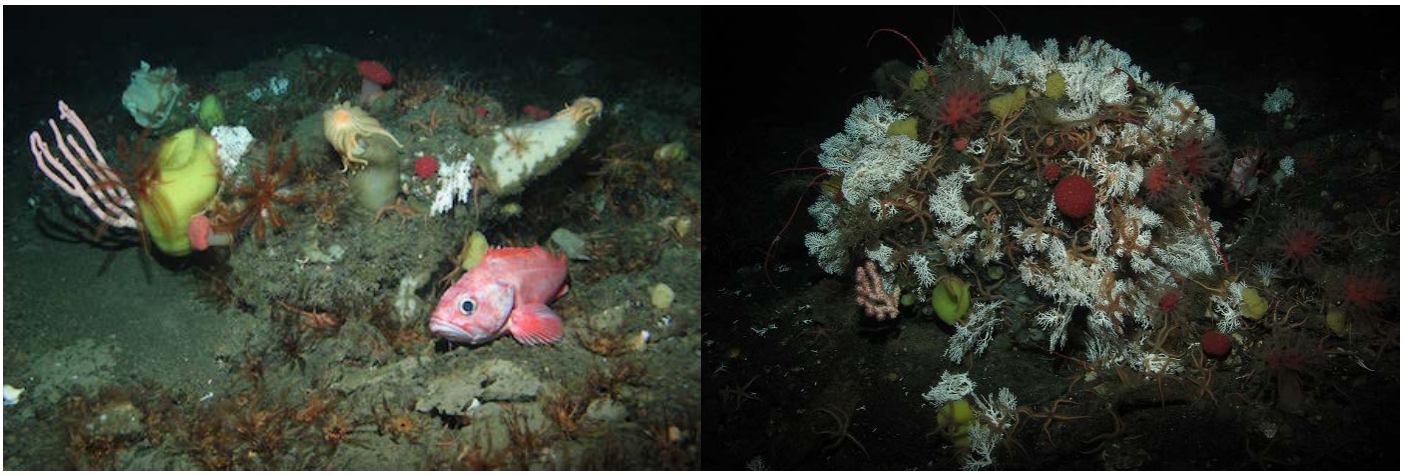
In 2018, the National Oceanic and Atmospheric Administration (NOAA) launched the West Coast Deep-Sea Coral Initiative, a four-year effort that aims to characterize and study deep-sea coral and sponge ecosystems offshore of California, Oregon, and Washington. The initiative is the latest regional research effort supported by NOAA's Deep Sea Coral Research and Technology Program. The Initiative is led by a team from multiple NOAA offices, and works in close collaboration with federal partners and academic institutions.

Guided by its science plan, the Initiative supports multiple research expeditions each year designed to map, survey, and sample deep-sea coral ecosystems, focusing on areas where information is needed to support management decisions. The Initiative is focused on surveying (1) baseline conditions of essential fish habitat that has been closed to trawling for more than a decade and is scheduled to reopen soon, (2) areas of high deep-sea coral bycatch, and (3) seafloor within the five national marine sanctuaries along the west coast.

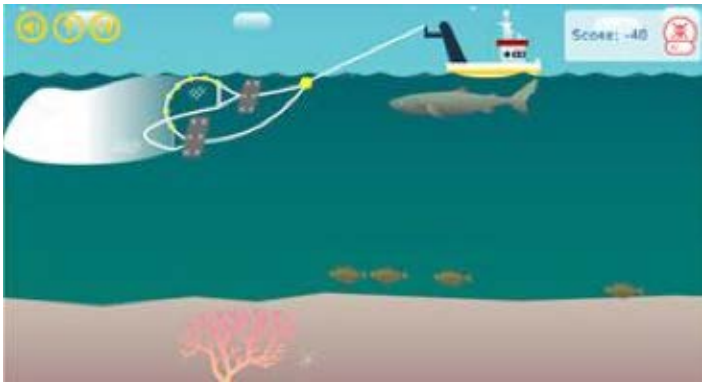
The West Coast Deep-Sea Coral Initiative is partnering closely with the Bureau of Ocean Energy Management and US Geological Survey on the EXpanding Pacific Research and Exploration of Submerged Systems (EXPRESS) campaign. This multiyear, multiplatform, multiagency effort has already begun characterizing areas of the deep seafloor that had never before been visited, and is providing valuable data for NOAA's Blue Economy initiative. EXPRESS's 2018 keystone

expedition succeeded in adding new species and range extension records, collecting information to assess potential impacts of bottom trawling, validating predictive habitat models, and expanding use of advanced technology including autonomous underwater vehicles. In 2019, the Initiative is partnering with NOAA's Office of Ocean Exploration and Research to characterize deep-sea communities in unexplored areas as well as to test new sensors, eDNA methods, and potentially telepresence technologies. Expeditions will also aim to collect organisms of high biopharma potential, describe habitat at possible offshore renewable energy sites, and investigate mineral resources in advance of potential industry interest.



An autonomous underwater vehicle and remotely operated vehicle were used to take high resolution photos of the seafloor off the coasts of Oregon and California, like these images from Mendocino Ridge.

ZSL launches interactive fishing game empowering children to save marine wildlife: New game aims to educate children on impacts of seabed trawling on marine habitats



Bubble-gum corals, skate fish and deep-sea water sponges are some of the vulnerable species children must avoid catching with their fishing nets while playing new '*Tricky Trawling*' launched by international conservation charity ZSL (Zoological Society of London) on 22 January 2019.

Inspiring children about the incredible diversity of deep-sea habitats off the coasts of West Greenland, the game – created by scientists at ZSL's Institute of Zoology and developers Octophin Digital – aims to inform children (aged 10-14 years old) about the impacts of unsustainable fishing practices such as seabed trawling in an informative but engaging way.

Casting their nets far and wide, players must attempt to catch fish out in the open ocean, while avoiding vulnerable seabed-dwelling creatures like octopus and skates in the fun game, which has a serious message behind it.

Highlighting the damage caused by bottom trawling – a specific method of fishing involving dragging a heavy net held open by 'doors' weighing several tonnes across the seabed, having limited control over what species are damaged or caught – the game demonstrates how improved technology such as upgrading fishing equipment with floating doors, can reduce negative impacts and help protect the environment.

Scientists at ZSL have been conducting research on the impact of trawling, on deep-sea habitats in Greenland since 2011, working with partners from the Greenland Institute for Natural Resources (GINR) and Sustainable Fisheries Greenland via European Union funding (BEST 2.0 Programme), advising fishers on more sustainable practices.

Dr Chris Yesson, Research Fellow at ZSL and creator of the game said: "The '*Tricky Trawling*' game puts players in control of a fishing boat and a net, with the aim of collecting valuable fish on the seabed without damaging vulnerable habitats.

"Seafood products account for more than 80 percent of Greenland's exports, so protecting vulnerable seabed habitats is vital for the ecosystem health and long-term sustainability of the fishing industry, but protection requires public awareness and support. "We recognise that young people today are very aware of the impacts they have on the environment and are keen to minimise negative impacts as much as they can. We're hoping this game will inspire them to influence the purchasing choices of the adults in their lives.

Many animals featured in the game like sponges and corals build delicate frameworks across the seafloor but because they're stationary cannot escape the trawl path. Others such as Lophelia species – which are a group of deep-sea cold-water branching corals, are slow growers, with some estimated to be over 800 years old. This means they're more vulnerable to trawling due to their slow recovery rates.

Dr Mona M. Fuhrmann, Postdoctoral Researcher at ZSL, who provided local knowledge and scientific input into the game said: "The deep-sea floor of West Greenland is full of interesting and diverse animals, but sadly has been extensively trawled over recent years. Coral habitats have been damaged and reduced by decades of trawling and it could take decades or longer for areas to recover, while some species may never fully recover.

"For example, bubblegum corals were once a relatively common sight in the area but are now difficult to find with deep-sea trawling likely the key cause of their decline.

"People can help the cause by playing the game and sharing what they have learnt with others, but also by buying locally sustainably sourced seafood – or simply asking the method of catch, avoiding bottom trawling." Kristina Guldbæk from Sustainable Fisheries Greenland (SFG), said. "Responsible fishers in Greenland are adopting conservation measures such as supporting marine protected areas and adapting lower impact fishing gear to support a healthy ocean, which is fundamental to the long-term stability of our industry. We hope this game will help foster greater interest in the beautiful and bountiful habitats of Greenland."

Find out more about the work ZSL does in Greenland and play the game here: https://campaign.zsl.org/trickytrawling/

Climate Linked Atlantic Sector Science: a UK programme for sustained deep ocean observations, models and technology development

Penny Holliday

CLASS Science Coordinator, National Oceanography Centre, Southampton, UK

Five UK marine science research centres have come together to develop a unique programme that integrates decadal-length deep-ocean time series with model and technology development.

CLASS (Climate Linked Atlantic Sector Science, projects.noc.ac.uk/class) is a NERC National Capability programme delivered in partnership by the National Oceanography Centre (noc.ac.uk), the Scottish Association for Marine Science (sams.ac.uk), the Sea Mammal Research Unit (smru.st-andrews.ac.uk), and the Marine Biological Association (mba.ac.uk).

The overall objective of this 5-year programme is to deliver the knowledge and understanding of the Atlantic Ocean system that society needs to make evidence-based decisions regarding ocean management.

CLASS supports some of the UK's most exciting physical, chemical and biological observation networks that have been in existence for decades, including the Continuous Plankton Recorder survey (cprsurvey.org), the Porcupine Abyssal Plain Observatory (projects.noc.ac.uk/pap), the Ellett Array (formerly the Extended Ellett Line, projects.noc.ac.uk/ExtendedEllettLine), the Atlantic Meridional Transect (amt-uk.org) and the South Atlantic Tide Gauge network (ntslf.org/networks/uk-south-atlantic-network). The extraordinary achievement of keeping these programmes going through tough funding renewal cycles, continues to reward the effort and investment as they reveal more world-leading scientific discoveries.

CLASS will translate some of that new insight into improvements in ocean, climate and earth systems models, leading to improved skill in short and long-term predictions. Skillful predictions are, of course, key to evidence-based policy decision-making.

This programme makes use of the old, but is also looking forward to the new. We have an exciting focus on next-generation platforms, sensors and samplers to enhance our existing networks and methodology. The ability to deploy low-cost, low-power and highly accurate sensors on autonomous vehicles will enable us to enhance present-day networks to obtain the observations of the Essential Ocean Variables and Essential Biology Variables (goosocean.org) where and when we need them.

For more information about the CLASS programme, including how you could take part in our fieldwork programme or visit one of research centres, visit https://projects.noc.ac.uk/class/

Delving Deep in the Pacific

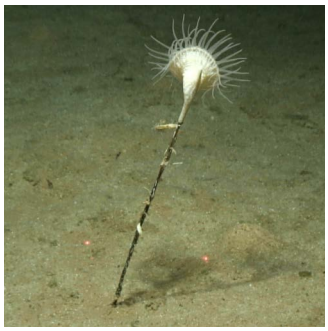
Liz Taylor

DOER Marine, California USA

www.doermarine.com

The University of Hawaii's H6500 ROV "*Lu'ukai*" supported a number of missions in 2018, making over 100 dives in total. DOER Marine built the H6500 system which includes an ROV with TMS that operates on standard .681 oceanographic umbilical. The ROV is equipped with dual manipulator arms, multiple cameras, Cathx lighting, seven 5HP thrusters, a retractable collection drawer, sonar, altimeter, DVL, Phins, and additional sensors/instruments. The multiple TMS cameras and lighting provide overhead views of the ROV when working in terrain or around objects on the sea bed.






ROV image credits: University of Hawaii, DeepCCZ & DOER Marine (ROV)

During a 7 week Clarion Clipperton Ridge cruise, numerous species were documented and secured in bio boxes using

the dual manipulator arms. On average, dives ranged from 4000m to 5500m with up to twenty hours of bottom time. A fossilized whale skeleton was observed along with the mineral nodules that are of intense interest to mining companies. Drs. Jeff Drazen and Craig Smith were the lead PIs for the expedition.

The ROV, ship and marine center at UH are vital, regional assets for the Pacific and of special value for investigation and monitoring of the CCZ.

DEEP-OCEAN STEWARDSHIP INITIATIVE

DOSI Updates April 2019

Over the past few months, DOSI members have been making great leaps forward in advancing science in environmental policy. Read below to see highlights from some of the current working groups. This work would not be possible without the guidance from Arcadia who support DOSI with core funds. Further critical funding is supplied by Benioff Ocean Initiative, JM Kaplan Fund, PEW Charitable Trusts and Synchronicity Earth. DOSI continues to grow and we are now a network of over 650 members from a variety of nations, sectors and disciplines. Look out for our new professional and streamlined DOSI website this summer!

Minerals WG

The DOSI delegation of seven experts, led by Dr Diva Amon, attended the International Seabed Authority 25th Annual Session in February 2019, and delivered a well-attended side-event entitled: New scientific knowledge to guide the environmental management and regulatory framework for deep-sea mining. Four DOSI interventions were also made.

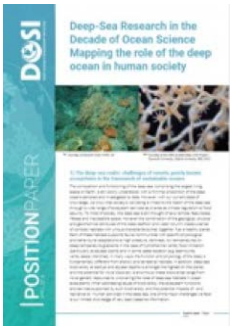
Preparations are underway for the July 2019 session. Recent paper published by members of this DOSI group: Tunnicliffe *et al*. (2019) Strategic Environmental Goals and Objectives: Setting the basis for environmental regulation of deep seabed mining. Marine Policy. Read more about this group's activities here.

BBNJ WG

DOSI made quite a splash at the BBNJ negotiations in March 2019 (at the 'make or break' IGC2) with a delegation of

eight scientists and legal experts, led by Harriet Harden-Davies. DOSI policy briefs on Marine Genetic Resources were quoted on the floor by State delegations and DOSI also made interventions. Five side-events were co-organised by DOSI during this meeting with IGOs and States, generating positive feedback from States about our constructive and evidence-based statements. For all policy briefs and further information about this group's activities see here.

Decade of Deep-Sea Science WG



As a result of DOSI Day 2018 discussions (photo at top) and a further WG meeting in Aveiro in October, members of the Decade WG have produced a document entitled: Deep-Sea Research in the Decade of Ocean Science: Mapping the role of the deep ocean in human society which is being distributed to national delegations of the IOC and elements highlighted during the 1st UN Decade of Ocean Science for Sustainable Development Global Planning Meeting held in Copenhagen in May 2019 which DOSI representatives attended (see report in this issue of DSL).

Climate Change WG

Following on from DOSI attendance to UNFCCC COP meetings where we have highlighted deep ocean impacts, the Climate group have recently produced a BBNJ-Climate Policy Brief (Link), circulated during IGC1 September 2018, which led to a requested contribution on climate change in the deep in a side event at the recent IGC2 meeting in March 2019. Several DOSI Climate WG members are contributing to an IPCC special report on Ocean and Cryopshere. This report is due Sept 2019. Deep-Ocean Climate Change Impacts on Habitat, Fish and Fisheries have been discussed in a recently published FAO technical report in collaboration with DOSI climate and fisheries WGs (link). Lisa Levin presented "Sustainability in Deep Water: Climate Change, Human Pressures and Biodiversity Conservation as this year's Roger Revelle commemorative lecture at the National Academies of the Sciences in April. DOSI preparations are underway for COP 25 (Chile).

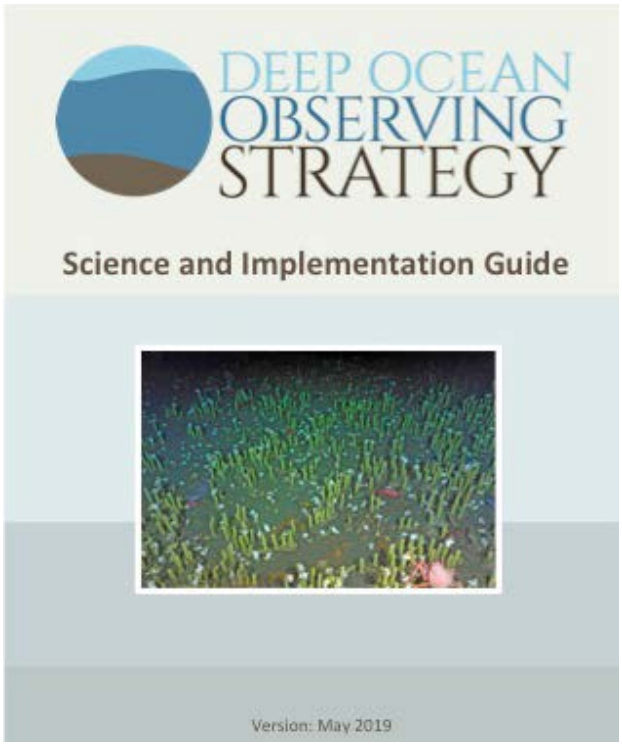
DSGR WG

Participants within the Deep-Sea Genetic Resources WG have submitted a manuscript entitled 'Review of practices regarding access to Marine Genetic Resources (MGR) raising awareness and strengthening best-practices through a new agreement for biodiversity beyond national jurisdiction (BBNJ)' (Muriel Rabone et al). This manuscript was distilled into a policy brief and distributed during IGC2 in March 2019. Professor Marcel Jaspars (co-lead of DSGR working group) and colleagues at the University of Aberdeen co-hosted a side event with IUCN and DOSI at IGC2 focusing on: Access and Benefit Sharing and Capacity Building, exploring solutions to enable scientific research, innovation and commercialisation of MGR in ABNJ.

Pollution WG

Jennifer Durden (NOCS, UK) will co-lead a new DOSI WG on pollution with Lucy Woodall (Uni of Oxford, UK). They will work with a small group to decide on a strategy and main group missions in advance of inviting group membership interest from the community.

The Deep Ocean Observing Strategy (DOOS) Update



The Deep Ocean Observing Strategy (DOOS) has completed two seminal documents for the Project.

These are available from the Project's website: deepoceanobserving.org

2019 DOOS Science and Implementation Guide (SIG): The SIG has been written to bring focus to the vision and primary activities of DOOS. The DOOS Project will use this document to guide sponsor and stakeholder focus toward primary scientific, technology, data, and demonstration activities that will result in a globally integrated network of systems that observe the deep ocean effectively in support of strong science, policy, and planning for sustainable oceans.

This document describes the Project's goals and objectives including its relationship to GOOS and other endeavors focused on the deep ocean. An overview of activities related to defining requirements is also provided, including those related to the definition of EOVs, sensor and platform maturation, and the adoption of FAIR data principles. The report also describes additional core project activities including the ongoing online inventory, and a wide range of coordination initiatives.

Ocean Obs '19 CWP: Global Observing Needs of the Deep Ocean: Leading up to the Ocean Observation 2019 Conference in Honolulu, Hawaii, USA, ocean observing stakeholders were asked to submit abstracts for Community White Papers (CWP).

The Obs '19 Program Committee then combined related abstracts into common papers. This paper is the result of the Deep Ocean CWP: "Global Observing Needs of the Deep Ocean" combining the work 38 authors from eight separate abstracts.

Meetings & Workshops

Advances in ocean biological observations: sustained system for deep-ocean meroplankton

Marina R. Cunha[1], Luciana Génio[1]*, Florence Pradillon[2], Morane Clavel-Henry[3]

& the Foresight Workshop Participants

[1]Universidade de Aveiro, Aveiro, Portugal; [2]IFREMER, Brest, France; [3]CSIC, Barcelona, Spain

*Currently at: The International Seabed Authority, Kingston, Jamaica

Workshop participants under the microscope! Back row: Fábio Matos, Jonathan Gula, Henrique Queiroga, Rob Young, Sven Laming, Kirstin Meyer, Jozée Sarrazin, Craig Young, Fabio De Leo; Front Row: Jim Birch, Morane Clavel-Henry, Marina Cunha, Clara Rodrigues, Florence Pradillon, Anna Metaxas. Via videoconference: Luciana Génio, Dhugal Lindsay, Stace Beaulieu, Francisco Campuzano, Hiromi Watanabe, Susan Mills

The Foresight Workshop on "Advances in ocean biological observations: sustained system for deep-ocean meroplankton", took place in Aveiro, Portugal from 27-29th May 2019. This workshop was organized around three main themes: i) Advances in the knowledge of deep-sea larval diversity and distribution: key challenges and priorities; ii) Recent developments in plankton observation approaches and technology; iii) Data integration and oceanographic modelling. The three days of the meeting included two keynote talks by Craig Young and Jim Birch and short talks by Jonathan Gula, Anna Metaxas, Jozée Sarrazin and Fabio De Leo. The organizers presented digests of pre-workshop contributions from the participants, followed by lively discussions among the 15 scientists present in Aveiro and others who participated via videoconference from Japan, USA and Jamaica. The main goals were to debate how the existing gaps in the knowledge on connectivity and resilience in the deep ocean can be addressed by sustained observations of larval processes, which are the technological challenges and added societal value of this approach and what synergies can be built with deep ocean observation initiatives and existing observatory networks. As some of you may remember, good Portuguese food during the meals (and wine at dinner) always contributes to a friendly atmosphere and cross-fertilization of ideas. Keep reading Deep-Sea Life, this group promises more news in the near future!

Report: International Marine Soundscape Workshop (May 22, Yokohama, Japan)

Hiromi Kayama Watanabe[1], Tzu-Hao Lin[1], Tomonari Akamatsu[2]

[1]Japan Agency for Marine-Earth Science and Technology (JAMSTEC); [2]Fisheries Research and Education Agency, Japan

Deep-sea animals are known to use visual and chemical cues in the extreme darkness and depth environments. Recent studies showed that marine animals also listen to underwater soundscapes in assisting the dispersal, habitat selection, and communication. It is plausible that deep-sea animals sense soundscape, however, interactions between underwater soundscapes and deep-sea fauna remain unclear.

An international workshop on marine soundscape was held at Yokohama Institute for Earth Science, JAMSTEC, on May 22, 2019. In this event, scientists of marine bioacoustics, biology (including deep-sea), and earth science discussed the current research progress, scientific gaps, and future directions of the marine soundscape. Most previous studies were carried out in shallow water due to social requirements and technical limitation. Despite that, several research projects used deep-sea seismometer networks and cabled acoustic observatories to explore the soundscape dynamics in deep-sea. In addition to the ecological applications, the marine soundscape can also be used in geophysical applications, such as monitoring of volcanic eruptions. The integration of deep learning and underwater acoustics should further advance the capability of soundscape-based ecosystem monitoring.

Soundscape monitoring may serve as an alternative for remote sensing of deep-sea biodiversity. However, the lack of information on the acoustic behavior and hearing of deep-sea animals remains a big hurdle for practical applications. We believe that this research field will contribute to elucidate the dynamics of deep-sea ecosystems, under extreme darkness and pressure conditions. **Therefore, we wish to extend an invitation to researchers interested in scientific collaboration.**

Please contact lintzuhao@jamstec.go.jp for further information.

Joint Workshop - Science for Solutions:

Bringing Stakeholders Together to Improve Ocean Planning and Governance for Areas Beyond National Jurisdiction in the South East Atlantic and Western Indian Ocean

10–12 June 2019, Cape Town, South Africa

African States met in Cape Town in June to address ocean sustainability. Government officials, international and regional organisations, NGOs and academia came together for an open dialogue on sustainably managing marine resources, including in the High seas, to secure nature conservation, social and economic stability and regional cooperation.

Over 70% of the surface of the Earth is ocean. The ocean includes diverse and dynamic ecosystems that provide benefits and services to societies, through fisheries, climate stabilization and oxygen production. However, pressures over biodiversity, commonly seen as unlimited resources, are alarming. The growing economic and political interest in marine resources use – both within countries' national waters and in the High Seas or Areas Beyond National Jurisdiction (ABNJ) is putting ocean life at risk and greatly threatening human wellbeing. To address this global challenge, countries have made voluntary international commitments to use natural resources wisely and meet the United Nations Sustainable Development Goals by 2030. Activities in the High Seas that impact biodiversity can have implications for biodiversity in national waters too, adding pressures on coastal communities.

"It is essential that the world community, including all African States, take significant strides to effectively and coherently conserve and sustainably manage marine resources – both within and outside of national jurisdiction. Without immediate action to overcome marine biodiversity loss, there will be severely negative consequences for all human life" says Ben Boteler, from IASS and coordinator of the event in Cape Town. Fortunately, the international community is awakening for this important issue and agreed to develop a global, legally binding instrument on the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction. This instrument should address countries' roles and responsibilities in governing international waters, that is, waters that are outside the jurisdiction of single countries under the United Nations Convention on the Law of the Sea. The negotiations of this instrument started in April 2018.

To help facilitate this discussion for African States, the ABNJ Deep Seas and STRONG High Seas projects, and Abidjan and Nairobi Convention Secretariats presented the state of play for ocean governance in Africa with regard to sustainable use of marine biodiversity in ABNJ and the ongoing UN Negotiations at a Dialogue Workshop in Cape Town in June 2019. The event in Cape Town aims at advancing this agenda. It will identify new opportunities for the development of long-term strategies and approaches for wider societal participation, enabling the African region with stronger capacity for more effective engagement in global policy negotiations.

"It is an exciting opportunity to have countries from around Africa working together to strengthen the region's position in the UN negotiations that could have consequences for marine biodiversity and the Blue Economy, globally" commented Adnan Awad, Director of IOI-SA, one of the local partner institutions. "By developing a united voice towards these shared interests, African States can strengthen their potential to leverage opportunities for their common objectives in future regional and global discussions" continued Adnan.

The workshop will be the final workshop of the ABNJ Deep Seas Project and the second in a series of 5 workshops for the STRONG High Seas Project. These projects work with the Nairobi Convention on the East Coast of Africa and the Abidjan Convention on the West Coast of Africa, respectively. This workshop is a unique opportunity to bring States from both coasts together to share ideas and perspectives in South Africa – a member of both Conventions. For more information visit: www.prog-ocean.org/our-work/strong-high-seas.

7th International Symposium on Chemosynthesis-Based Ecosystems (CBE7)

23-28 August 2020, Brazil

Dear Lovers of Chemosynthesis-Related Science,

We would like to invite you for the 7th International Symposium on Chemosynthesis-Based Ecosystems (CBE7), to be

held between **23-28 August 2020** in Brazil. CBE7 represents the 7th iteration of a successful symposium series, that has already taken place in Europe (Portugal, France), North America (United States and Canada), and Asia (Japan). It is the premier meeting for scientists, explorers, managers, policymakers, industry specialists and students to exchange ideas and share knowledge of advances on chemosynthesis-based ecosystems.

We are looking forward to offering you and spending with you a very productive and pleasant week in Guarujá, on the north coast of São Paulo state. The proposed venue is called **Casa Grande Hotel Resort & Spa**, located on Enseada beach in Guarujá. With a unique architecture in an authentic Brazilian colonial style, the hotel has an ocean view, and perfectly integrates with the 5.5 km-white-sandy-beach and clear waters.

Guarujá is considered one of the best vacation spots for people who live in São Paulo. With a total area of 142.7km² and a tropical climate, Guarujá has 27 beautiful beaches, and it stands out for providing opportunities for nautical and historical tourism, and for hiking along trails in the lush Atlantic forest. The hotel has an excellent location and easy access, being only 70 km/ 45 miles away from São Paulo and 90 km/ 55 miles from Guarulhos International Airport. For further information on the symposium venue, please visit http://www.casagrandehotel.com.br/language/en/.

The scientific program will count on keynotes lectures, oral and poster presentations, and selected flash talks, largely following the successful format of the last CBE6 in Woods Hole. We hope it will be a great opportunity to increase connections to worldwide initiatives, and to bring the vast array of chemosynthesis-related science to the attention of undergraduate and graduate students, as well as early career scientists.

BEM-VINDOS!

Local Committee: Camila Signori, Cristina Nakayama, Maurício Shimabukuro, Paulo Sumida & Vivian Pellizari

Oceanographic Institute, University of São Paulo

Contact: cbe7brazil@gmail.com

Deep-Sea Taxonomy under Pressure

Torben Riehl

Senckenberg Research Institute and Natural History Museum Germany

E-mail: torben.riehl@senckenberg.de

A quarter of all species described on our planet are threatened with extinction due to human activities*, yet most deep-sea animals are not yet even known to science.

The deep ocean, the largest environment on Earth, is one of the most diverse ecosystems where wondrously bizarre life forms abound. It is at risk from pressures including fishing, pollution, climate change and mining. There is a danger that large numbers of species will go extinct before they are even discovered. We urgently need to understand the deep-sea environment and the species that live there in order to conserve and manage it.

Taxonomists provide the critical baseline knowledge. Their discovery and description of unknown species is at the heart of biology. Finding means of accelerating and sustaining this fundamental work, has been the focus of a workshop at the Senckenberg Research Institute and Natural History Museum Frankfurt.

Twenty-seven deep-sea scientists from twelve countries, devoted to deep-sea biodiversity discovery, participated in the international meeting. They discussed strategies to tackle the increasing pressures faced by taxonomists. The scientists call for improved collaboration and standardization of open-access data repositories as well as substantially increased funding for taxonomic projects and positions. The need for technological development of biodiversity discovery in the deep sea is clear. The workshop was a great success and has provided the momentum for this group to develop strategies for the future of deep-sea taxonomy.

Suggested reading: *UN report media release: https://www.ipbes.net/news/Media-Release-Global-Assessment

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GOLDSCHMIDT®
BARCELONA 2019
18–23 AUGUST

August 18-23: Goldschmidt Conference (Barcelona, Spain) (https://goldschmidt.info/2019/).

Theme: Chemistry of the Oceans and Atmosphere, Session: The Oceanic Particle Flux and its Cycling within the Deep Water Column (ID 10h) (https://goldschmidt.info/2019/program/programViewThemes).

Co-conveners: Maureen Conte (BIOS), Phoebe Lam (UCSC), Henry Ruhl (MBARI; NOC), and Rut Pedrosa Pamies (MBL).

Session description:

The oceanic particle flux plays a major role in global elemental cycles, the ocean uptake of carbon dioxide, and the transfer of energy and matter to the deep ocean and sediments. The particle flux and its composition represent a dynamic balance between biological processes that generate large sinking particles in the upper ocean and particle cycling processes within the ocean interior that consume, modify and produce new sinking particles, including biologically-driven organic matter remineralization, particle aggregation/disaggregation, chemical scavenging, and authigenic mineral precipitation. New observational platforms, sampling methods and advances in chemical and molecular techniques (e.g., metabolomics, metagenomics, transcriptomics) allowing for expanded particle characterization are providing novel insights on particle flux transformations within the deep water column, including the depth evolution of particle-associated microbial communities and the scavenging of dissolved and suspended materials associated with biological reprocessing of flux materials. Synthesis and modeling studies are providing increased understanding of linkages between ecosystem structure and global patterns in surface export and flux transfer efficiency to the deep

ocean. This multidisciplinary session will bring together scientists under research themes related to geochemistry, biology, oceanography, modeling and climatology to present the current status of our understanding of processes controlling the magnitude and composition of the oceanic particle flux, its attenuation and transformation with depth, and its coupling with associated biogeochemical cycles. Session presentations will describe novel findings and syntheses which, in turn, will highlight key knowledge gaps in the particle flux and its role in geochemical cycles.

1st Global Ocean Decade Planning Meeting, Copenhagen, Denmark, May 13-15, 2019

Kerry Howell

University of Plymouth, UK

I would like to share with you my reflections on the first global Ocean Decade planning meeting. DOSI and deep-sea biology were out in force with Elva Escobar, Lisa Levin, Harriet Harden-Davies, Me, Alex Rogers, Paul Snelgrove and Riccardo Serrao Santos in attendance to name but a few (there were more!).

The meeting was spread over 3 days. On day one different panels outlined the identified societal outcomes (SOs) for the Decade, largely repeating information given in the road map but offering personal perspectives on it. On day two we were split into working groups with different groups focusing on different SOs. I attended the “predicted ocean” and “sustainably harvested and productive ocean” groups in the morning and afternoon respectively. Each group was asked to consider the knowledge gaps and key science questions under each theme, as well as to identify existing initiatives relevant to addressing these gaps and questions. We were also asked to discuss the role of some of the identified cross-cutting themes in addressing science questions. On day three we heard reports back from each of the SO working groups summarising the discussion had the previous day. We then had a series of panels dealing with the following themes: capacity building and technology transfer, partnerships and financing, data and information sharing and knowledge exchange, and communicating the decade; before a final wrap up session.

I feel that between all the deep-sea people there, we were able to ensure that deep-sea biology was highlighted as an important part of the Decade. The deep sea was certainly highlighted in a number of the working group summaries on the last day, so that is positive. Discussion over the three days was very high level as might be expected from the first Global Planning Meeting. There were some key messages that came across that I can share:

1. The Decade is (and will be) whatever we make of it. It is a grass roots initiative and it is on us to develop research programmes.

2. There is no special pot of cash to pay for new programmes. The Decade brand could help attract philanthropic funding, and there is the potential for private-public partnerships, partnering with industry, but essentially there is no UN level cash. Individual nations may make money available but you would need to speak to your own national representatives about that.

3. It is “the decade of ocean science for sustainable development” so it is important to recognise and identify how any proposed research contributes to sustainable development. It will also be important to include other disciplines

in programmes, for example environmental economists, social scientists, etc as these are the folks who connect the research to people.

4. Fairness, equity, inclusivity, and capacity development are all central to the decade plans.

5. It is desirable to work with existing initiatives where possible, for example Seabed 2030 and GOOS were both mentioned.

6. Seabed 2030 is not just about bathymetry mapping it is all mapping (biological, chemical, human use, ecosystem services etc), GOOS is actively looking to include more biology.

7. Collating and making use of existing data is good, for us this could include things like interpreting old video / image data so we know what we have before we collect more, mining historical expedition data, etc.

8. Open access and open data sharing is also a must.

9. The Sustainable Development Goal 14 is “Life below water” so biology is central to the Decade, even though at present there is a lot of focus on physical oceanography and climate.

So in summary I think the Decade does represent a golden opportunity for our community to do something special. To think bigger and on longer timescales of research than we have allowed ourselves to in the past. To reach out to new partners and regions that have not traditionally engaged in deep-sea science. To think creatively about how we study the deep sea, and how new technology might help unlock new lines of research, while cheaper technology might help bring more nations into the field. But ultimately, to expand our knowledge of this amazing ecosystem we are all privileged to study.

Link here to DOSI Decade Position Paper entitled: Deep-Sea Research in the Decade of Ocean Science Mapping the role of the deep ocean in human society.

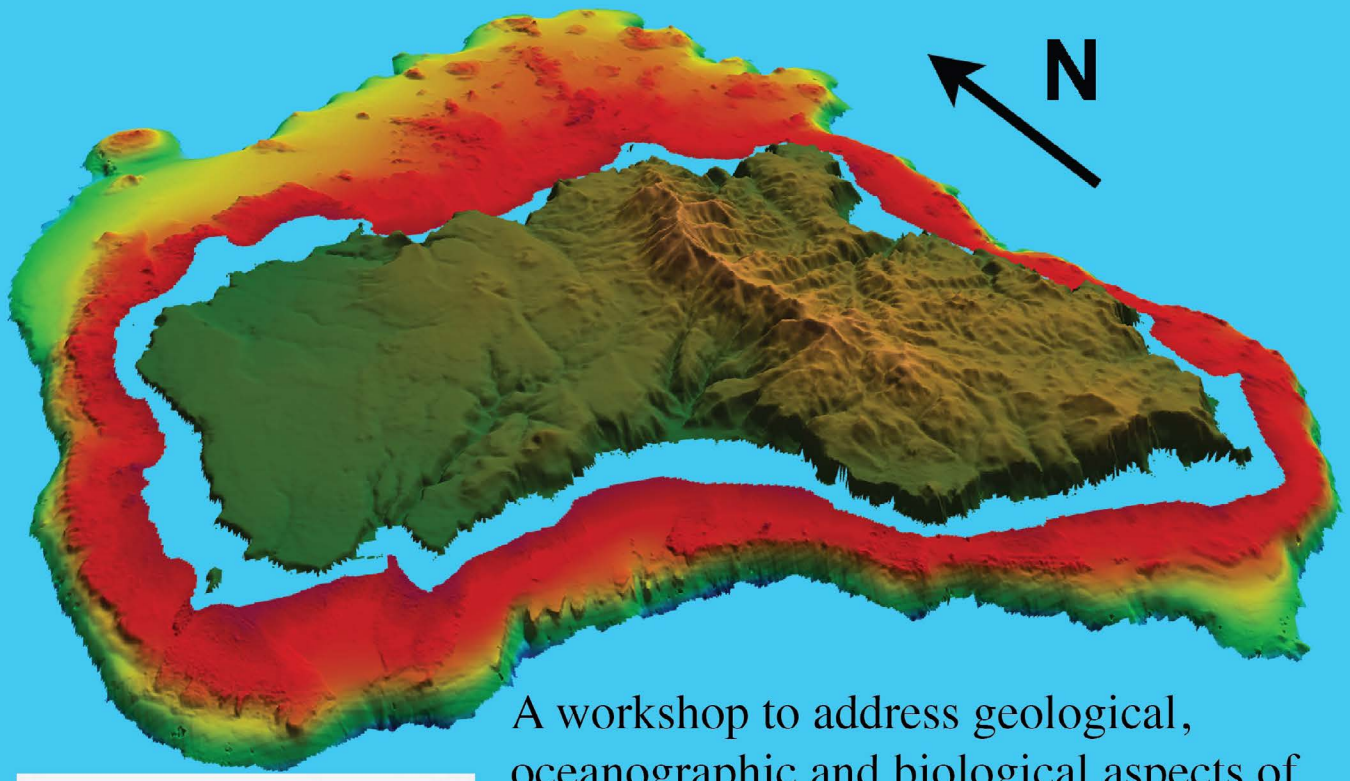
Lisa Levin presenting during the 1st Global Decade Planning Meeting.

INTER RIDGE international cooperation in ridge-crest studies

19-21 Sept 2019

International Science Council SCOR Scientific Committee on Oceanic Research

Workshop on seamounts and islands near mid-ocean ridges



A workshop to address geological, oceanographic and biological aspects of seamounts and islands located near mid-ocean ridges, to be held at the Instituto Hidrografico, Lisbon. Limited funding is available for developing country young researchers from the SCOR.

More details from www.interridge.org or from the convenors:
Neil Mitchell (University of Manchester)
Rui Quartau (Instituto Hidrographico)
Christoph Beier (University of Helsinki)

Scientist Profiles

Travis Washburn

Postdoctoral Researcher – Deep-sea benthic ecology

School of Oceanography and Earth Science and Technology, Department of Oceanography, University of Hawai'i at Mānoa, 1000 Pope Rd., Honolulu, HI 96822

Contact: twashbur@hawaii.edu

From a young age I developed a love of aquatic environments, swimming in the lakes of Missouri, but my desire to explore the unknown quickly took me to the coast. Working on my Master's degree I came to appreciate the benthos (in my case macrobenthic infauna) and all the questions that could be answered through morphological taxonomy while crawling through the mud of South Carolina tidal creeks. This work also helped to show first-hand the damage we humans are having on the marine environment as I explored impacts of watershed development.

I cut my deep-sea teeth with my work on oil seeps and the Deepwater Horizon (DWH) Oil Spill during my Ph.D. The unprecedented DWH disaster was the clearest, if not first, instance of human activities having a large, direct impact on the deep-sea environment. I gained experience defining unknown harm to the deep sea at large spatial scales (100s km^2) using benthic communities and describing indicators for future disturbance. I also gained an appreciation for the necessities of research outside the natural sciences. I began to explore marine ecosystem functions and services, and like to think that the continued health of our oceans and therefore the very processes that make life on Earth possible, are enough for everyone to be concerned about.

During my post-doctoral work at Duke University, I broadened my deep-sea expertise to include habitats associated with deep-sea mining and impacts of mining operations via an expert risk assessment. This work included a review of the current state of knowledge on deep-sea mining through scientific articles as well as becoming well-versed in international policy. This research greatly increased my understanding of manganese nodule mining, inactive sulfides, and cobalt crusts of seamounts.

I recently began a post-doctoral position at the University of Hawaii, continuing my exploration of human impacts on the deep sea through studies on manganese nodule mining. I am assisting with a regional assessment of the Clarion-Clipperton zone for various aspects of biodiversity and connectivity, from microbes to megafauna and community structure to ecosystem functions.

I have grown to love and respect the worms that are so prevalent throughout the world's oceans. Learning about the natural and human factors influencing them is not only fascinating but can help us understand and hopefully limit the damage we are currently doing to the world. I have worked in many different habitats in several water bodies looking at various human activities and plan to do so for a long time. If you are a deep-sea ecologist or study human impacts on this vast environment, there is a good chance that we will meet, if not work together, sometime in the future!

Oliver S. Ashford

Postdoctoral Scholar – ecology of Costa Rican methane seep macrofauna

Scripps Institution of Oceanography (SIO), University of California San Diego, USA

Contact: oashford@ucsd.edu

I am an ecologist who enjoys asking fundamental questions, as well applying scientific knowledge to real-world problems. I have been fortunate enough to gain experience working in a variety of marine environments, and with a selection of taxonomic groups; from temperate coastal waters (microscopic protists), to the deep sea of Antarctica, the North Atlantic, and the tropical Pacific (peracarid crustaceans, polychaetes, corals, sponges and xenophyophores). I have experience with both morphological and molecular (eDNA) taxonomy, and a selection of sampling gears, including manned submersibles, ROVs, AUVs, box corers and multi-corers, mid-water and benthic trawls, and benthic lander camera systems. I have a particular interest in investigating functional and phylogenetic facets of biodiversity, as well as taxonomic, and am proficient in phylogenetics, functional trait analyses, habitat suitability modelling, GIS analysis, stable isotope analysis, and advanced statistical modelling (e.g. Generalised Additive and Structural Equation models), as well as traditional community ecology analysis methods.

My current research aims to investigate the ecology of benthic macrofaunal communities found at and around Costa Rican methane seeps. I am particularly interested in the importance of biodiversity in promoting the healthy functioning of deep-sea ecosystems, and how ecosystem functioning and macrofaunal biodiversity change with increasing distance from seeps. Such relationships are poorly understood at present, especially within the macrofauna, but, if understood, could provide us with detailed information about the role of seeps in promoting deep-sea ecosystem functioning and biodiversity, and the potential rate of ecosystem functioning loss in deep-sea ecosystems in response to human disturbances.

Other Research Interests: I concurrently maintain an interest in the impacts of bottom trawling on deep-sea fauna, understanding the environmental shapers of deep-sea communities (including predicting the impacts of climate change on deep-sea fauna), and investigating the influence of benthic megafaunal invertebrates on deep-sea macrofaunal assemblages. I am also in the process of describing a new species of large Antarctic amphipod. My position at Scripps will come to an end this September, and so I am currently looking for my next scientific challenge. Please feel free to contact me, whether you know of any available positions, or just want to chat about my research in more detail!

Education

D.Phil Zoology, University of Oxford, 2017. Thesis title: ‘Illuminating the deep: an exploration of deep-sea benthic macrofaunal ecology in the Northwest Atlantic Ocean’. Merton College. Supervisors: Professor Alex Rogers, Dr Andrew Kenny.

MSc (Distinction) Taxonomy and Biodiversity, Imperial College London and the Natural History Museum, 2012. Thesis title: ‘An exploration of haplosporidian and paramyxean diversity using environmental DNA and culture-based techniques’.

MA (First-Class Honours) Natural Sciences Tripos (Zoology), University of Cambridge, 2011. Peterhouse. Thesis title: ‘Litter manipulation and the soil arthropod community in a lowland tropical rainforest’.

Opportunities

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DARWIN INITIATIVE

Darwin Initiative Announces Opening of New Funding Round

The Darwin Initiative is funded by the UK Department for Environment, Food and Rural Affairs (Defra) and was announced at the Rio Earth Summit in 1992. It supports developing countries to conserve biodiversity and reduce poverty and is the UK's primary mechanism to champion biodiversity conservation and support the development of vibrant in-country conservation sectors. Four of its programmes are now open to application.

Main Projects

Main Projects support projects tackling key threats to biodiversity in developing countries. Projects must also be able to demonstrate how they will help to achieve the international Sustainable Development Goals (SDGs).

Applicant organisations can be based in any country although applications should preferably have a UK connection, consistent with the UK Aid Strategy.

There is no minimum or maximum award size. Awards have ranged from £50,000 to £430,000 (with an average project award of £300,000) for a three year Darwin project.

The minimum length of a project is 1 year and the maximum length is 3 years. Any budget commitment must end by 31 March 2023.

Fellowship Awards

Darwin Fellowships are targeted at promising individuals who have links with recent or current Darwin Initiative projects who are working in biodiversity or related fields or whose work may have an impact on biodiversity, and are from countries which are rich in biodiversity but poor in financial resources (including the Overseas Territories of the United Kingdom).

The host organisation where the individual will carry out the training or research must be in the UK. Applications for Fellowship funding should come from the UK organisation.

There is no specific minimum or maximum level for a Fellowship Award, however, a typical award is around £20,000 to £25,000.

Fellowships are provided for up to 14 months, and should start on or after 1 July 2020 and finish on or before 1 October 2021.

Partnership Projects

Partnership Projects (formerly Scoping Awards) are small grants intended to help organisations who are new to the Darwin Initiative to develop a robust application. The awards do this by:

- Connecting organisations new to Darwin with partners who have experience of managing successful Darwin Projects; and/or
- Supporting work to build new partnerships between applicant organisations.

Applications for partnership projects must be to establish new partnerships and must not simply be to continue existing working relationships. Defra would normally expect applications from partnerships involving around 2-4 organisations.

Funding up to a maximum of £10,000 is available.

In most cases, travel should commence after 1 April 2020 and, at the latest, be completed by 31 March 2021.

Darwin Plus (for UK Overseas Territories) programmes

Grants are available for projects working on environment or climate change issues in the UK's Overseas Territories (UKOTs) that help deliver long-term strategic outcomes for the natural environment in these locations. Regional projects (ie involving more than one UKOT) are encouraged and budgets for regional projects should be proportionate to the complexity of the issues tackled. Projects may be new ideas, or build on existing work, but applicants will be expected to demonstrate that the proposed project will be of real value to the host UKOTs by meeting clearly identifiable needs and priorities, for example, as may be identified in OT roadmaps.

The key priorities for Darwin Plus in Round 8 are:

- Delivering a Blue Belt of marine protection around the OTs
- Conservation and effective management of coral reef, seagrass meadows and mangrove forest ecosystems
- Dealing with invasive non-native species
- Waste management strategies, particularly those with a focus on plastics
- Responding to, and mitigating against, the impacts of natural disasters on the OTs
- Implementing National Biodiversity Action Plans
- Conservation, restoration and wise use of wetlands.

Application is open to all organisations working in the UKOTs. This may include UKOT Governments, NGOs, research institutions, the private sector and other stakeholders.

There is no minimum or maximum award size for Darwin Plus projects. The funding pot in any given year is, however, limited and projects with a value exceeding £300,000 are less likely to be funded.

The application deadlines are as follows:

- Stage One applications to the Main Projects programme is 16 July 2019
- Round 26 applications to the Partnership Project and Fellowship Awards is 5 November 2019
- Round 8 Stage 1 UK Overseas Territories applications is 9 July 2019.

UNIVERSITY OF Southampton

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FutureLearn is an online platform offering a diverse selection of courses from leading universities and cultural institutions from around the world. These are delivered one step at a time, and are accessible on mobile, tablet and desktop, so you can fit learning around your life. They give you the chance to connect with others for lively discussion. The University of Southampton is currently running two ocean-related courses:

Exploring Our Ocean

Explore the half of our world covered by deep ocean, and how our lives affect the hidden face of our planet.

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What lies in the half of our world covered by water more than two miles deep? How are our everyday lives connected to the ocean depths, and what challenges and opportunities does this previously hidden realm hold for our future?

Meet scientists exploring the ocean from the deepest undersea vents to the chilly waters of the Poles and find how what we now know about the ocean depths is as amazing as the unknown that remains. By taking this course, you will see how the deep ocean is no longer out of reach, and join a global debate about the future of our "blue planet".

What topics will you cover?

- History of ocean exploration
- Modern mapping of the ocean
- The movement of ocean currents
- The composition of the ocean
- Ocean biodiversity
- Characteristics of life in the deep sea
- Ocean resources and ownership
- Human impacts on the ocean (featuring DOSI)

https://www.futurelearn.com/courses/exploring-our-ocean

Beneath the Blue: The Importance of Marine Sediments

Understand the importance of our planet's seafloor and get an introduction to the exciting field of ocean science.

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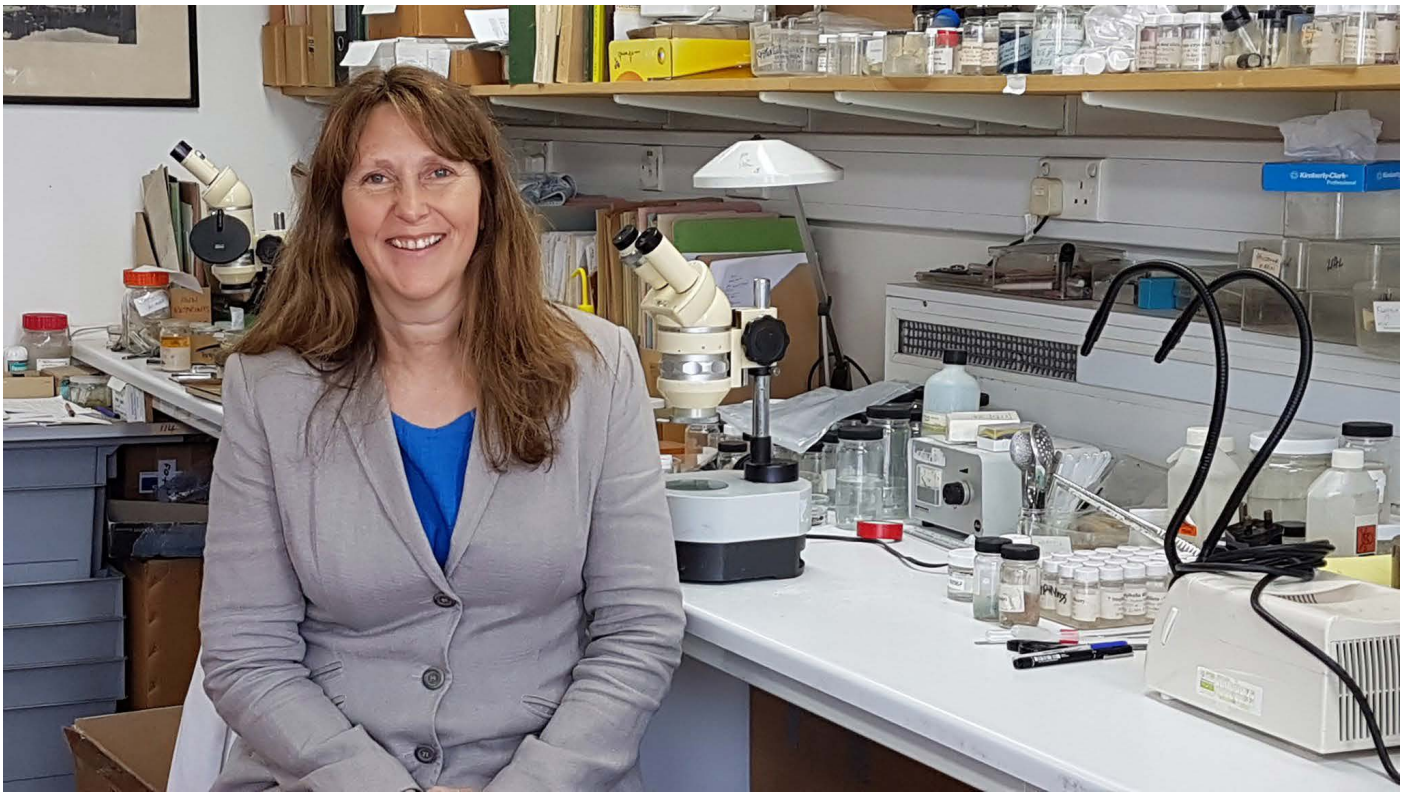
society, the current rate at which humans are exploiting seafloor habitats and the need to conserve these systems.

What topics will you cover?

- The composition and global distribution of marine sediments.
- Biodiversity; how it is measured and how it has changed though geological time.
- Scientific illustration and taxonomy (the classification of living organisms)
- Defining and classifying functional groups.
- How humans benefit from, and impact on, marine benthic ecosystem processes.

https://www.futurelearn.com/courses/beneath-the-blue/1



Maria Baker talks about DOSI during MOOC.

It's Your Opinion

Marine litter: the oceans are filling up

Charles Nyanga

Zambia College of Agriculture, Mpika, Zambia, Africa

What is marine litter? The United Nations Environmental Program, defines marine litter as: "Persistent, manufactured or processed solids that have been disposed of or abandoned, deliberately or unintentionally in the sea". The oceans are being filled up by marine litter. The most notorious form of marine litter is the synthetic product called plastic. Plastic is known to form microparticles over time although it has a slow degeneration rate. What more frightening is that almost 50-80% of the marine litter is plastic. Additionally, we are informed by experts that by 2050, there will be more plastics in our oceans than fish. Imagine! Fish being outnumbered by plastics. Further, what we see is only 5% of plastics floating on the sea in most pelagic waters, the remaining 95% finds its way down into the deep waters. However, benthic sea litter is mostly made up of fishing gear, which in some seas constitutes over 70% of all deep-sea litter. Information from researchers and the UN show that at least 800 species are affected by marine litter which is dumped at the rate of 13 million metric tons each year. Scientific evidence shows that five countries are pouring more litter into our seas than any other. These countries are China, Indonesia, the Philippines, Thailand and Vietnam. The "marine litter pentagon" are currently spewing 60% of all plastic litter into the world seas. We hope someone will come up with a solution since our oceans are filling up and the marine creatures are being suffocated from this litter.

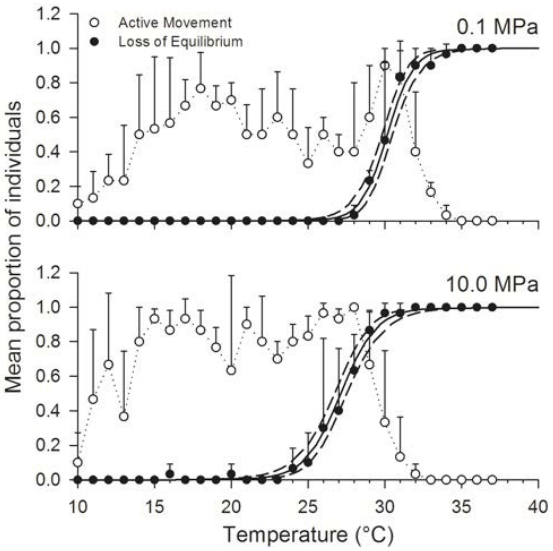
Marine litter collected with a benthic trawl at 2000 m in the western Mediterranean Sea. (c) BIOFUN cruise, ICM-CSIC.

Hot off the Press

The effect of high hydrostatic pressure acclimation on acute temperature tolerance and phospholipid fatty acid composition in the shallow-water shrimp *Palaemon varians*

Brown, A., Thatje, S., Martinez, A., Pond, D., Oliphant, A. (2019)

Journal of Experimental Marine Biology and Ecology, 514-515: 103-109



Extant deep-sea fauna, including hydrothermal vent endemics such as bresiliid shrimp, are descended from shallow-water ancestors. Previous studies have demonstrated the capacity of shallow-water shrimp to acclimate to hydrostatic pressure representative of the vent environment. It has been proposed that this hyperbaric acclimation depends in part on shifts in phospholipid fatty acid composition to maintain biomembrane function. These shifts are also predicted to reduce critical temperature tolerance, potentially limiting the possibility of direct colonisation of the hydrothermal vent environment. Here, we present evidence that acclimation to high hydrostatic pressure (10 MPa ≈ 1000 m water depth) decreases acute temperature tolerance from 30.2°C to 27.1°C in the shallow-water shrimp *Palaemon varians* acclimated to 10°C. Statistically significant shifts in phospholipid fatty acid composition occurred during exposure to high hydrostatic pressure, suggesting that homeoviscous modifications support shifts in environmental tolerances during hyperbaric acclimation. Despite the reduction in temperature tolerance, *P. varians* retains sufficient thermal scope to tolerate the thermal regime in the hydrothermal vent environment, allowing for the possibility of direct deep-sea hydrothermal vent colonisation by shallow-water shrimp.

Link to paper: https://doi.org/10.1016/j.jembe.2019.03.011

Temperature adaptation in larval development of lithodine crabs from deep-water lineages

Brown, A., Thatje, S., Oliphant, A., Munro, C., Smith, K.E. (2018)

Journal of Sea Research, 142: 167-173

Adaptations in per-offspring investment and larval development are considered to have been crucial to the global radiation of deep-water lineages of lithodine crabs (Lithodinae). Temperature is proposed to drive latitudinal trends in energy provisioning of eggs in marine invertebrates, mediated by thermally dependent intraspecific plasticity in per-offspring investment. Consequently, a changing climate may be expected to directly affect larval provisioning. We analysed available data to examine any differences in per-offspring investment and larval development among deep-water lineage lithodines. Although data are few, interspecific differences in the thermal scope of deep-water-lineage

lithodine larvae appear coupled with differences in biogeography. This coupling suggests environmental temperature influences larval thermal scope. Lithodine phylogeography suggests that larval cold-eurythermy in deep-water-lineage lithodines is a derived trait that has evolved in relatively warm and variable subantarctic shallow water. Therefore, we hypothesise that capacity to adapt to warmer and more variable environmental conditions may afford deep water-lineage lithodines some resilience to ocean warming, depending on the rates of environmental and adaptive change. Interspecific comparisons also suggest that larval duration and per-offspring investment are positively correlated. Faster development at a given temperature is associated with higher respiration rates and greater energetic reserve utilisation. Therefore, we hypothesise that selection pressure for contrasting metabolic adaptations in different thermal environments contributes to shifts in larval duration and per-offspring investment.

Link to paper: https://doi.org/10.1016/j.seares.2018.09.017

Temperature effects on larval development in the lithodid crab *Lithodes maja*

Brown, A., Thatje, S., Oliphant, A., Munro, C., Smith, K.E. (2018)

Journal of Sea Research, 139: 73-84

Physiological adaptations enabling tolerance of low temperature, as well as adaptations in larval development, are thought to be critical to the global radiation of deep-water lineages of lithodine crabs. However, global climate change is warming the oceans, potentially impacting the biogeographic distributions of these large predatory crabs. To date, larval thermal scope has only been explored in a few deep-water lineage lithodines. We assessed larval development parameters in the northern stone crab *Lithodes maja* (Fig. 1) at temperatures ranging from 1 °C to 15 °C. We examined larval survival, duration of development, energetic reserve utilisation, and respiration rate. *L. maja* larvae displayed a narrow thermal tolerance window and metamorphosed successfully at 6 °C only. Differential uses of energetic reserves among temperatures during development in *L. maja* support the interpretation of a narrow larval thermal scope and indicate that 6 °C is the optimum temperature for development in this species. Consequently, continued ocean warming is likely to force biogeographic range shifts in *L. maja*.

Fig. 1. Lithodines maja.

Link to paper: https://doi.org/10.1016/j.seares.2018.06.009

Submarine canyons support distinct macrofaunal assemblages on the deep SE Brazil margin

Bernardino, A.F., Gama, R.N., Mazzuco, A.C.A., Omena, E.P., Lavrado, H.P. (2019)

Deep Sea Research Part I, In Press

Submarine canyons are common topographic features of continental margins where increased organic matter trapping

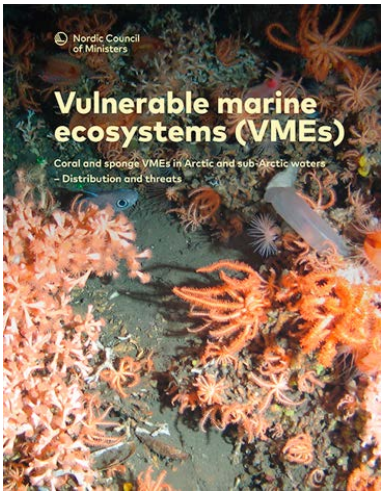
and complex topography may enhance the abundance of benthic assemblages. Here we studied and compared benthic macrofaunal assemblages of four submarine canyons and nearby slope transects (150–1300 m depth) on the E-SE Brazil margin (19–23 °S) along the Espírito Santo (ESB) and Campos Basins (CB). We asked if these submarine canyons would increase sediment total organic carbon (TOC) content and thus support higher abundances, lower diversity and dissimilar composition of macrofaunal benthic organisms if compared to open slope stations at similar depths. In general, we found limited support for a higher sediment TOC or macrofaunal abundances in canyons compared to slopes, although a steeper unimodal curve of TOC with depth in canyons was evidenced. Significant differences in sediment grain size and macrofaunal assemblages also occurred at spatial scales of basins, water depth and interactions between depth and environment (slope/canyon); highlighting the importance of intra-canyon heterogeneity processes. However, canyons and slope environments had significant differences in the structure of macrofaunal assemblages that were partially explained by water depth, TOC and mean grain size. The spatial heterogeneity within canyons and a variable proximity to continental runoff lead to a high dissimilarity of upper slope canyon assemblages indicating that these environments should be included in marine spatial conservation planning along Brazil's EEZ in view of increasing offshore deep-sea exploration.

Link to paper: https://doi.org/10.1016/j.dsr.2019.05.012

Vulnerable marine ecosystems (VMEs): Coral and sponge VMEs in Arctic and sub-Arctic waters – Distribution and threats

Buhl-Mortensen, L., Burgos, J.M., Steingrund, P., Buhl-Mortensen, P., Ólafsdóttir, S.H. and Ragnarsson, S.Á. (2019)

Nordic Council of Ministers



This report presents results from the NovasArc project that has collated data on the distribution of vulnerable marine ecosystems (VMEs) in Arctic and sub-Arctic waters. Eleven VMEs were identified, based on management goals for coral and sponge communities. Many of the VMEs in the study area have a wide distribution. Soft and hard bottom sponge aggregations, hard bottom gorgonians, sublittoral sea pen communities, and cauliflower corals are predicted to cover > 20% of the study area shallower than 1000 meters.

Of the anthropogenic activities in the study area bottom trawling represents the main threat to the VMEs. The compilation of trawling activity in the study area shows that fisheries mainly occurs shallower than 1000 meters and that 50 to 60% of the seafloor is not targeted. However, 30% of the seafloor has experienced intermediate to very high fishing effort.

In general, the VMEs shows a larger overlap with fishing when the risk analysis is based on areas with an optimal habitat suitability. Using this conservative threshold to model the distribution of VMEs the results indicate that most VMEs have experienced an intermediate to high level of fishing in less than 40% of their distribution area in the whole study area.

Link to book: http://dx.doi.org/10.6027/TN2019-519

Abyssal deposit-feeding rates consistent with the Metabolic Theory of Ecology

Durden, J.M., Bett, B.J., Huffard, C.L., Ruhl, H.A., Smith, K.L. (2019)

Ecology, 100(1): e02564

The Metabolic Theory of Ecology (MTE) posits that metabolic rate controls ecological processes, such as the rate of resource uptake, from the individual- to the ecosystem- scale. Metabolic rate has been found empirically to be an exponential function of whole organism body mass. We test a fundamental assumption of MTE, whether resource uptake scales to metabolism, by examining detritivores accessing a single common resource pool, an ideal study case. We used an existing empirical model of ingestion for aquatic deposit feeders adjusted for temperature to test whether ingestion by abyssal deposit feeders conforms to MTE-predicted feeding rates. We estimated the sediment deposit-feeding rates of large invertebrates from two abyssal study sites using time-lapse photography, and related those rates to body mass, environmental temperature, and sediment organic matter content using this framework. Ingestion was significantly related to individual wet mass, with a mass-scaling coefficient of 0.81, with 95% confidence intervals that encompass the MTE-predicted value of 0.75, and the same pattern determined in other aquatic systems. Our results also provide insight into the potential mechanism through which this fundamental assumption operates. After temperature correction, both deep- and shallow-water taxa might be summarized into a single mass-scaled ingestion rate.

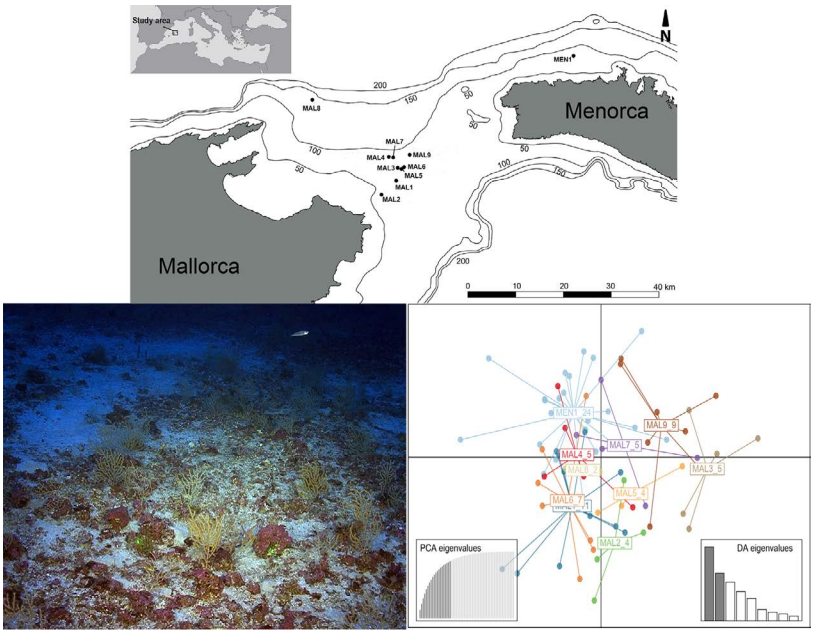
Link to article: https://doi.org/10.1002/ecy.2564

Exploring the genetic diversity and the population structure of the mesophotic *Paramuricea macrospina* in the Menorca Channel

Maria Grazia Paletta, Jordi Grinyó, Josep-Maria Gili, David Díaz, Anabel Muñoz, Joaquim Garrabou, Marco Abbiati, Jean-Baptiste Ledoux, and Federica Costantini (2019)

Estuarine, Coastal and Shelf Science, 219: 444–452

Gorgonians play an important structural and functional role promoting high diversity and biomass of associated fauna. Up to now, studies on gorgonian ecology in the Mediterranean Sea have been focused mainly on the SCUBA diving depth range. Although increased availability of remotely operated vehicles allowed access to the deeper areas, gorgonian assemblages located on continental shelf and slopes are still barely known. Gorgonian assemblages on continental shelves are extremely vulnerable to anthropogenic impacts, especially bottom trawling and longline fishing. To implement effective management and conservation policies it is crucial to understand patterns of genetic structure among populations since connectivity enhances the resilience of populations. *Paramuricea macrospina* is a key structuring gorgonian in the Menorca Channel's (Balearic Archipelago) outer continental shelf where it covers vast extensions, reaching very



high densities. Combining two mitochondrial markers and 10 microsatellites, this study gives the first insight into the genetic diversity and population structure of *P. macrospina* between 60 and 100m depth in the Menorca Channel and at a horizontal spatial scale of about 60 km. Overall, we demonstrate a low genetic diversity and a lack of genetic structure among populations, which may be explained by the geomorphology and hydrodynamic features of the Menorca Channel (e.g. internal waves, high currents). Our study suggests some connectivity among *P. macrospin*a populations in accordance with the high recruitment rates observed. This connectivity may increase the resilience and foster the recovery of impacted populations since the study area will become a Marine Protected Area of the Natura 2000 network in the near future. Nevertheless, complementary studies based on a larger sample size should be conducted to complement our results. In addition, temporal genetic monitoring of these populations should be envisaged to monitor the potential reduction of genetic diversity of this mesophotic species.

Link to the paper: https://www.sciencedirect.com/science/article/pii/S0272771418306413

Antarctic environmental protection: Strengthening the links between science and governance

Hughes, K.A., Constable, A., Frenot, Y., López-Martínez, J., McIvor, E., Njåstad, B., Terauds, A., Liggett, D., Roldan, G., Wilmotte, A., Xavier, J.C. (2018)

Environmental Science & Policy, 83: 86-95

The Antarctic has significant environmental, scientific, historic, and intrinsic values, all of which are worth protecting into the future. Nevertheless, the area is subject to an increasing level and diversity of human activities that may impact these values within marine, terrestrial and cryosphere environments. Threats to the Antarctic environment, and to the aforementioned values, include climate change, pollution, habitat destruction, wildlife disturbance and non-native species introductions. Over time, a suite of legally binding international agreements, which form part of the Antarctic Treaty System (ATS), has been established to help safeguard the Antarctic environment and provide a framework for addressing the challenges arising from these threats. Foremost among these agreements are the Protocol on Environmental Protection to the Antarctic Treaty and the Convention on the Conservation of Antarctic Marine Living Resources. Many scientists working in Antarctica undertake research that is relevant to Antarctic environmental policy development. More effective two-way interaction between scientists and those responsible for policy development would further strengthen the governance framework, including by (a) better communication of policy makers' priorities and identification of related science requirements and (b) better provision by scientists of 'policy-ready' information on existing priorities, emerging issues and scientific/technological advances relevant to environmental protection. The Scientific Committee on Antarctic Research (SCAR) has a long and successful record of summarizing policy-relevant scientific knowledge to policy makers, such as through its Group of Specialists on Environmental Affairs and Conservation (GOSEAC) up to 2002, currently the SCAR Standing Committee on the Antarctic Treaty System (SCATS) and recently through its involvement in the Antarctic Environments Portal. Improvements to science-policy communication mechanisms, combined with purposeful consideration of funding opportunities for policy-relevant science, would greatly enhance international policy development and protection of the Antarctic environment.

Link to paper: https://www.sciencedirect.com/science/article/pii/S1462901117311279

Climate Change and Ocean Governance: Politics and Policy for Threatened Seas

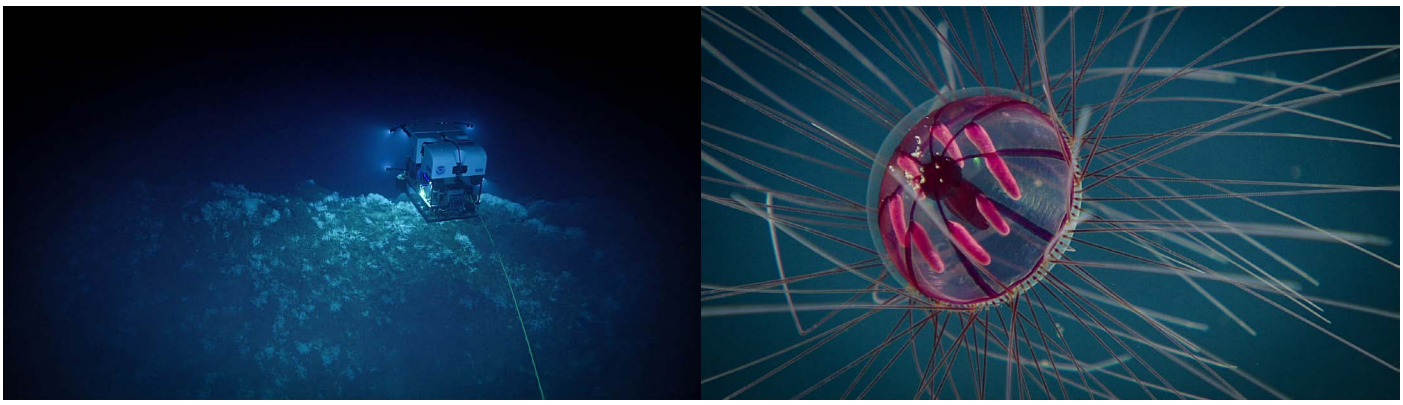
Paul G. Harris (ed.)

Cambridge University Press

Some of the most profound effects of climate change will occur across the world's oceans, seas and coastlines. Indeed, these effects are already being experienced. The environmental, social and economic consequences of oceanic change present tremendous challenges for governments and other actors. Existing national and international institutions for marine governance that were created when oceanic conditions were relatively static may not be adequate for a future characterized by continuous oceanic change. The impacts of climate change on oceans and seas will have political implications at all levels – local, national, international and global. Oceanic change will require politically difficult choices for governments and other actors. New and innovative policies for governing oceans and seas, and managing vital marine resources, have never been more important. Scientific literature on the role of oceans and seas in climate change is now extensive. In contrast, the body of literature analyzing the governance of oceanic change is relatively small. Climate Change and Ocean Governance aims to address this imbalance by bringing together research findings from political science and cognate disciplines to examine the political and policy dimensions of climate change for the world's oceans. With contributions from 40 international researchers, Climate Change and Ocean Governance presents a snapshot of the current state of knowledge and portrays a cross-section of research and analyses being conducted in this vital area of climate-related scholarship. To read a blog about this book, click here. To see the table of contents, click here. To read the first chapter, click here. To obtain a discount flyer from Cambridge University Press, click here.

Link to book: https://doi.org/10.1017/9781108502238

Newly Released: New Frontiers in Ocean Exploration



NOAA's Office of Ocean Exploration and Research (OER) is pleased to announce the release of New Frontiers in Ocean Exploration: The E/V Nautilus, NOAA Ship Okeanos Explorer, and R/V Falkor 2018 Field Season, a report of OER activities for 2018 including NOAA Ship Okeanos Explorer expeditions and sponsored projects funded to leverage OER's mission to explore the unknown and poorly known areas of the deep ocean. The publication includes decadal-themed articles and graphics of the Okeanos Explorer's evolution and progress toward fulfilling the vision of the President's Panel on Ocean Exploration. The efforts of the Ocean Exploration Trust and Schmidt Ocean Institute are also featured. The report is live and available for download with hard copies arriving in mid-May.

Multidisciplinary scientific cruise to the Rio Grande Rise

Jovane, L., Hein, J.R., Yeo, I.A., Benites, M., Bergo, N.M., Correa, P.V.F., Couto, D.D.M., Guimarães, A.D.F., Howarth, S.A., Miguel, H., Mizell, K.L. (2019)

Frontiers in Marine Science, 6: 252

Our multidisciplinary research was conducted in the western Rio Grande Rise (RGR), which is an extensive oceanic rise (~150,000 km²) in the South Atlantic Ocean, located ~1,000 km to the east of the Brazil and Argentine basins. The RGR has gained special attention from scientists and governments worldwide due to its marine mineral deposits and, as yet, the controversial origin of the rise itself. In 2015, the International Seabed Authority (ISA) and the state-owned Companhia de Pesquisa de Recursos Minerais (CPRM) of Brazil signed a 15-year contract for exploration of Co-rich ferromanganese crusts in the RGR, accentuating the need for baseline environmental studies in the area. Co-rich ferromanganese crusts are of interest as potential resources for critical and rare metals such as Co, Ni, Mn, Bi, Mo, Nb, Pt, REEs, Te, Th, Ti, W, Y, and Zr, most of which are essential for high- and green-technology industries. The supply of these rare metals is becoming critical as global consumption increases, hence deep-ocean mineral deposits may present an additional resource for these raw materials. In this cruise report, we detail the geophysical, hydrographic, geological, oceanographic, and ecological surveys carried out onboard the N/Oc Alpha Crucis of the Instituto Oceanográfico da Universidade de São Paulo between January and February 2018. The goal of the RGR cruise (RGR1) was to gather multidisciplinary data to supplement and expand previous environmental studies of RGR, to serve as baseline data on understanding Fe-Mn deposit formation, and environmental assessments for possible future mining activities on the RGR.

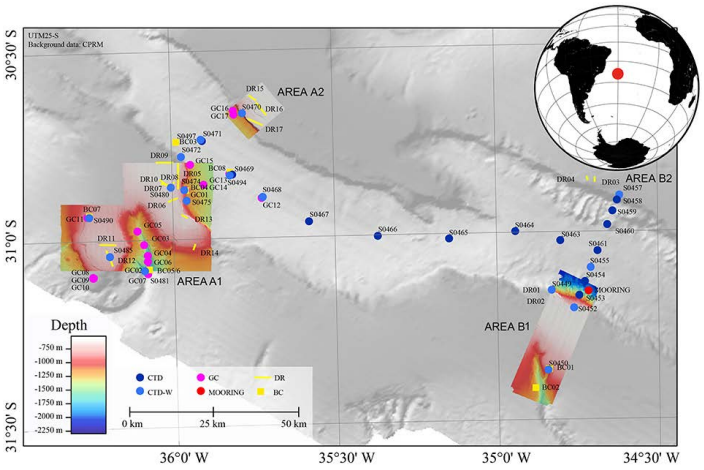


Figure 1. Location map of the operations performed during the oceanographic expedition RGR1 to Rio Grande Rise on board the research vessel Alpha Crucis *(Universidade de São Paulo). High resolution bathymetry was performed during the cruise. GC, gravity corer; DR, dredge; BC, box-corer.*

Link to paper: https://doi.org/10.3389/fmars.2019.00252

Global Observing Needs in the Deep Ocean

Levin, L.A., Bett, B.J., Gates, A.R., Heimbach, P., Howe, B.M., Janssen, F., McCurdy, A., Ruhl, H.A., Snelgrove, P., Stocks, K.I., Bailey, D., Baumann-Pickering, S., Beaverson, C., Benfield, M.C., Booth, D.J., Carreiro-Silva, M., Colaço, A., Eblé, M.C., Fowler, A.M., Gjerde, K.M., Jones, D.O.B., Katsumata, K., Kelley, D., Le Bris, N., Leonardi, A.P., Lejzerowicz, F., Macreadie, P.I., McLean, D., Meitz, F., Morato, T., Netburn, A., Pawlowski, J., Smith, C.R., Sun, S., Uchida, H., Vardaro, M.F., Venkatesan, R., Weller, R.A. (2019)

Frontiers in Marine Science, 6: 241

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Abstract: The deep ocean below 200 m water depth is the least observed, but largest habitat on our planet by volume and area. Over 150 years of exploration has revealed that this dynamic system provides critical climate regulation, houses a wealth of energy, mineral, and biological resources, and represents a vast repository of biological diversity.

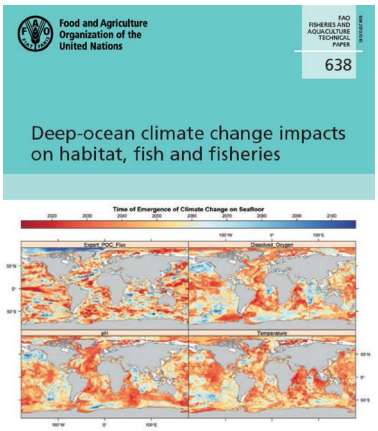
A long history of deep-ocean exploration and observation led to the initial concept for the Deep-Ocean Observing Strategy (DOOS), under the auspices of the Global Ocean Observing System (GOOS). Here we discuss the scientific need for globally integrated deep-ocean observing, its status, and the key scientific questions and societal mandates driving observing requirements over the next decade. We consider the Essential Ocean Variables (EOVs) needed to address deep-ocean challenges within the physical, biogeochemical, and biological/ecosystem sciences according to the Framework for Ocean Observing (FOO), and map these onto scientific questions. Opportunities for new and expanded synergies among deep-ocean stakeholders are discussed, including academic-industry partnerships with the oil and gas, mining, cable and fishing industries, the ocean exploration and mapping community, and biodiversity conservation initiatives. Future deep-ocean observing will benefit from the greater integration across traditional disciplines and sectors, achieved through demonstration projects and facilitated reuse and repurposing of existing deep-sea data efforts. We highlight examples of existing and emerging deep-sea methods and technologies, noting key challenges associated with data volume, preservation, standardization, and accessibility. Emerging technologies relevant to deep-ocean sustainability and the blue economy include novel genomics approaches, imaging technologies, and ultra-deep hydrographic measurements. Capacity building will be necessary to integrate capabilities into programs and projects at a global scale. Progress can be facilitated by Open Science and Findable, Accessible, Interoperable, Reusable (FAIR) data principles and converge on agreed to data standards, practices, vocabularies, and registries. We envision expansion of the deep-ocean observing community to embrace the participation of academia, industry, NGOs, national governments, international governmental organizations, and the public at large in order to unlock critical knowledge contained in the deep ocean over coming decades, and to realize the mutual benefits of thoughtful deep-ocean observing for all elements of a sustainable ocean.

Link to paper: https://doi.org/10.3389/fmars.2019.00241

Deep-ocean climate change impacts on habitat, fish and fisheries

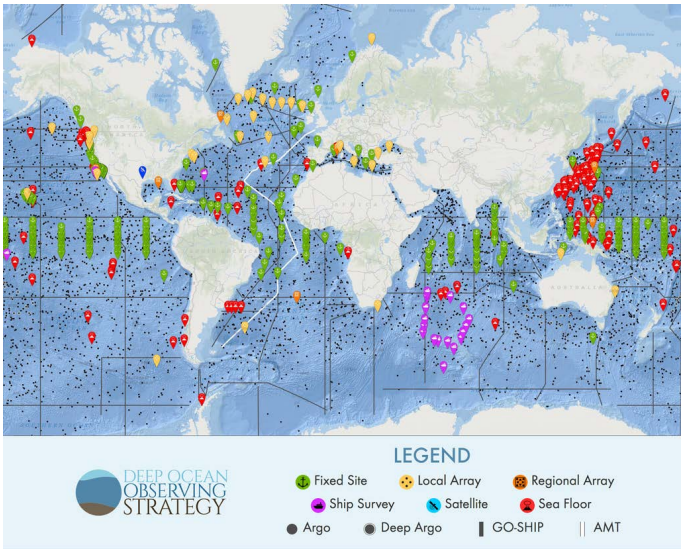
Levin, L., Baker, M., Thompson, T. (eds.)

FAO Fisheries and Aquaculture Technical Paper No 638. Rome, FAO. 186 pp.



Climate change is pervasive and is now exposing deep-ocean ecosystems to altered environmental conditions. We face considerable challenge in understanding how this will affect deep-sea habitats, fish and fisheries, and what management actions can be taken in response. This presentation highlights outcomes from a collaboration between the FAO/UNEP ABNJ Deep-seas and Biodiversity project and the Deep Ocean Stewardship Initiative, undertaken in response to UNGA Res. 71/123 (article 185) which calls upon states and RFMOs to '*take into account the potential impacts of climate change and ocean acidification in taking measures to manage deep-sea fisheries and protect vulnerable marine ecosystems*'. The study was initiated with a workshop at Woods Hole Oceanographic Institution in Summer 2017 and subsequently completed and summarized in FAO Fisheries and Aquaculture Technical Paper No. 638.

The principal cause of climate change is rising greenhouse gases and other compounds in the atmosphere that trap heat causing global warming, leading also to deoxygenation and acidification in the oceans. Three-dimensional, fully coupled earth system models were used to predict the extent of these changes at the bathyal ocean floor (200–2,500 m depth) for individual ocean basins, slopes, seamounts, canyons, and VME closed areas for 6 RFMOs plus CCAMLR. Trends in changes are identified in temperature, pH, oxygen and supply of particulate organic carbon (POC) to the seabed. Model predictions indicate that most of the deep seafloor is likely to experience warming and declines in pH by 2041–2060



and 2081–2100, especially at higher latitudes, with greatest warming effects at bathyal depths of the northwest Atlantic, western Greenland Sea and Barents Sea, Red Sea and Sea of Okhotsk. The most severe reductions in pH values are projected to occur at bathyal depths of the north Atlantic, Arctic and Southern Ocean. Deoxygenation (oxygen loss) is predicted to be greatest in the north Atlantic and part of the Arctic and Southern Oceans, while a significant decline in export POC flux at 200–2,500 m is expected in the north and south Atlantic, north Indian and south Pacific Oceans, with the greatest declines on the Atlantic slope. Cumulative impact assessment and time of climate signal emergence (from background variability) can help identify areas that will be subject to the most change most rapidly. The northeast Atlantic will probably be exposed to the highest cumulative negative impact of warming, and declines in pH, O_2 and POC flux among all regions under the RCP8.5 climate change scenario. At the bathyal seafloor, change in all variables except POC flux is projected to exceed historic variability by 2050; temperature and pH are projected to emerge in the 2030s in the Atlantic and Arctic Oceans.

The response of various fish and invertebrate species to these changes in the physical environment are considered based on published literature and analyzed using hazard and habitat suitability modelling. Features that make fish vulnerable to strong environmental influence include changes that affect the attached egg phase, pelagic egg phases and larval phases which may be related to ocean currents, temperatures and dependent on food availability. Fish distributional change in response to warming, especially near the poles is likely to be the first detectable response. (e.g. Greenland cod).

Key elements in assessing risk of impact to VMEs and fish were exposure to climate hazard (amount of change relative to natural variability), and climate vulnerability (underpinned by species' intrinsic sensitivity and adaptive capacity). Of 41 commercial species examined, all are predicted to experience a high level of climate hazards, with risk of impacts by 2100 being on average 13 percent higher than the risk by 2050. The most vulnerable taxa were Antarctic toothfish, yellowtail flounder and golden redfish, a result of larger body size and narrow thermal tolerance. Vulnerable species were most concentrated in the northern Atlantic Ocean and the Indo-Pacific region, but also in offshore West Africa and in the south Pacific. High vulnerability in the Antarctic region results from the high vulnerability of Antarctic toothfish.

Invertebrate/VME sensitivities are linked to physiological tolerances including those for reef formation, level of habitat specialization, dependence on environmental triggers for reproduction, development of mutualistic interactions, as well as on adaptive capacity and longevity. Of six VME indicator taxa examined for projected habitat change, all but one was predicted to have their suitable habitat reduced inside the fisheries management areas by 2100.

Key challenges identified in assessing deep-sea climate impacts include (a) mismatch in spatial scales of global and regional climate modelling and scales of VME designation. (b) failure of climate models to account for the non-linear response of ecosystems resulting from the combination of stressors and species interactions (c) scarcity of long-term climate observations on the deep seafloor needed to verify models, capture periodicity and short-term events, and to further mechanistic understanding and (d) limited availability of oxygen and other biogeochemical sensors on observing platforms.

Science needs include increased deep-ocean observing, particularly around existing and exploratory RFMO fishing areas and VME closures, and on the vulnerability and adaptability of key habitat-forming species and fisheries species to changing deep-ocean conditions. Collaboration among scientific networks with industry are needed to achieve these goals.

Bearing the above in mind, and the uncertainty in the specific details of the predictions, we know that climate change *will* bring change in the deep ocean, and therefore the status quo of today will not apply to tomorrow. Therefore, we must ensure monitoring programs are in place that will identify these changes, and that management can adapt in a timely fashion to promote sustainable fisheries and minimize undesirable impacts. Specific management adaptations could include: (i) more rigorous impact assessments of new fisheries that incorporate climate as a cumulative impact; (ii) a more thorough review process prior to allowing new fisheries to develop; (iii) strengthened monitoring and mapping of bottom-fishing areas and species associated with VMEs vulnerable to climate change; (iv) identification of areas to be more intensely monitored for fishing impacts on the environment; and (v) preventing further significant impacts and monitoring the effects of climate change by broadening of VME indicator species reporting to include all encounters, and with bycatch species reporting.

Deep-sea mining on the Rio Grande Rise (Southwestern Atlantic): A review on environmental baseline, ecosystem services and potential impacts

Montserrat, F., Guilhon, M., Corrêa, P.V.F., Bergo, N.M., Signori, C.N., Tura, P.M., de los Santos Maly, M., Moura, D., Millo, C., Jovane, L, Pellizari, V. (2019)

Deep-Sea Research Part I, 145: 31–58

The Rio Grande Rise is an extensive seamount region in the South-western Atlantic, with potential for deep-sea mining activities in the future. Such activities pose significant long-term disturbances and potentially severe impacts to both ecosystem structure and functioning, as well as associated ecosystem services. The Rio Grande Rise presents a severely understudied area, with very little knowledge on either local and regional scales. Most detailed knowledge available is centered on highly localised geological information and interpolated and/or modelled environmental data, while high-resolution data on biogeography, ecosystem processes and functioning are lacking. The Rio Grande Rise is most likely a remnant of the Paraná-Etendeka igneous province, and formed when the African and South-American plates separated to form the Southern Atlantic basin, about 75 million years ago. More recent cruises have generated very local and high-resolution acoustic impedance data on the substrate, showing extremely dense layers, likely to be cobalt-rich crusts and underlying bedrock, interspersed with thick sediment layers. Literature studies revealed that nowadays the Rise appears to be located within a relatively low-productivity oceanic region. Open-database mining yielded large-scale, extrapolated environ- mental data rasters, which show the Rise to be an oceanic region relatively free of pollution and anthropogenic disturbances, with high geomorphological heterogeneity and potential for high biodiversity. This image was confirmed in a small number of scientific submarine cruises, where a diverse range of seascapes was observed, from soft sediment to carbonate pavement and cobalt crust outcrops. Especially the latter substrata were found to be inhabited by diverse benthic communities, dominated by sessile organisms, presenting three-dimensional structural heterogeneity and with associated vertebrate and invertebrate animals. Cobalt-rich crusts appear to grow at an extremely slow rate of several mm per million years, in the deep ocean where biological and ecological processes such as reproduction, growth and recolonisation are characterised by slow dynamics. The main disturbances posed by deep-sea mining of cobalt-rich crusts on the Rio Grande Rise consist of (1) complete removal of substrate with its particular benthic communities, (2) strong localised increases in suspended particulate matter, causing smothering of breathing apparatus and dilution of food particles, (3) crushing by tailings and overburden and (4) toxicity effects by released metals and other toxic substances, likely to be increased under high pressure. These impacts will likely change the deep-sea ecosystem at the Rio Grande Rise and its functioning for time scales in the order of decades to centuries. State-of-the-art geological, environmental and ecological modelling, complemented with high-quality, fine-resolution data are needed to provide a detailed evaluation of the impacts of cobalt-rich ferromanganese crust mining in the Rio Grande Rise, with the goal to formulate strategic environmental management plans.

Link to paper: https://doi.org/10.1016/j.dsr.2018.12.007

Contrasting processes drive ophiuroid phylodiversity across shallow and deep seafloors

O'Hara, T.D., Hugall, A.F., Bribiesca-Contreras, G., Woolley, S.N.C., Bax, N.J. (2019)

Nature, 565: 636–639

Museum researchers are challenging ideas of how biodiversity accumulates on our planet by shinning the light on deep-sea life. Biologists have long speculated that evolution is sped up by relatively high tropical temperatures, leading to the large diversity of tropical species. But the deep sea has a different pattern. Here, it is the coldest region, Antarctica, which is currently generating species at the fastest rate. In contrast, the tropical deep sea has slowly accumulated its rich diversity over hundreds of millions of years. This is where marine "living fossils" survive, animals that have not changed much in appearance since the dinosaur era, ancient lineages that retain much of the evolutionary history of our seas within their genes. Our conclusion is that evolution of the world's biodiversity does not follow one simple rule but rather depends on the geological, climatic and biological history of individual ecosystems.

Link to paper: https://doi.org/10.1038/s41586-019-0886-z

Transoceanic Migration of Pacific Lamprey, *Entosphenus tridentatus*

Murauskas, J.G., Orlov, A.M., Keller, L., Maznikova, O.A., Glebov, I.I. (2019)

Journal of Ichthyology 59 (2): 280-282

We used passive telemetry to document the first evidence of transoceanic migration in lampreys. Forty (40) adult Pacific lampreys *Entosphenus tridentatus* were tagged with passive integrated transponder (PIT) tags in the western Bering Sea between 2012 and 2015. In September 2015, one adult lamprey was detected numerous times in the Columbia River Basin over 5000 km from feeding grounds. These results indicate that Pacific lamreys are capable of lengthy transoceanic migrations from feeding grounds in the Bering Sea to spawning grounds in North American rivers.

Link to paper: https://link.springer.com/article/10.1134/S0032945219020115

Inter- and Intra-Species Relationships of Greenland Halibut *Reinhardtius hippoglossoides* (Pleuronectidae) Based on the Analysis of Nuclear and Mitochondrial Genetic Markers

Orlova, S.Y., Volkov, A.A., Shcepetov, D.M., Maznikova, O.A., Chernova, N.V., Chikurova, E.A., Glebov, I.I., Orlov, A.M. (2019)

Journal of Ichthyology 59 (1): 65–77

Samples of Greenland halibut *Reinhardtius hippoglossoides* (Jordan and Snyder, 1901) from the Atlantic, Arctic, and

Pacific Oceans were compared using eight microsatellite loci and the Cyt b mtDNA gene. The data obtained revealed a population connectivity of the Greenland halibut from the Laptev Sea to those from the Atlantic Ocean that is the result of considerable eastward range extension due to recent climate change. Genetic differences between the Greenland halibut groupings of the Atlantic and Pacific Oceans, according to Fst values (0.141–0.197), reach a high level. Given the genetic differences revealed by both nuclear and mitochondrial markers, the taxonomic status of the Greenland halibut inhabiting the Pacific Ocean requires reevaluation at least to the rank of subspecies. It is suggested that the Greenland halibut populations of the Atlantic Ocean basin originated from those of the North Pacific. The time and conditions of Greenland halibut penetration from the North Pacific to the Atlantic Ocean are discussed.

Link to paper: https://link.springer.com/article/10.1134%2FS0032945219010119

Blue Hake *Antimora rostrata* (Gadiformes: Moridae) off the Atlantic Coast of South America: an Overview on Its Distribution and Biology

Orlov, A.M., Sytov, A.M., Marí, N., Figueroa, D.E., Barbini, S.A., Costa, P.A.S., Marin, Y.H. and Mincarone, M.M. (2019)

Journal of Ichthyology 59 (2): 174–175

Long-term data on spatial and bathymetric distributions, preferred bottom temperatures, length and weight of blue hake *Antimora rostrata* caught off the Atlantic coast of South America are presented based on published and unpublished materials. The species frequently occurred in waters of southern Argentina where catches were considerably higher as compared with Brazilian waters. The blue hake were captured at depths from 97 to 2162 m (average depth 1279 m). Most of the specimens (65.1%) were collected at depths from 700 to 1300 m, similar to depths in other parts of the species' range. Bottom temperatures at sites of blue hake captures in Brazilian waters were 2.18–4.20°C (average 2.93°C). Specimens in bottom trawl catches were 9–61 cm in total length, averaging 34.84 cm. The bulk of the catches (85.5% of individuals) were fish of 25–45 cm. Body weight ranged from 70 to 1380 g (average 437.5 g). Frequency of occurrence decreased from southern Argentina to northern Brazil; complete absence of records in the Central Western Atlantic might relate to different means by which the blue hake colonized the Pacific and Atlantic coasts of South America.

Link to paper: https://link.springer.com/article/10.1134/S0032945219020127

Quantification is more than counting: Actions required to accurately quantify and report isolated marine microplastics

Rivers M.L., Gwinnett C., Woodall L.C. (2019)

Marine Pollution Bulletin, 139: 100-104

Research on marine microplastics continues to increase in popularity, with a large number of studies being published every year. However, with this plethora of research comes the need for a standardised approach to quantification and analysis procedures in order to produce comparative assessments. Using data collected from neuston nets in 2016, parameters for quantifying microplastics were compared. Surface area was the most accurate parameter to describe plastic size and should be used to describe plastic quantity (per km^2 or m^3), alongside abundance (Fig. 1). Of the two most commonly used methods for calculating plastic concentration (flowmeter and ship's log), ship's log provided

consistently smaller abundances, with the exception of one sample, calling for a standardisation in the techniques and measurements used to quantify floating microplastics.

Link to paper: https://doi.org/10.1016/j.marpolbul.2018.12.024

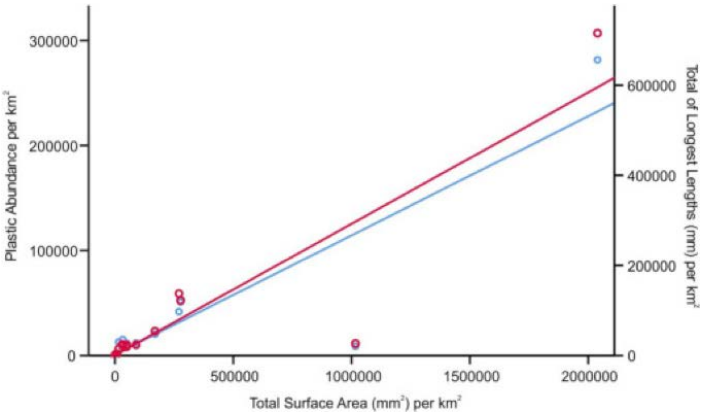
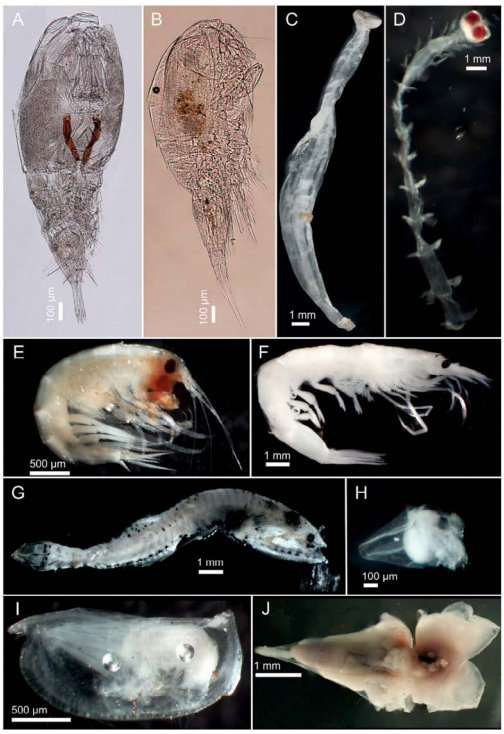


Fig. 1. Scatter plot showing the relationships between abundance and total surface area of plastic debris ($F_{1,18}$ = 67.624, $p < 0.001$, $r = 0.894$), and between total surface area and total of the longest lengths ($F_{1,18}$ = 70.131, $p < 0.001$, $r = 0.897$), calculated using a flowmeter. Blue data points and trend line represent plastic abundance, red data points and trend line represent total plastic longest lengths. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Changes in zooplankton communities from epipelagic to lower mesopelagic waters

Stefanoudis P.V., Rivers M., Ford H., Yashayaev I.M., Rogers A.D., Woodall L.C. (2019)

Marine Environmental Research, 146: 1-11



Zooplankton form a trophic link between primary producers and higher trophic levels, and exert significant influence on the vertical transport of carbon through the water column ('biological carbon pump'). Using a MultiNet we sampled and studied mesozooplankton (i.e. >0.2 mm) communities (Fig. 1) from six locations around Bermuda targeting four depth zones: ~0–200 m, ~200–400 m, ~400–600 m (deep-scattering layer), and ~600–800 m. Copepoda, our focal taxonomic group, consistently dominated samples (~80% relative abundance). We report declines in zooplankton and copepod abundance with depth, concurrent with decreases in food availability. Taxonomic richness was lowest at depth and below the deep-scattering layer. In contrast, copepod diversity peaked at these depths, suggesting lower competitive displacement in these more food-limited waters. Finally, omnivory and carnivory, were the dominant trophic traits, each one affecting the biological carbon pump in a different way. This highlights the importance of incorporating data on zooplankton food web structure in future modelling of global ocean carbon cycling.

*Fig. 1. Representative examples of zooplankton groups encountered in the MultiNet samples of this study. A) Copepoda (Corycaeidae, 100–200 m), B) Copepoda (Oncaeidae, 350–550 m), C) Chaetognatha (*Sagitta *sp., 200–400 m), D) Polychaeta (Alciopidae, 350–550 m), E) Amphipoda (Gammaridae, 200–400 m), F) Euphausiacea (Euphasiidae, 550–750 m), G) Fish larvae (*Cyclothone *sp., 600–800 m), H) Cladocera (Podonidae, 0–100 m), I) Ostracoda (Halocyprididae, 600–800 m), J) Gastropoda (Cavoliniidae, 350–550 m).*

Link to paper: https://doi.org/10.1016/j.marenvres.2019.02.014

Depth-Dependent Structuring of Reef Fish Assemblages From the Shallows to the Rariphotic Zone

Stefanoudis P.V., Gress E., Pitt J.M., Smith S.R., Kincaid T., Rivers M., Andradi-Brown D.A., Rowlands G., Woodall L.C., Rogers A.D. (2019)

Frontiers in Marine Science, 6: 307

Shallow coral reef ecosystems worldwide are affected by local and global anthropogenic stressors. Exploring fish assemblages on deeper reefs is therefore important to examine their connectivity, and to help understand the biodiversity, ecology, distinctiveness, evolutionary history and threats in this sparsely studied environment. Conducting visual surveys on the Bermuda slope and a nearby seamount at depths from 15 to 300 m, we document decreasing fish biomass and diversity with increasing depth. Fish assemblages were primarily depth-stratified, with distinct suites of species inhabiting shallow (<30 m depth) and upper (60 m) and lower (90 m) mesophotic coral ecosystems, and confirming the presence of a distinct rariphotic (150–300 m) assemblage. We also report evidence of anthropogenic pressures throughout our surveyed depths. Our results highlight the novelty of deeper reef fish faunas, therefore suggesting limited applicability of the deep reef refuge hypothesis, and showcase the vulnerability of deep reefs to targeted fishing pressure and invasive species.

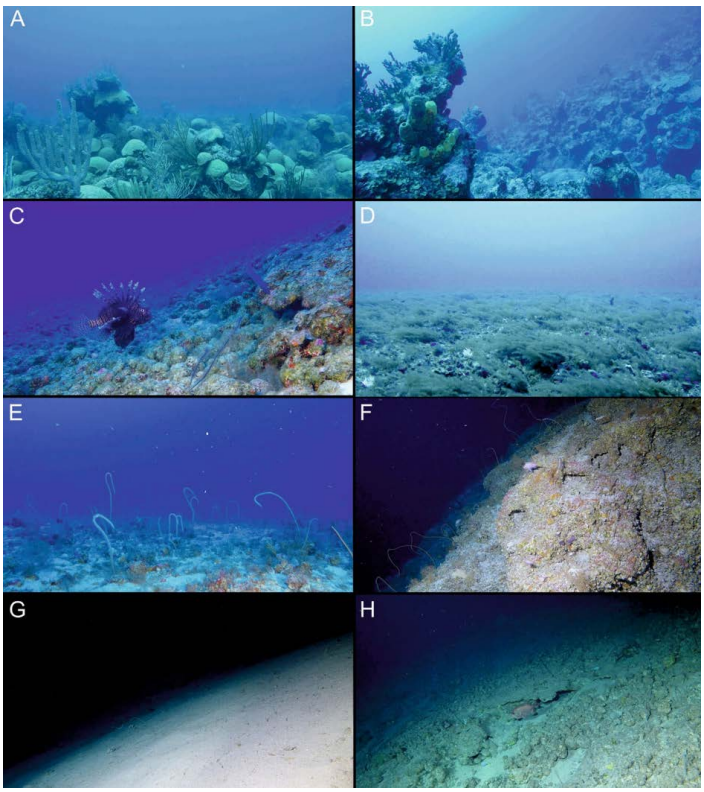


Fig. 1. Representative reef environments assessed in Bermuda (A-H). A-B) Shallow reefs dominated by reef-building scleractinians creating complex three-dimensional habitat structures (15–30 m), C) Rhodolith bed on reef slope (60 m), D) Macroalgal fields (60 m), E) Mosaic of sand and bedrock (90 m), F) Reef wall (150 m), G) Flat, sedimented habitat (250 m), H) Hard bottom habitat with patches of sand and gravel (300 m). I) Change in percentage cover of hard coral and macroalgae with depth. The bars indicate the mean and 95% confidence intervals.

Link to paper: https://www.frontiersin.org/articles/10.3389/fmars.2019.00307

Deep-water fisheries along the British Isles continental slopes: status, ecosystem effects and future perspectives

Vieira R.P., Trueman C.N., Readdy L., Kenny A., Pinnegar J.K. (2019)

Journal of fish biology, 1–12

In this paper, we revisit the state of deep-water fisheries to the west of the British Isles and aim to provide an overview on the key drivers behind community changes along continental margins. The deep-water fisheries to the west of the British Isles that extend from the shelf-slope break down to the lower slope and along banks and seamounts of the Rockall Basin, mainly target blue ling *Molva dypterygia*, roundnose grenadier *Coryphaenoides rupestris*, orange roughy *Hoplostethus atlanticus*, with by-catches of black scabbardfish *Aphanopus carbo* and tusk *Brosme brosme*. These fishing grounds experienced a long period of exhaustive exploitation until the early 2000s, but subsequently the

implementation of management strategies has helped to relieve excessive fishing pressure. It is widely accepted that a better understanding of the long-term implications of disturbance is needed to understand patterns in deep-water communities and what sustainable use and exploitation of resources might look like in this context.

Link to paper: https://doi.org/10.1111/jfb.13927

Ecological risk assessment for deep-sea mining

Washburn, T.W., Turner, P.J., Durden, J.M., Jones, D.O., Weaver, P., Van Dover, C.L. (2019)

Ocean and Coastal Management, 176: 24-39

Ecological risk assessment for deep-sea mining is challenging, given the data-poor state of knowledge of deep-sea ecosystem structure, process, and vulnerability. Polling and a scale-intensity-consequence approach (SICA) were used in an expert elicitation survey to rank risk sources and perceived vulnerabilities of habitats associated with seabed nodule, sulfide, and crust mineral resources. Experts identified benthic habitats associated with seabed minerals as most vulnerable to habitat removal with a high degree of certainty. Resource-associated benthic and pelagic habitats were also perceived to be at risk from plumes generated during mining activities, although there was not always consensus regarding vulnerabilities to specific risk sources from different types of plumes. Even for risk sources where habitat vulnerability measures were low, high uncertainties suggest that these risks may not yet be dismissed. Survey outcomes also underscore the need for risk assessment to progress from expert opinion with low certainty to data-rich and ecosystem-relevant scientific research assessments to yield much higher certainty. This would allow for design and deployment of effective precautionary and mitigation efforts in advance of commercial exploitation, and adaptive management strategies would allow for regulatory and guideline modifications in response to new knowledge and greater certainty.

Link to paper: https://doi.org/10.1016/j.ocecoaman.2019.04.014

Antarctic environmental protection: Strengthening the links between science and governance

Hughes, K.A., Constable, A., Frenot, Y., López-Martínez, J., McIvor, E., Njåstad, B., Terauds, A., Liggett, D., Roldan, G., Wilmotte, A., Xavier, J.C. (2018)

Environmental Science & Policy, 83: 86-95

The Antarctic has significant environmental, scientific, historic, and intrinsic values, all of which are worth protecting into the future. Nevertheless, the area is subject to an increasing level and diversity of human activities that may impact these values within marine, terrestrial and cryosphere environments. Threats to the Antarctic environment, and to the aforementioned values, include climate change, pollution, habitat destruction, wildlife disturbance and non-native species introductions. Over time, a suite of legally binding international agreements, which form part of the Antarctic Treaty System (ATS), has been established to help safeguard the Antarctic environment and provide a framework for addressing the challenges arising from these threats. Foremost among these agreements are the Protocol on Environmental Protection to the Antarctic Treaty and the Convention on the Conservation of Antarctic Marine Living Resources. Many scientists working in Antarctica undertake research that is relevant to Antarctic environmental policy development. More effective two-way interaction between scientists and those responsible for policy development

would further strengthen the governance framework, including by (a) better communication of policy makers' priorities and identification of related science requirements and (b) better provision by scientists of 'policy-ready' information on existing priorities, emerging issues and scientific/technological advances relevant to environmental protection. The Scientific Committee on Antarctic Research (SCAR) has a long and successful record of summarizing policy-relevant scientific knowledge to policy makers, such as through its Group of Specialists on Environmental Affairs and Conservation (GOSEAC) up to 2002, currently the SCAR Standing Committee on the Antarctic Treaty System (SCATS) and recently through its involvement in the Antarctic Environments Portal. Improvements to science-policy communication mechanisms, combined with purposeful consideration of funding opportunities for policy-relevant science, would greatly enhance international policy development and protection of the Antarctic environment.

Link to paper: https://www.sciencedirect.com/science/article/pii/S1462901117311279

Evidences of possible influences of methylmercury concentrations on condition factor and maturation of *Lophius vomerinus* (Cape monkfish)

Erasmus, V.N., Iitembu, J.A., Hamutenya, S., Gamatham, J., (2019)

Marine Pollution Bulletin, 146: 33-38

Muscle and liver tissues of *Lophius vomerinus* off the coast of Namibia were analysed to investigate the influence of MeHg on the biological parameters of *L. vomerinus* by (i) determining if the variability in total MeHg concentrations is influenced by length, maturity status and sex, and (ii) assessing if there is a relationship between biological indices (Condition factor (K), Gonadosomatic Index (GSI) Hepatosomatic Index (HSI)) and MeHg concentrations. Correlations between total MeHg concentrations and fish length, K and HSI were observed. A weak positive correlation was observed between total MeHg and GSI for combined sex. Total MeHg concentration in tissues of *L. vomerinus* is significantly dependent on the maturity stages ($p < 0.05$). K was significantly inversely correlated with total MeHg in tissues of *L. vomerinus*. The evidence presented in this study suggests that MeHg in *L. vomerinus* tissues could be detrimental to both its physiology and population dynamics.

Link to paper: http://www.sciencedirect.com/science/article/pii/S0025326X1930428X

Recruitment of Arctic deep-sea invertebrates: Results from a long-term hard-substrate colonization experiment at the Long-Term Ecological Research observatory HAUSGARTEN

Meyer-Kaiser, K., Bergmann, M., Soltwedel, T., Klages, M., (2019)

Limnology and Oceanography, 1-15

For benthic marine invertebrates, recruitment strongly influences the composition and abundance of resulting communities. We present the results of a long-term (1999–2017) colonization experiment at the Long-Term Ecological Research observatory HAUSGARTEN in the Fram Strait (Arctic Ocean, 79°N, 04°E, 2500 m water depth). Recruitment panels were constructed from plastic and brick and deployed attached to a metal frame in 1999. The experiment was monitored using a remotely operated vehicle in 2003 and 2011 and recovered in 2017. Recruitment was very low, with only foraminiferans being visible after 4 yr (2003) and one metazoan species, the hydroid *Halisiphonia arctica*, being

visible on the panels after 12 yr (2011). After 18 yr underwater, panels were colonized by 13 metazoan species as well as calcareous and agglutinating foraminiferans. Recruitment was higher on brick panels than on plastic, but while some species were more common on panels at higher altitude (*H. arctica* and the crinoid *Bathycrinus carpenterii*), others were more common on panels closer to the seafloor (serpulid polychaetes) or on panels in line with the predominant bottom current (small round white sponges). The most common species recruiting to our panels can be described as opportunistic. Meanwhile, large hexactinellid sponges that are common in natural communities did not recruit to our panels. These results suggest that community assembly in the Arctic deep sea takes much longer than the two decades spanned by this study.

Link to paper: https://aslopubs.onlinelibrary.wiley.com/doi/abs/10.1002/lno.11160

Deep sea polymetallic nodule fields are unusual mosaic habitats

Simon-Lledó, E., Bett, B.J., Huvenne, V.A., Schoening, T., Benoist, N.M., Jones, D.O. (2019)

Limnology and Oceanography, 1-12

Mineral deposits, in the form of potato-sized nodules, which cover wide areas of the world's sea floor, are extremely important in structuring communities of deep-sea animals according to research published by scientists at the National Oceanography Centre, Southampton (NOC), UK. These nodules are of commercial interest for potential deep-sea mining because they contain a range of important metals, including copper, cobalt and nickel.

This new study, in the Journal of Limnology and Oceanography, shows that the dominant deep-sea animals in a nodule field changes with nodule concentration.

The implication of this is that successful conservation of deep-sea ecosystems in the event of nodule mining will require the preservation of areas with a full range of nodule concentrations, and not just the 'low density' areas that are least attractive to mining. Baseline ecological assessments like this are extremely important for informing the management of future commercial mining activities.

NOC scientist, Dr Erik Simon-Lledo, the lead author of the study said: "Nodule fields are an unusual mosaic habitat where the hard substratum provided by nodules increases habitat complexity, promoting the development of diverse sea-floor communities. Understanding what processes lead to the high diversity found in this remote environment will be key to understand how to protect it."

Most of the world's deep ocean floor is soft sediment. However, there are large areas that also have these polymetallic nodules scattered over the sediment surface. This study is focussed on an area in the central Pacific known as the Clarion Clipperton Zone, one of the most important areas for nodules in the world. Yet, the living environment of this remote area is poorly known.

This study was based on data collected during a research expedition led by NOC scientist Dr Daniel Jones to the Clarion Clipperton Zone in 2015 on board the RSS James Cook. During this expedition, high definition photos were taken of the nodule field on the sea floor. This allowed the team to examine the animals present on each image and compare that with the concentration of nodules in that area.

This research is one of the key outputs from the “Managing Impacts of Deep-sea Resource Exploitation” (MIDAS) project, funded by the European Union Seventh Framework Programme.

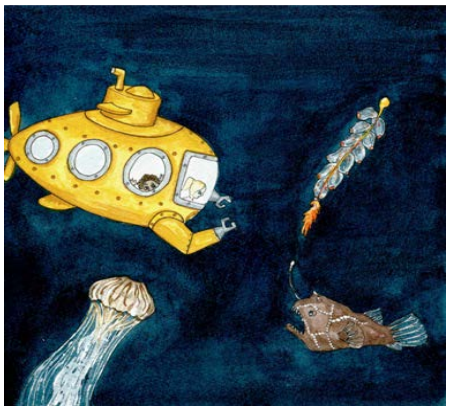
Link to paper: https://aslopubs.onlinelibrary.wiley.com/doi/full/10.1002/lno.11157

Treasures of the Deep

By Maria Baker, Ana Hilário, Hannah Lily, Anna Metaxas & Eva Ramirez-Llodra

Illustrated by Abigail Pattenden

Coming soon……. Release date end June 2019



The deep ocean is a source of inspiration for all, where science, education and art meet to reveal a hidden world. The seabed also contains mineral resources, and interest in their exploitation is mounting. We have produced an illustrated book that will take young children on a journey to discover the treasures found at hydrothermal vents, exposing them to both the mineral richness and the exotic ecosystems.

The aim of the book is to reveal the concepts of sustainable resource extraction and conservation. They will learn about the potential for seabed mining and how exploitation would be conducted, and they will be faced with the anticipated environmental impacts of mining activities. The book raises questions regarding the balance between exploitation and conservation and will ask the audience to consider all elements. This book will expand knowledge among school children, their teachers and families (with a factual account of the resource types and issues at the end of the book).

Keep an eye out for the release of this exciting book which will be available online as an E-Book, and with limited print copies.

The Commonwealth DOSI DEEP-OCEAN STEWARDSHIP INITIATIVE UNIVERSITY OF Southampton IN DEEP

Deep-Sea Biology Society Business

President's Letter, June 2019

Dear Deep-Sea Biology Colleagues,

It is with great pleasure I write to you now in the northern hemisphere summer of 2019 with an update on news from the Deep-Sea Biology Society. Our membership now stands at a record number of 491, including 141 students, following an equally record-breaking Deep-Sea Biology Symposium in 2018, where 405 delegates attended a fantastic symposium in Monterey, USA. Despite the challenges of obtaining science funding, and the ever-increasing costs of doing science, our discipline is thriving. Part of this reflects the increasing applied aspects of deep-sea science. This has come from the rapid growth in the discussion of deep-sea conservation, for example in the context of the United Nations Intergovernmental Conferences on a proposed high seas treaty to protect marine biodiversity in areas beyond national jurisdiction that are meeting this year and next. It has also come from the rapidly-growing interest in seabed mining, and continuing industrial activity in hydrocarbon extraction. But there is also a strong argument that as we better organise our discipline, and find new ways of networking and communicating with each other, more deep-sea biology proposals are being submitted.

Facilitating networking and communicating as means to develop our science ideas is a core area of work for the Society. The Society was founded to ensure the long-running Deep-Sea Biology Symposia continued in a regular and fair manner. We were all delighted with the success of the 15th Deep-Sea Biology Symposium in Monterey and look forward to the next one, to be held for the first time in Asia in 2021. But alongside our triennial meeting, we have also formalised the way the Society works in conjunction with the International Symposium on Deep-Sea Corals and the International Symposium on Chemosynthesis-Based Ecosystems. These now all occur, with Society support, in consecutive years and we are thus able to host the Annual General Meeting's (AGM) of the Society - to which all members are invited - at each of these symposia. We held our first AGM at the Woods Hole Oceanographic Institute, USA, in 2017, and we are now planning to continue this format of a Wednesday mid-week evening AGM, with a free social and networking event for all. The next one will be held on Wednesday 31st July at 6.30pm in the InterContinental Hotel, Cartagena, Columbia during the 7th International Symposium on Deep-Sea Corals (ISDSC7).

The AGM is an important legal requirement for the Society in which the principal business item is the transparent reporting of our finances to all members. But it is also an opportunity to hear from the Society officers on their work, and receive input from members on what they want from the Society in the future. We have also started the excellent tradition of combining this business with a social event.

The 7th ISDSC meeting also marks a step-change in the role of the Society, as for the first time we are the official hosting institution, underwriting the meeting, contracting the venue and arranging the finances. This brings major advantages to our community in that we are able to return any surplus income from the event back to the community. In the case of ISDSC7 we have so far been able to sponsor a remarkable 20 scientists to attend who otherwise would have struggled to find the necessary finance. It is important for me to point out that none of this would have been possible without the amazing organisation and support from the local organising committee, led by Santiago Herrera, who is also our Membership Secretary. We should also thank the tireless support from our Treasurer, Chris Yesson, in arranging the contracts and financial transactions needed. All members can learn more about how this worked at the AGM, but one important point is that it opens the possibility to run future meetings in this manner.

Below you can read more from our officers on forthcoming meetings, student events, early-career support and most importantly news on Society Awards. We are currently seeking nominations for our Paper of the Year award, so please send your nominations in now! The deadline is 1st July, and details are available on the website awards section.

Adrian Glover, President
a.glover@nhm.ac.uk

Deep-Sea Biology Society Meetings

The Society holds its Annual General Meeting at each of the three main conferences that it supports, currently the triennial Deep-Sea Biology Symposium (DSBS) (next one in 2021), the International Symposium on Chemosynthesis-Based Ecosystems (CBE, next one in 2020) and the International Symposium on Deep-Sea Corals (ISDSC, next one in 2019).

Notice of the Deep-Sea Biology Society 2019 Annual General Meeting

Notification of the 2019 Annual General Meeting (AGM) of the Deep-Sea Biology Society. The 2019 AGM will be held at 6.30pm on 31st July 2019 during the 7th International Symposium on Deep-Sea Corals at the InterContinental Hotel, Carrera 1 No 5-01, Bocagrande, Cartagena, Colombia. An agenda will be circulated to all members by the Society Secretary prior to the meeting.

The AGM will include our financial report, reports from the Officers, open discussion for all members, and a free social event. All are welcome, and non-members can join at the event!

7th International Symposium on Deep-Sea Corals

The International Symposium on Deep-Sea Corals is the premier meeting for scientists, explorers, managers, policymakers, industry specialists and students to exchange ideas and share knowledge of deep-sea and cold-water corals and their ecosystems. The 7th edition of the symposium (ISDSC7), is organized by Santiago Herrera (Lehigh University), Juan Sanchez (Universidad de los Andes) and Luisa Dueñas (Universidad Nacional de Colombia), and will take place in Cartagena, Colombia. This is the first time the symposium will take place in Latin America, and the second time in the southern hemisphere. This is the first time that the symposium is organized with support from the Society.

There are approximately 170 registered participants to the symposium, 20 of which received travel awards granted by the organizers and the Society. The Society will hold events for students and early career scientists, as well as the Annual General Meeting during the symposium. The Society will also sponsor awards for the best talks and posters. For more information visit https://www.deepseacoral2019.org/

Deep-Sea Biology Society Students

The Deep-Sea Society have appointed a new student representative, Zoleka Filander (Nelson Mandela University / Department of Environmental Affairs, South Africa), whose role it is to represent the student members' interest, the processing of awards for student achievements at respective meetings or symposiums and facilitating efficient communication of student opportunities within the field. Activities under development include the profiling of student research across various communication platforms and to ensure student needs are represented within the ongoing mentorship scheme. Ms Filander also plans to host a student mixer side-event at the upcoming Deep-Sea Coral symposium this July in Colombia. As it currently stands Zoleka will be representing the 141 student members from 27 different countries, but will have a mandate to grow the community, particularly in those areas that are currently under represented.

Zoleka welcomes your input on ideas to support students, please get in touch at the new #students channel dsbsoc.slack.com (if not already a member, you can join with this link) or directly with Zoleka at zfilander@gmail.com.

Deep-Sea Biology Society Early-Career Support

Dr Andrea Quattrini (Harvey Mudd College, USA) is the new Early Career (EC) Officer for the society. The goal of this position is to promote the professional development of early career researchers (<10 years post-PhD) to help foster their success as deep-sea scientists.

This year, Andrea has plans to host four webinars geared toward EC researchers, but these are open to everyone. The first webinar was conducted in March and it was focused on work-life balance and time management. Guest speakers

included Amy Baco-Taylor (FSU) and Heather Bracken-Grissom (FIU). We had 10 people in attendance.

The second webinar was held in June and focused on Effective Science Outreach. The guest speaker was Liz Baird, Chief of the School and Lifelong Education Center for the NC Museum of Natural Sciences.

Other events that will happen this year include: 1) an EC mixer at the 7th ISDSC Meeting, 2) a webinar focused on Academic Job Prep, and 3) a webinar focused on Proposal writing. There is also an active mentoring network through the society for students and EC researchers. If you would like more information, please contact Rachel Jeffreys - rachel.jeffreys@liverpool.ac.uk

Andrea polled EC scientists earlier this year to see what interested them, and the results of that poll can be found on our #early-career slack channel. Please note that Andrea will also be posting updates and opportunities to our public DSBS slack on a regular basis. If you haven't joined, please consider doing so at https://dsbsoc.slack.com/

One outcome of the poll was that EC scientists need more at-sea opportunities. So, if any of you need to fill a cruise berth, please post that opportunity on slack. We are looking at our budget, with the hopes of helping to defray costs of travel for these unique cruise opportunities.

Andrea looks forward to seeing some of you at the 7th ISDSC meeting in Cartagena.

Deep-Sea Biology Society Awards and Prizes

Report on 2019 Calls to date

The Society is pleased to announce that in conjunction with the local organising committee we have awarded 20 travel awards (1000 USD each) to support attendance at the 7th International Symposium on Deep-Sea Corals, to be held in Cartagena, Colombia, July 29 - August 2, 2019. These have been awarded to: Salome Ursula Buglass (Charles Darwin Foundation), Daniel Lauretta (Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Argentina), Nicholas Hitt (Victoria University Of Wellington, New Zealand), Giovanni Chimienti (University of Bari Aldo Moro, Italy), Bárbara de Moura Neves (Department of Fisheries and Oceans, Canada), Antonella Lavorato (Universidad Autonoma de Baja California Sur, Mexico), Phil Alderslade (CSIRO, Australia), Janina Vanessa Büscher (GEOMAR Helmholtz Centre for Ocean Research, Germany), Nissa Kreidler (NOAA & Humboldt State University, USA), Ulrike Hanz (Royal Netherlands Institute for Sea Research, Netherlands), Danielle De Leo (Florida International University, USA), Candice Untiedt (CSIRO & University of Tasmania, Australia), Guillem Corbera Pascual (University of Southamtpon, UK), Krista Greeley (Memorial University of Newfoundland, Canada), Luke McCartin (Woods Hole Oceanographic Institution, USA), Tabitha Pearman (National Oceanography Centre Southampton, UK), David Price (University of Southampton, UK), Beatriz Mejia-Mercado (Florida State University, USA), Íris Sampaio (University of the Azores, Portugal), Leslie Wickes (Thrive Blue LLC, USA).

The Society is currently in the process of judging and awarding two Dive Deeper bursaries, and the Lounsbery workshop award. Thank you to those that applied and please keep an eye on the website and Twitter for announcements concerning the recipients!

Calls open for 2019

We currently have one award still open in 2019 for excellence in scientific publishing, the Paper of the Year award. For terms and conditions please see here.

We really value your input to these awards and they should be driven by the community so please send in your nominations for this award!

We will also be awarding prizes for best oral and poster presentation at the 7th International Symposium on Deep-Sea Corals, to be held in Cartagena, Colombia, July 29 - August 2, 2019.