8th International Symposium

Deep-Sea Corals

29 May - 2 June Edinburgh, Scotland

Symposium Handbook & Book of Abstracts

ISDSC8 - 2023

Greetings to the Participants of the 8th International Symposium on Deep-Sea Corals!

We are very excited to welcome all of you to this year's symposium in historic Edinburgh, Scotland. For the first time, this conference will be in a hybrid format, allowing us to share and discuss the exciting advances in our field in person and online.

For those of you attending in person, we hope you will take some time to explore this wonderful city, with an extinct volcano running along one side (with stunning views of the city if you walk up it), and a historic 12th century castle sitting imposingly in the middle of the city. Our conference dinner and ceilidh (Scottish dancing) will be in the UK's leading Earth Science Engagement centre, which also showcases the deep-sea and cold-water corals.

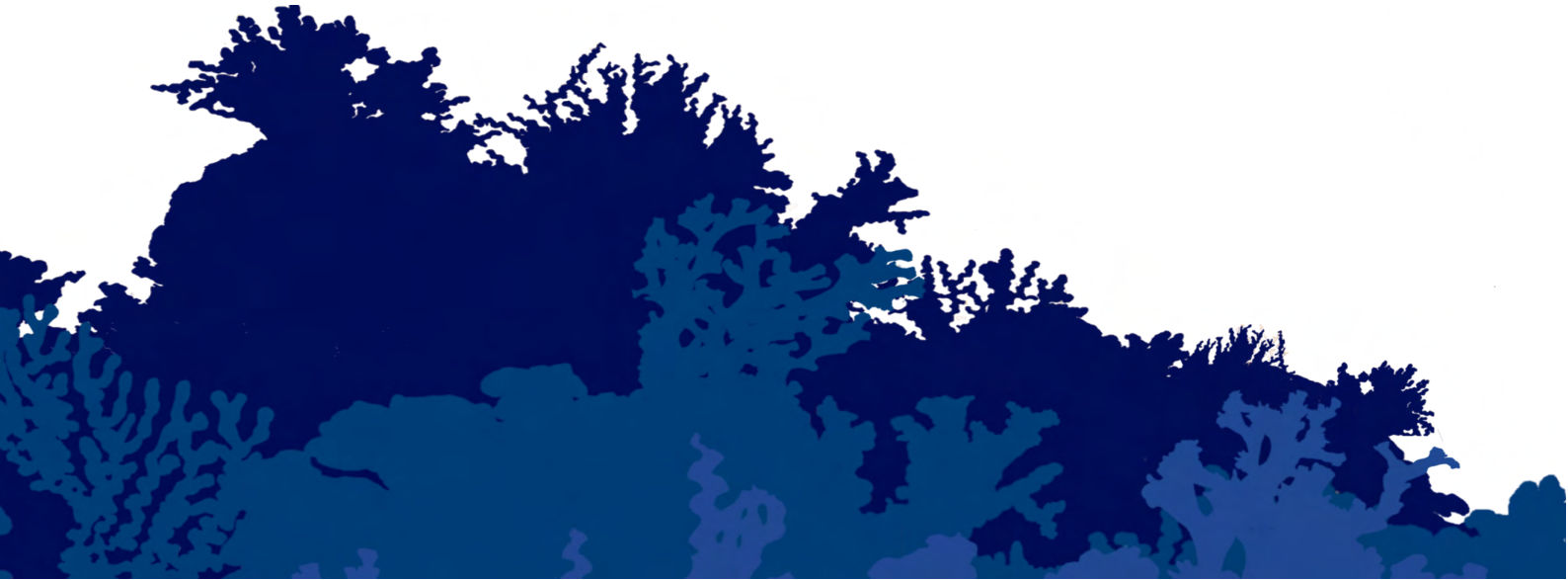
We have a great program lined up for you, where we will hear about advances in coral palaeoceanographic reconstructions, evolution, biology and reproduction, biogeochemical cycling, habitat mapping and biogeography, and also discuss how we engage with these charismatic habitats through policy and management, but also through wider society.

We will start off the week with a reception on the Sunday evening, before opening the conference on the Monday morning with a keynote by Prof. André Freiwald and Prof. Murray Roberts, reflecting on the last 20 years of deep-sea coral reef research and exploration. During the week we will have 9 different conference themes, and in each theme, we will hear from established and emerging researchers in a variety of formats to allow engagement in person and online.

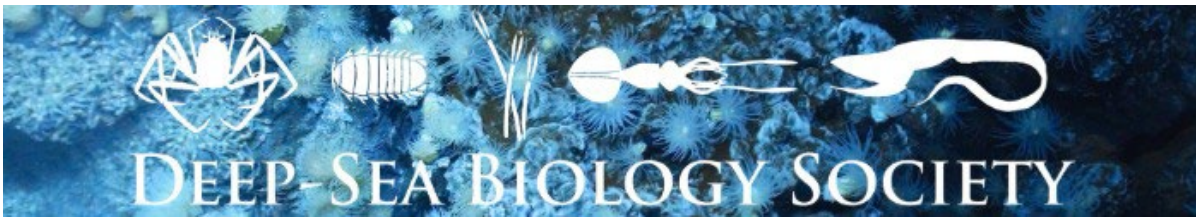
On the Wednesday and Thursday afternoons we will hold a selection of workshops, ranging from skill-based development in emerging technologies, to open discussions on a variety of topics including impacts of fisheries, coral restoration and funding opportunities, allowing us the time to discuss and consider how to grow our research going forwards.

A core theme of this conference is not only to hear about and discuss the cutting edge of our field, but to make new contacts, collaborations and friends. This will be aided through formal events and our symposium mentorship programme, but also through informal receptions and breaks throughout the conference, so please do take the opportunity to meet new people in your field and share your passion for deep-sea corals. On behalf of the organisers and steering committee, we welcome you to Edinburgh and the 8th International Symposium on Deep-Sea Corals!

Kind regards,
Dr Sebastian Hennige
Symposium Coordinator, on behalf of the Programme Committee
& Local Organising Committee



With thanks to our sponsors partners!



NOAA

BOEM
Bureau of Ocean Energy Management

USGS
science for a changing world

THE UNIVERSITY OF EDINBURGH

MARINE ALLIANCE FOR SCIENCE AND TECHNOLOGY FOR SCOTLAND

JNCC

SAGES
Scottish Alliance for Geoscience, Environment and Society

ENVIRONMENTAL RESEARCH INSTITUTE
SOUTH ATLANTIC

Summary

What to expect and look out for in this document:

- Venue Details

  In this section you will find address, map, floorplan and link to the website for our conference venue, as well as the list of the rooms used for different parts of the ISDSC8 and information about WiFi, accessibility and special needs.

- Information for remote participants

  This section contains all ISDSC8 Zoom links – for participants, remote panellists, virtual networking space and hybrid workshops.

- Symposium Running Order

  A full running order of the Symposium, including keynotes, full talks and speed talks in each of the sessions listed chronologically and sorted by day.

- Workshops ad Side-Events

  Full descriptions and timetable of the Symposium workshop and breakouts.

- Book of Abstracts

  Abstracts for all keynotes, full talks and speed talks of the ISDSC8, presented by session.

- Research Highlights & Posters

  Abstracts and links to video recording for ISDSC8 research highlights and posters sorted alphabetically.

Contents

ISDSC8 Code of Conduct & Social Media Policy

The Code of Conduct and social media Policy for ISDSC8 adopt the principles published by Favaro et al. 2016 and followed by the previous ISDSC.

We are committed to providing a friendly, professional, respectful, inclusive and safe environment for all participants at the ISDSC8. By participating in the Symposium, all attendees agree to this Code of Conduct. Any behaviours that violate this code should be reported to isdsc8@ed.ac.uk and may result in the removal of the participant from the event. We commit to respond to any reports of such behaviours in a respectful and timely manner, while ensuring privacy.

Examples of Expected Behaviours

- Treat all participants, guests, organisers and volunteers of ISDSC8 with **respect and consideration.**
- Communicate openly and thoughtfully with others and be **considerate of the multitude of views** and opinions that are different than your own.
- Be **respectful and mindful** in your critique of ideas.
- Maintain **a safe and appropriate physical and emotional distance** in all interactions.
- **Do not record** presentations.

These behaviours are expected by all symposium participants during presentations, social hours, events and when using online platforms including social media.

Examples of Behaviours that will not be tolerated during the Symposium:

- Harassment and intimidation, including any verbal, written, or physical conduct designed to threaten, intimidate, or coerce another delegate, conference organisers, or staff.
- Discrimination based on gender or gender identity, sexual orientation, age, disability, physical appearance, race, religion, national origin, or culture.
- Physical or verbal abuse of any attendee, speaker, volunteer, exhibitor, staff member, service provider or other meeting guest.
- Disrespectful disruption of presentations.

The ISDSC8 embraces wider dissemination, collaboration, and partnership and has established social media channel to facilitate this.

During the Symposium, many of our speakers will be presenting exciting novel research that is not yet published and **we respect the speakers' right to request that their work not be shared across social media**. During the ISDSC8 we ask all presenters to make it clear during their talks if any data, research plans or other information need to be kept confidential. This should be explained verbally and by inserting a graphic similar to the example below on the relevant PowerPoint slides.

Recording or reproducing audio or video of presentations is not allowed. However, please note, that the organisers will record the sessions for the use on ISDSC8 website and social media. Please contact isdsc8@ed.ac.uk if you do not give consent to appear on any photos or videos published by the event.

Provided there are no restrictions on dissemination, **we encourage participants at the ISDSC8 to share information through their social media accounts** using the hashtags and handles listed below. It is the responsibility of the ISDSC8 participants to acquire appropriate permission to publish any photographs that feature other participants.

#ISDSC8

Twitter: @ISDSC8

ISDSC8 Programme & Organising Committee

Scientific Steering Committee

	**Andrea Gori** *Universitat de Barcelona, Spain*		**Di Tracey** *National Institute of Water & Atmospheric Research, New Zealand*
	**Marcelo Kitahara** *University of São Paulo, Brazil*		**Marco Taviani** *National Research Council of Italy*
	**Sandra Maier** *Greenland Climate Research Centre*		**Marina Carreiro Silva** *Universidade dos Açores/ Insitituto do Mar (IMAR), Portugal*
	**Asako Matsumoto** *Planetary Exploration Research Center (PERC), Chiba Institute of Technology, Japan*		**Narissa Bax** *South Atlantic Environmental Research Institute, Falkland Islands*
	**Andrea Quattrini** *Smithsonian National Museum of Natural History, USA*		**Covadonga Orejas** *Instituto Español de Oceanografía (IEO-CSIC, Spain*
	**Nadia Santodomigo** *University of Oxford, UK*		**Andrew Wheeler** *University College Cork, Ireland*
	**Michelle Taylor** *University of Essex, UK*		**Ann Larsson** *University of Gothenburg, Sweden*

	**Sonia Rowley** *University of Hawaii, USA*		**Paolo Montagna** *Institute of Polar Sciences (ISP-CNR)*
	**Santiago Herrera** *Lehigh University, USA*		**Alberto Lindner** *Universidade Federal de Santa Catarina, Brazil*
	**Tabitha Pearman** *National Oceanography Centre, UK*		**Jaret Bilewitch** *National Institute of Water & Atmospheric Research, New Zealand*
	**Zoleka Filander** *Nelson Mandela University, South Africa*		

Local Organising Committee – University of Edinburgh, UK

	**Sebastian Hennige** Symposium Coordinator		**Anna Gebruk** Deputy Symposium Coordinator
	**Laurence de Clippele** Workshop Coordinator		**Johanne Vad** Volunteer Coordinator
	**Kristina Beck** Exhibitor Coordinator		**Murray Roberts** Local Organising Committee
	**Lea-Anne Henry** Local Organising Committee		**Eva Turley** Symposium Volunteer
	**Ayla Besemer** Symposium Volunteer		**Ruby Rose Bader** Symposium Volunteer

ISDSC8 Mentoring Scheme

We are mostly grateful to the ISDSC8 participants who have joined the Symposium Mentoring Scheme! The purpose of the scheme is to provide space for more close networking and create a more welcoming environment to our early career participants by linking them with more experienced researchers in the field.

Duddingston Room in the conference centre will be available as a mentor-mentee networking area throughout the ISDSC8, with a dedicated ice breaking session on Monday after lunch.

Any students and early career researchers are welcome to join the scheme as mentees and anyone willing to join as a mentor – please come to the registration desk!

Preliminary list of ISDSC8 Symposium Mentors

Name of mentor	*Affiliation*
Amanda W.J. Demopoulos	U.S. Geological Survey
Andrea Quattrini	Smithsonian National Museum of Natural History
Cheryl Morrison	US Geological Survey
Covadonga Orejas Saco del Valle	Spanish Institute of Oceanography (IEO-CSIC)
Dianne M. Tracey	NIWA
Frank Parrish	NOAA Pacific Islands Fisheries Science Center
Geoff Shester	Oceana
Janessy Frometa	NOAA
Lea-Anne Henry	University of Edinburgh
Marina Carreiro-Silva	Okeanos-Institute of Marine Sciences, University of the Azores, Portugal
Martha Nizinski	NOAA/National Marine Fisheries Service/National Systematics Lab
Murray Roberts	University of Edinburgh
Nadia Santodomingo	University of Oxford / Natural History Museum, London
Narissa Bax	South Atlantic Environmental Research Institute
Paris Stefanoudis	University of Oxford
Rhian Waller	Gothenburg University
Timothy Shank	Woods Hole Oceanographic Institution
Vreni Haussermann	San Sebastian Univesity, Puerto Montt, Chile

ISDSC8 Programme Overview

Please note that the time Zone is BST (GMT + 1)!

Time (GMT+1)	Sunday 28 May	Monday 29 May	Tuesday 30 May	Wednesday 31 May	Thursday 1 June	Friday 2 June
08:00-08:30		Registration	Welcome teas and coffees			
08:30-09:00		Opening Keynote	Announcements			
09:00-09:15			Seascape Genomics and Connectivity	Trophodynamics and Biogeochemical Cycling	Policy, Management, and Conservation	Habitat Mapping and Environmental Controls
09:15-10:30		Evolution, Taxonomy and Systematics				
10:30-11:00		Coffee				
11:00-12:45		Evolution, Taxonomy and Systematics	Coral Reproduction, Biology and Physiology	Deep-Sea Corals in Society	Policy, Management, and Conservation	Habitat Mapping and Environmental Controls
12:45-13:45		Lunch				
13:45-14:15		Posters & Mentor Ice-Breaker	Posters	Workshops	Posters	Posters
14:15-15:00		Coral Reproduction, Biology and Physiology	Geological Approaches		Workshops	Coral Biogeography and Associated Biodiversity
15:00-15:30	Registration					
15:30-16:00				Coffee		
16:00-16:30		Coffee	Coffee	Workshops	Coffee	Coffee
16:30-17:30		Coral Reproduction, Biology and Physiology	Geological Approaches		Workshops	Coral Biogeography and Associated Biodiversity
17:30-18:00						
18:00-19:00	Ice Breaking Reception		Refreshments and posters	Conference Dinner		Prizes and wrap up talk
19:00-19:30						
19:30-21:30						

Sessions

1. Evolution, Taxonomy and Systematics

Chairs: Tina Molodtsova & Jeremy Horowitz

Session time: Monday 29th May 09:15-10:30; Monday 29th May 11:00-12:45, Pentland Room

Mitigating anthropogenic threats towards deep-sea biodiversity is difficult because we lack fundamental knowledge on the number of valid species, their systematic relationships, and their evolutionary histories. Contributions are welcomed on systematics, species delimitation, evolutionary history, and the diversification of corals and their symbionts. New technological and/or methodological approaches including the use of historical DNA are also welcome.

2. Coral Reproduction, Biology and Physiology

Chairs: Rhian Waller & Marina Carreiro Silva

Session time: Monday 29th May 14:15-16:00; Monday 29th May 16:30-18:00; Tuesday 30th May 11:00-12:45, Pentland Room

We welcome contributions on the many facets of deep-sea coral reproduction, larval dispersal including modelling, age and growth studies, biomineralisation, and impacts of multiple stressors including climate change impacts (e.g., effects of ocean acidification and ocean warming) and direct human impacts (fishing and mining). New technological and/or methodological approaches to the field are also welcome, as well as any other aspects of coral biology and physiology.

3. Trophodynamics and Biogeochemical Cycling

Chairs: Laurence de Clippele & Sandra Maier

Session time: Wednesday 31st May 09:00-10:30, Pentland Room

Contributions are invited on, e.g., *in situ* and *in vivo* measurements of deep-sea coral (reef) respiration, nutrient cycling, carbon storage and biomass mapping, benthic-pelagic coupling, food supply and food webs. The session includes work on the organism level and (modelling) at the ecosystem scale and covers deep-sea coral reefs below 200 m water depth, mesophotic reefs and rarophotic reefs. New technological and/or methodological approaches to the field are also welcome.

4. Geological Approaches for Coral Biomineralisation, Habitat and Palaeoceanographic Reconstructions

Chairs: Chelsea Korpanty, Guillem Corbera Pascual, Joseph Stewart & Andrea Burke

Session time: Wednesday 31st May 14:15-16:00; Wednesday 31st May 16:30-18:00, Pentland Room

We welcome contributions from the diverse geological, palaeontological and geochemical fields investigating deep-sea corals, their habitats and ecosystems. Contributions may range from elemental and isotopic analysis of corals, diagenetic effects, sedimentological analysis, mound growth reconstructions, fossil fauna diversity, and palaeoenvironmental and palaeoceanographic proxies. New technological and/or methodological approaches to the geological fields are also encouraged.

5. Coral Biogeography and Associated Biodiversity

Chairs: Andrea Quattrini, Martha Nizinski, Covadonga Orejas

Session time: Friday 2nd June 14:15-16:00; Friday 2nd June 16:30-18:00, Pentland Room

Contributions that focus on the diverse faunal assemblages, including microbiomes, associated with mesophotic and cold-water corals are welcome. This session also welcomes talks that focus on community assembly of coral communities and coral biodiversity and biogeography. We hope that this session emphasises the progress made since the first ISDSC 20 years ago. We also invite presentations that highlight new analytical and technical approaches, such as environmental DNA, to study biodiversity. We hope this session stimulates discussion on existing knowledge gaps surrounding coral-faunal interactions as well as chart a way forward to better address these knowledge gaps, predict impending community shifts, and conserve habitats in the face of global change.

6. Policy, Management, and Conservation

Chairs: Georgios Kazanidis & Anna Gebruk

Session time: Thursday 1st June 09:15-10:30; Thursday 1st June 11:00-12:45, Pentland Room

We welcome varied contributions on, e.g., impacts of human activities on deep-sea coral ecosystems, the identification, management and reporting on vulnerable marine ecosystems (VMEs), deep-sea coral restoration, the designation and effectiveness of marine protected areas (MPAs) and other area-based management tools (ABMTs) such as marine spatial planning, strategic environmental assessment and environmental impact assessment, and adequacy of fisheries and deep-sea mining regulations. Contributions on the latest negotiations e.g., regarding the Biodiversity Beyond National Jurisdiction (BBNJ) Treaty, are also welcomed.

7. Seascape Genomics and Connectivity

Chairs: Alexis Weinnig & Cheryl Morrison

Session time: Tuesday 30th May 09:15-10:30, Pentland Room

We welcome contributions of deep-sea coral population connectivity (i.e., population genetics/genomics) and seascape genomics through the integration of connectivity analysis with environmental factors and larval/circulation models to better understand distribution patterns. We encourage contributions that shed light on how these data can inform best management practices. New technologies and/or methodologies to the field are welcomed.

8. Habitat Mapping and Environmental Controls of Deep-Sea Coral Incidence

Chairs: Rebecca Ross, Tabitha Pearman & Ryan Gasbarro

Session time: Friday 2nd June 09:15-10:30; Friday 2nd June 11:00-12:45, Pentland Room

We welcome contributions on the geology and physicochemical aspects of deep-sea coral habitats, e.g., discoveries of new deep-sea coral habitats, geomorphology, hydrography as well as the use of species distribution and habitat suitability modelling approaches (SDM and HSM, respectively), and drivers of deep-sea coral placement to understand present day and future distribution patterns. New technological and/or methodological approaches to the field are also welcome.

9. Deep-Sea Corals in Society

Chair: Anna Gebruk

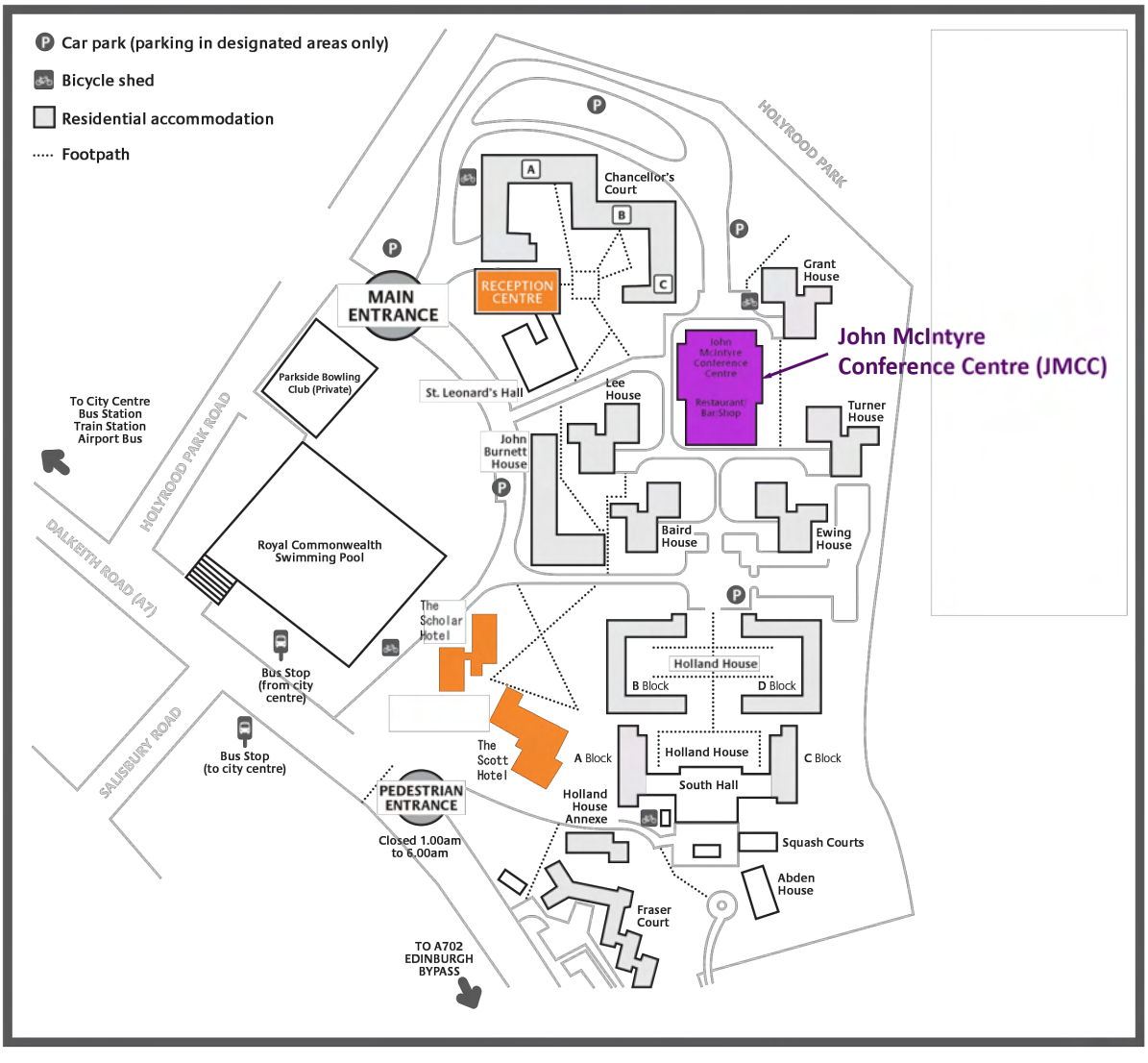
Session time: Thursday 1st June 11:00-12:45, Pentland Room

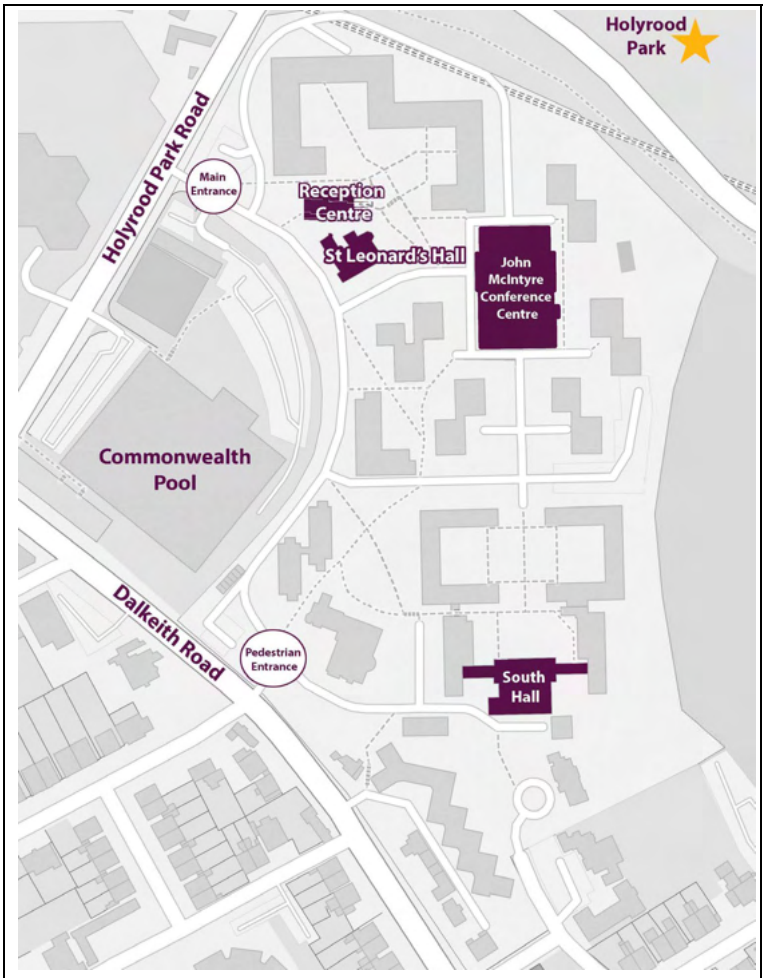
This session welcomes a wide range of contributions on the growth in public engagement and education opportunities since the first Deep-Sea Coral Symposium in 2000, as well as citizen science and the resurgence of submersibles for deep-sea tourism. Also welcomed are contributions on, e.g., open-access data portals, and capacity–building/training needs in an era of deep-sea corals in a changing ocean, ecosystem services and valuations of deep-sea corals.

Venue Details & Useful Links

John McIntyre Conference Centre (JMCC)

The main conference venue is John McIntyre Conference Centre (JMCC) at the Pollock Halls Estate of the University of Edinburgh





Address:

John McIntyre Conference Centre
Pollock Halls Estate
18 Holyrood Park Road
Edinburgh, UK, EH16 5AY

Website:

https://www.uoecollection.com/conferences-events/venue-hubs/pollock-estate/john-mcintyre-conference-centre/

Floorplan:

chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.uoecollection.com/media/2693/jmcc-floorplan-1.pdf

All of the ISDSC8 main sessions, registration, exhibitor area, poster sessions, coffee-breaks and lunches will be within the JMCC building and clearly sign-posted.

The list of the main conference spaces / rooms used throughout the ISDSC8:

Pentland Room, JMCC	Main sessions & workshops
Holyrood Room, JMCC	Workshops / breakouts
Salisbury Room, JMCC	Workshops / breakouts
Duddingston Room, JMCC	Mentor-mentee networking
Prestonfield Room, JMCC	Posters

WiFi

Eduroam WiFi network is available everywhere at the Pollock Halls Estate. For non-eduroam guest WiFi access, please contact the conference registration desk.

Accessibility & special needs

The John McIntyre Conference Centre (JMCC) has ramped/sloped access, and ambulant bathrooms available.

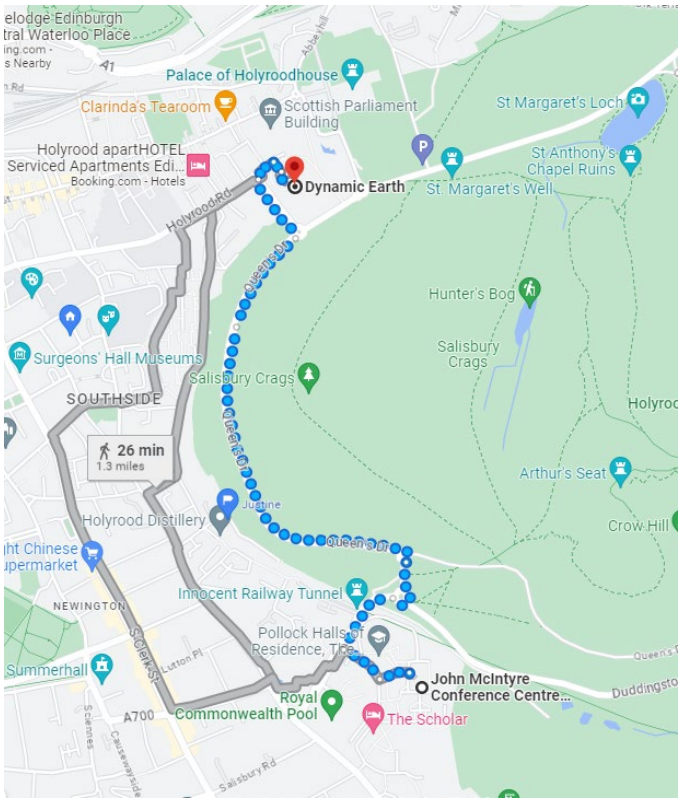
Throughout the ISDSC8 we will have one of the smaller rooms dedicated as a quite space if someone feels the need to take a break from intense networking.

Our lunch menu will be vegetarian with other dietary requirements and allergies clearly labelled.

If you have any other special needs, please do not hesitate to contact isdsc8@ed.ac.uk – we would be delighted to discuss how we could make the conference space more inclusive of all needs!

Dynamic Earth

The public outreach workshop and conference dinner on Wednesday 31 May will be at the Dynamic Earth – a state-of-art science outreach centre near the Holyrood Palace. It is approximately a 25-minute walk from the JMCC through the beautiful Holyrood Park, and we will have conference volunteers leading the groups on both occasions if you would like to join a group walk!



Address:

Dynamic Earth, Holyrood Rd, Edinburgh EH8 8AS

Website:

https://www.dynamicearth.co.uk/

Things to see and do in Edinburgh

The city of Edinburgh is steeped in rich history, and a short summary here would not do it justice. Instead, we have a series of links below to tourism guides of the city and a few recommendations of our own.

- Arthurs Seat. This is the ancient volcano running next to the city. It is a lovely walk up it and the views are spectacular.
- Open top bus tours. These are a great way to see a lot of the city and hear about the history.
- Bagpipers – at any moment if you walk through the old town, or near the Scotts Monument you will likely hear bagpipers playing in the streets.
- Edinburgh has several underground vaults. Access to these is typically through the history and ghost tours, and are worth it to see a very different side to the city not accessible normally. These walking tours also run late into the night as well, so can be joined in the evenings.
- Edinburgh Castle dominates the skyline and is a very impressive venue to visit, even if it is just the terrace in front of it.
- For Harry Potter fans, Tom Riddle's gravestone is in Greyfriars Cemetery, a short walk from the conference venue, and next to a school that some say was the inspiration of Hogwarts.
- National Museum of Scotland in the old town – has something for everyone.

For travel, there are Black Cabs that can be hailed on the street, and the bus service is very good (Lothian bus app for your phone is very useful). Uber is also very popular in the city. However, the city itself is relatively small, and most places are within a 30-minute walking radius from the conference centre.

Some good resources are:

- The Official Guide to Edinburgh- Forever Edinburgh
- Top 13 Things to Do in Edinburgh | VisitScotland

Information for Remote Participants

The ISDSC8 will be streamed online via Zoom. There are 3 Zoom links that will be functional throughout the conference:

1. Link for the main conference sessions – please use this link to join any of the main ISDSC8 science sessions. This is a Zoom webinar, you can type questions in the 'chat' and they will be addressed during the panel discussion session at the end of the session.
2. Link for remote panellists – if you are a remote participant with a pre-recorded presentation in the session, please use this link to join the panel discussion at the end of the session. Please log-in as a speaker using this link from the beginning of the session and our technical moderators will guide you through the next steps.
3. Link for virtual networking space – this is a link for an informal Zoom meeting space, which will be open during the conference lunch- and coffee-breaks, poster sessions, and mentor 'speed-dating' session, you can join the meeting at any time to network with the colleagues online, and we can also arrange virtual break-outs upon request.

Link for main conference sessions

Please click the link below to join the webinar:

- https://us02web.zoom.us/j/86003214407?pwd=dDR3WWhpZCtZOXQvNWFrK1pMc1Vpdz09
- Passcode: 458908

Calendar link for main conference sessions

To add the Symposium Webinar to your calendar - please download and import the following iCalendar (.ics) files to calendar system.

- Daily: https://us02web.zoom.us/webinar/tZItd-qqrz8uGtP-0GlMkXvnmFmQ1IARFWwe/ics?icsToken=98tyKuGurjspGNWRtBmARpwAAoigb-rzmClbjbdt0U_CDw1YWhX4O8RPA-NWMer2
- Topic: ISDSC8 29th May - 2nd June 2023

Link for remote panellists

- https://us02web.zoom.us/j/88394871407?pwd=RUVKQmlyb2twTkUrUkRYS0tydnQ0UT09
- Meeting ID: 883 9487 1407
- Passcode: 915417

Link for virtual networking space

- https://us02web.zoom.us/j/85950834508?pwd=LzhrUFBzZUgvOXBSSTh3VmVoT3JEdz09
- Meeting ID: 859 5083 4508
- Passcode: 107948

Hybrid Workshops Links

Workshop	Time, BST	Zoom Link	Zoom Passcode
1 – Good practices for **estimating damage to deep-sea coral and sponge habitat** from existing bycatch data	Wednesday 31st May 13:45-17:30	https://us02web.zoom.us/j/86151419783?pwd=d2pkWkJwNmRZWithbmJIT0dESG5NZz09	577808
2 – **Image analysis made easy**: introduction to a new machine learning software for automatically measuring species area	Wednesday 31st May 13:45-15:30	https://ed-ac-uk.zoom.us/j/82148208637	L9buF2BJ
3 – BOEM Town Hall: 50 Years of Ocean Science for Decisions in the US Offshore	Wednesday 31st May 13:45-15:30	https://us02web.zoom.us/j/85950834508?pwd=LzhrUFBzZUgvOXBSSTh3VmVoT3JEdz09	107948
4 – Applying data to the challenges of **restoration, protection, and management of deep sea corals**	Thursday 1st June 14:15-16:00	https://us02web.zoom.us/j/86151419783?pwd=d2pkWkJwNmRZWithbmJIT0dESG5NZz09	577808
5 – Creating Vital Metrics for Cold Water Corals: **Establishing an Essential Ocean Variable** (EOV) for Scleractinia and Stylasteridae	Thursday 1st June 14:15-16:00	https://us02web.zoom.us/j/85950834508?pwd=LzhrUFBzZUgvOXBSSTh3VmVoT3JEdz09	107948
6 – **Restoration and Conservation of Deep Sea Corals**. CORDAP results, findings and discussions.	Thursday 1st June 16:30-18:00	https://us02web.zoom.us/j/86151419783?pwd=d2pkWkJwNmRZWithbmJIT0dESG5NZz09	577808
7 – Advancing Achievements Through Increasing **Collaboration in Ocean Sciences Research**	Thursday 1st June 16:30-18:00	https://us02web.zoom.us/j/85950834508?pwd=LzhrUFBzZUgvOXBSSTh3VmVoT3JEdz09	107948

Symposium Running Order

Monday 29 May

08:30 – 09:15 Announcements and Opening Keynote

09:15 – 10:30 EVOLUTION & TAXONOMY

Chairs: Dr Tina Molodtsova & Dr Jeremy Horowitz

- **09:15 – 09:40** (25 min) - Keynote, **Catherine McFadden** 'Coral species, speciation and trait evolution: the promise of phylogenomics'
- **09:40 – 09:50** (10 min) - Full talk, **Steven Auscavitch** 'A genetic reference library for the central Pacific Ocean deep-water Octocorallia and application in eDNA characterization of the benthos'
- **09:50 – 10:00** (10 min) - Full talk, **Meredith Everett** 'Application of RAD-tag sequencing to taxonomic resolution of the Plexauridae on the U.S. West Coast'
- **10:00 – 10:10** (10 min) - Full talk, **Adriana Patricia Rodriguez Bermudez** 'Unravelling the hidden diversity and biogeographical patterns of the golden octocoral *Plumarella*'
- **10:10 – 10:20** (10 min) - Full talk, **Tina Molodtsova** 'Tube anemones of the Northern Hemispher, revised'
- **10:20 – 10:23** (3 min) - Speed talk, **Nelson Manrique-Rodríguez** 'Checklist of Corals from Colombia with Reference to Mesophotic and Deep Sea Records'
- **10:23 – 10:26** (3 min) - Speed talk, **Roger Aires** 'Diversity and Ecology of deep-sea Zoantharia in the North Atlantic: preliminary results'
- **10:26 – 10:30** (4 min) - Morning closing remarks

10:30 – 11:00 Coffee (30 min)

11:00 – 12:45 EVOLUTION & TAXONOMY

Chairs: Dr Tina Molodtsova & Dr Jeremy Horowitz

- **11:00 – 11:20** (20 min) - Keynote, **Claudia Francesca Vaga** 'Filling in the gaps: description of novel families of azooxanthellate corals (Anthozoa, Scleractinia) and new insights on the evolutionary history of the order'
- **11:20 – 11:30** (10 min) - Full talk, **Declan Morrissey** 'Bamboozled! Resolving deep evolutionary nodes within the phylogeny of bamboo corals (Octocorallia; Order Scleralcyonacea)'
- **11:30 – 11:40** (10 min) - Full talk, **Upasana Ganguly** 'Phylogenomic study of sea pens with focus on the evolutionary history of specialized rock-inhabiting sea pens'
- **11:40 – 11:50** (10 min) - Full talk, **Jaymes Awbrey** 'Evolution and Phylogenomics of 'Acanthogorgiidae' (Octocorallia: Malacalcyonacea)'
- **11:50 – 12:00** (10 min) - Full talk, **Jeremy Horowitz** 'Bathymetric evolution of black corals through deep time'
- **12:00 – 12:10** (10 min) - Full talk, **Adrien Tran Lu Y** 'Colonial and solitary congeners? Comparative genomics of *Desmophyllum pertusum* and *D. dianthus*'
- **12:10 – 12:13** (3 min) - Speed talk, **Andrea Quattrini** 'Skimming and targeting genomes for systematics and population genetics of deep-sea corals'
- **12:13 – 12:16** (3 min) - Speed talk, **Márcio Coelho** 'Sequencing of coral mitochondrial genomes: a new genetic resource based on long-read sequencing for genome assembly and to support species identification'

- **12:16 – 12:19** (3 min) - Speed talk, **Tina Molodtsova** 'One of the deepest genera of Antipatharia: taxonomic position revealed and revised'
- **12:19 – 12:22** (3 min) - Speed talk, **Mary Deere** 'What is that white branchy coral? Or: Challenges of in situ identification of octocorals'
- **12:22 – 12:25** (3 min) - Speed talk, **Les Watling** 'Functional Morphology of Octocoral Polyps: First Looks'
- **12:25 – 12:45** (20 min) - Panel Q&A with all speakers

12:45 – 13:45 Lunch (1 hour)
13:45 – 14:15 Posters (30 min)

14:15 – 16:00 BIOLOGY & REPRODUCTION

Chairs: Rhian Waller & Marina Carreiro Silva

- **14:15 –14:40** (25 min) - Keynote, **Meri Bilan** 'Bottom trawling induced sediment resuspension effects on physiology of six cold-water corals'
- **14:40 – 14:50** (10 min) - Full talk, **Inês Martins** 'Copper effects on cold-water octocorals under a climate change scenario: A land-based experiment towards environmental risk assessment for deep-sea mining'
- **14:50 – 15:00** (10 min) - Full talk, **Mathilde Chemel** 'Effects of temperature on cold-water coral holobiont in the Atlantic Ocean'
- **15:00 – 15:10** (10 min) - Full talk, **Joe Stewart** 'Stylasterid corals build aragonite skeletons in undersaturated water despite low pH at the site of calcification'
- **15:10 – 15:20** (10 min) - Full talk, **Jorge Corrales-Guerrero** 'Using natural analogues to evaluate the resilience of cold-water coral reefs to changes in environmental conditions'
- **15:20 – 15:23** (3 min) - Speed talk, **Alfredo Veiga** 'A Multipurpose Aquaria Experimental Set Up Studying the Interaction of Environmental Stressors in a Cold-Water Coral Species'
- **15:23 – 15:26** (3 min) - Speed talk, **Giovanni Sanna** 'Phenotypic responses of *Desmophyllum pertusum* to oceanographic factors across the Atlantic'
- **15:26 – 15:29** (3 min) - Speed talk, **Kristina Beck** 'Ontogenetic differences in the response of the cold-water coral *Caryophyllia huinayensis* to ocean acidification, warming and food availability'
- **15:29 – 15:32** (3 min) - Speed talk, **Julia Johnstone** 'Antarctic deep-sea coral larvae may be resistant to end-century ocean warming'
- **15:32 – 15:35** (3 min) - Speed talk, **Beatriz Arzeni** 'Multiple stressor impacts of deep-sea mining and ocean acidification on *Antipathella wollastoni* (Cnidaria: Antipatharia) under hyperbaric conditions'
- **15:35 – 16:00** (25 min) - Panel Q&A with all speakers
- **16:00 – 16:30** Coffee (30 min)

16:30 – 18:00 BIOLOGY & REPRODUCTION

Chairs: Rhian Waller & Marina Carreiro Silva

- **16:30 – 16:55** (25 min) - Keynote, **Franck Lartaud** 'Cold-water corals ecology and response to main threats – an overview of 10 years of experiment in a Mediterranean canyon'
- **16:55 – 17:05** (10 min) - Full talk, **Kathryn Murray** 'Behavioural and mucosal responses of the cup coral *Flabellum* (*Ulocyathus*) alabastrum to barite and bentonite sedimentation'
- **17:05 – 17:15** (10 min) - Full talk, **Maria Rakka** 'Resource acquisition of the deep-sea octocoral *Viminella flagellum* under ocean acidification and varying food availability'

- **17:15 – 17:25** (10 min) - Full talk, **Cristina Gutiérrez-Zárate** 'Assessing the Single and Multiple Effects of Warming, Acidification and Deoxygenation on the Ecophysiology of the Cold-Water Coral *Dendrophyllia cornigera*'
- **17:25 – 17:35** (10 min) - Full talk, **Marina Carreiro-Silva** 'Single and multiple stressor impacts of deep-sea mining and climate change on cold-water corals'
- **17:35 – 17:38** (3 min) - Speed talk, **Lara M. Beckmann** 'Deepwater coral and sponge gardens in Alaska: Reproduction and recruitment in keystone species'
- **17:38 – 17:41** (3 min) - Speed talk, **Magali Zbinden** 'Pressurised aquaria for long-term experiments on deep-sea corals'
- **17:41 – 18:00** (19 min) - Panel Q&A with all speakers

Tuesday 30 May

08:45 – 10:30 GENOMICS

Chairs: Alexis Weinnig & Cheryl Morrison

- **08:45 – 09:05** (20 min) - Keynote, **Santiago Herrera** 'Seascape Genomics Reveals Metapopulation Connectivity Networks of Deep-Sea Corals in the Northern Gulf of Mexico'
- **09:05 – 09:15** (10 min) - Full talk, **Cheryl Morrison** 'Can high genetic connectivity and deep water refugia save a keystone species, the red tree coral (*Primnoa pacifica*) in SE Alaska, from a reproductive dead end?'
- **09:15 – 09:25** (10 min) - Full talk, **Alexis Weinnig** 'Genomic differentiation among *Desmophyllum pertusum* populations from Continental margins of the United States'
- **09:25 – 09:35** (10 min) - Full talk, **Maria Belen Arias** 'Connectivity patterns are species dependent in Southern Ocean deep-sea corals'
- **09:34 – 09:45** (10 min) - Full talk, **Jessica Gordon** 'Population and Seascape Genomics of the Deep-sea Octocoral *Acanella arbuscula*'
- **09:45 – 09:48** (3 min) - Speed talk, **Oenone Scott** 'A Practical Guide to Ocean Models for use in Ecological Study'
- 'Population and Seascape Genomics of the Deep-sea Octocoral *Acanella arbuscula*'
- **09:48 – 09:51** (3 min) - Speed talk, **Syrmalenia Kotronaki** 'Population genomics of the black coral *Antipathes furcata (*Cnidaria: Antipatharia) in the mesophotic Gulf of Mexico'
- **09:51 – 10:11** (20 min) - Keynote, **Sophie Araund-Haond** 'Seascape genomics: merging habitat and biophysical modelling with genomic data to improve conservation and restoration plans'
- **10:11 – 10:30** (19 min) - Panel Q&A with all speakers

10:30 – 11:00 Coffee (30 min)

11:00 – 12:45 BIOLOGY & REPRODUCTION

Chairs: Rhian Waller & Marina Carreiro Silva

- **11:00 – 11:25** (25 min) - Keynote, **Julia Johnstone** 'A review of current knowledge on reproductive and larval processes of deep-sea corals'
- **11:25 – 11:35** (10 min) - Full talk, **Ann I. Larsson** 'Turbulence affects larval vertical swimming in the cold-water coral *Lophelia pertusa*'
- **11:35 – 11:45** (10 min) - Full talk, **Ignacia Acevedo-Romo** 'Larval ecology of *Desmophyllum dianthus* in the Chilean fjords'
- **11:45 – 11:55** (10 min) - Full talk, **Christina Egger** 'Comparative study of reproductive traits of a West Atlantic Gorgonian (Paramuricea) species after recent speciation'

- **11:55 – 12:05** (10 min) - Full talk, **Jenny Beaumont** 'Reproductive mode, larval settlement and development of a New Zealand deep-sea stony coral, *Goniocorella dumosa*'
- **12:05 – 12:08** (3 min) - Speed talk, **Lauren N. Rice** 'Methods for estimating the reproductive capacity of morphologically complex cold-water corals'
- **12:08 – 12:11** (3 min) - Speed talk, **Mathilde Chemel** 'Reproductive biology of the two main reef-building cold-water coral species (*Desmophyllum pertusum* and *Madrepora oculata*) in the Mediterranean Sea'
- **12:11 – 12:14** (3 min) - Speed talk, **Gal·la Edery** 'The importance of the sexual reproductive condition of octocorals for the success of ecological restoration'
- **12:14 – 12:17** (3 min) - Speed talk, **Ana Navarro Campoy** 'Early-life stages of the cold-water gorgonian coral *Primnoella chilensis*'
- **12:17 – 12:20** (3 min) - Speed talk, **Anaïs Sire de Vilar** 'Effects of various abiotic stressors on the early life stages of the cold-water coral *Lophelia pertusa*'
- **12:20 – 12:45** (25 min) - Panel Q&A with all speakers

12:45 – 13:45 Lunch (1 hour)
13:45 – 14:15 Posters (30 min)

14:15 – 16:00 GEOLOGICAL APPROACHES - CORAL CHEMISTRY AS A PALEO-ARCHIVE

Chairs: Chelsea Korpanty, Guillem Corbera Pascual, Joseph Stewart & Andrea Burke

- **14:15 –14:45** (30 min) - Keynote, **Norbert Frank** 'The Cold-Water Corals View of the Thermocline Atlantic since the Last Glacial Maximum'
- **14:45 – 14:55** (10 min) - Full talk, **Ashley Davis** 'Reconstructing the last millenium of ocean biogeochemistry around Aotearoa New Zealand using deep-sea black corals'
- **14:55 – 15:05** (10 min) - Full talk, **Daniel Sinclair** 'Trace Elements in Black Corals – Investigating Potential New Palaeoceanographic Proxies'
- **15:05 – 15:15** (10 min) - Full talk, **Evan Edinger** 'Calculating calcium carbonate production of a colonial scleractinian coral community in the northern Bay of Biscay: short-term and long-term estimates'
- **15:15 – 15:18** (3 min) - Speed talk, **Frank Parrish** 'Elemental composition of the proteinaceous skeleton of Hawaiian Gold Coral (*Kulamanamana haumeaae*)'
- **15:18 – 15:21** (3 min) - Speed talk, **James Kershaw** 'Controls on stylasterid skeletal Mg/Ca and Li/Ca ratios'
- **15:21 – 15:24** (3 min) - Speed talk, **Lélia Matos** 'Deep-sea corals as archives of export production on a multiproxy study'
- **15:24 – 15:27** (3 min) - Speed talk, **Laura Piccirillo** 'Growth rates and ages of two deep-sea bamboo coral species from the Northwest Atlantic'
- **15:27 – 15:30** (3 min) - Speed talk, **Gervaise Barre** 'Evaluating the thermal adaptation of *Lophelia pertusa*: Insights from paleo-reconstructions and present-day thermal amplitude'
- **15:30 – 15:33** (3 min) - Speed talk, **Rodrigo da Costa Portilho Ramos** 'Cold-water coral response to past expansion of the shallow oxygen minimum zone off Angola margin
- **15:33 – 16:00** (27 min) - Panel Q&A with all speakers

16:00 – 16:30 Coffee (30 min)

16:30 – 18:00 GEOLOGICAL APPROACHES - BIOLOGICAL RECORDS OF PAST OCEAN ENVIRONMENTS

Chairs: Chelsea Korpanty, Guillem Corbera Pascual, Joseph Stewart & Andrea Burke

- **16:30 – 17:00** (30 min) - Keynote, **Claudia Wienberg** 'Cold-water coral mounds - unique archives of reef growth in the geological past: What do we know after 25 years of research?'

- **17:00 – 17:10** (10 min) - Full talk, **Jürgen Titschack** 'AMOC-driven intermediate water-mass stratification favoured cold-water coral mound formation off Mauritania since the last glacial'
- **17:10 – 17:20** (10 min) - Full talk, **Dierk Hebbeln** 'Deglacial development of cold-water corals off northern Argentina driven by variability of the Atlantic Meridional Overturning Circulation'
- **17:20 – 17:30** (10 min) - Full talk, **Andy Wheeler** 'Are Submarine Canyons Refugia for Scleractinian Cold-water Corals in Glacial Periods?: Evidence from the Porcupine Bank Canyon, NE Atlantic'
- **17:30 – 17:33** (3 min) - Speed talk, **Narissa Bax** 'Exploring the Mesophotic Zone: Investigating Coral Gardens as Model Habitats in the Falkland Islands'
- **17:33 – 17:36** (3 min) - Speed talk, **Chelsea Korpanty** 'Decline in cold-water coral growth promotes molluscan diversity: A paleontological perspective from a cold-water coral mound in the western Mediterranean Sea'
- **17:36 – 17:39** (3 min) - Speed talk, **Ruby Schwartz** 'Temporal Diversity Dynamics Of Benthic Invertebrates In A Quaternary Cold-Water Coral Mound: Alboran Sea (Mediterranean Sea)'
- **17:39 - 17:42** (3 min) - Speed talk, **Guillem Corbera** 'Intermediate water mass circulation variations during the last glacial cycle and its potential role in controlling cold-water coral mound development off Tunisia'
- **17:42 – 18:00** (18 min) - Panel Q&A with all speakers

Wednesday 31 May

08:45 – 10:30 TROPHODYNAMICS AND BIOGEOCHEMICAL CYCLING

Chairs: *Laurence de Clippele & Sandra Maier*

- **08:45 – 09:05** (20 min) – Keynote, **Claudio Richter** 'Coupling of plankton, hydrodynamics and cold-water coral reefs'
- **09:05 – 09:25** (20 min) – Keynote, **Sandra Maier & Laurence De Clippele** 'Novel insights and approaches towards a deeper understanding of marine animal forest functioning'
- **09:25 – 09:35** (10 min) – Full talk, **Amanda Demopoulos** 'Trophic structure of deep-sea coral habitats along the U.S. Atlantic margin'
- **09:35 – 09:45** (10 min) – Full talk, **Beatriz Vihna** 'Trophic ecology of cold-water coral habitats of the Cabo Verde islands (NW Africa)'
- **09:45 – 09:55** (10 min) – Full talk, **Luis Greiffenhagen** 'Baseline ecological investigation of Fjordic Cold-Water Coral Reef Habitats: Biomass and Ecosystem Functions of five key-species comparing Sill Reefs to Wall Reefs'
- **09:55 – 09:58** (3 min) – Speed talk, **Evert de Froe** 'Food supply mechanisms towards a cold-water coral reef at Rockall Bank, North-East Atlantic Ocean.'
- **09:58 – 10:01** (3 min) – Speed talk, **Kostas Kiriakoulakis** 'Tracing particulate organic matter pathways in deep-sea ecosystems: Food supply and partitioning in Whittard canyon vulnerable marine ecosystems dominated by filter feeders'
- **10:01 – 10:04** (3 min) – Speed talk, **Wilder Greenman** 'Growth rates and trophic niches of deep-water corals in protected areas off Nova Scotia, Canada'
- **10:04 – 10:07** (3 min) – Speed talk, **Anna van der Kaaden** 'Tiger reefs in the deep sea: self-organised regular patterns in cold-water coral reefs'

- **10:07 – 10:10** (3 min) – Speed talk, **Narissa Bax** 'Uncovering the Blue Carbon Potential of the Burdwood Bank: Insights from Seafloor Ecosystem Engineers and Benthic Surveys'
- **10:10 – 10:30** (20 min) – Panel Q&A with all speakers

10:30 – 11:00 Coffee (30 min)

11:00 – 12:45 CORALS & SOCIETY

Chair: *Anna Gebruk*

- **11:00 – 11:20** (20 min) – Keynote, **Hermione Cockburn '**Discover the Deep: raising levels of ocean literacy via Scotland's deep-sea heritage'
- **11:20 – 11:30** (10 min) – Full talk, **Jason Cleland** 'A cross-sectoral research collaboration to study benthic fauna at the world's most famous deep-sea wreck, and a newly discovered ridge feature, during the OceanGate 2022 Titanic Expedition'
- **11:30 – 11:40** (10 min) – Full talk, **Ayla Besemer** 'Lophelia.org - a case study of the open-access educational platform on deep-sea corals'
- **11:40 – 11:50** (10 min) – Full talk, **Nina Ramos** 'Increasing accessibility to deep-sea science through 3D photogrammetry and museum collections'
- **11:50 – 12:00** (10 min) - Full talk, **Jaret Bilewitch** 'Using fisheries bycatch to document deep-sea octocoral diversity in Aotearoa New Zealand'
- **12:00 – 12:10** (10 min) - Full talk, **Jennifer Selgrath** 'Quantifying the Economic Value of Deep-Sea Corals and Sponges'
- **12:10 – 12:20** (10 min) - Full talk, **Lisa Gilbane** 'Deep-sea coral science and applications in offshore energy and mineral management within the United States'
- **12:20 – 12:23** (3 min) - Speed talk, **Robert McGuinn** 'US National Oceanic and Atmospheric Administration's National Database for Deep-sea Corals and Sponges: A freely available resource for deep-sea researchers and resource managers'
- **12:23 – 12:45** (22 min) – Panel Q&A with all speakers

12:45 – 13:45 Lunch (1 hour)

13:45 – 15:30 WORKSHOPS

15:30 – 16:00 Coffee (30 min)

16:00 – 17:30 WORKSHOPS

Evening programme (Dynamic Earth)

- **18:00 – 18:30** – Arrive and fizz
- **18:30 – 19:10** – Gallery walk though
- **19:10 – 19:30** – 'Beneath the waves there are many dominions yet to be visited and kingdoms to be discovered': Cold-water coral and the 19th-century quest to explore the ocean's depths – Keynote address by **Erika Jones**
- **19:40 – 21:30** – Dinner
- **21:30 – 22:30** – Ceilidh

Thursday 1 June

08:45 – 10:30 POLICY, MANAGEMENT, AND CONSERVATION

Chairs: Georgios Kazanidis & Anna Gebruk

- **08:45 – 09:05** (20 min) – Keynote, **Christine Gaebel** 'Integrating marine science under the BBNJ Agreement: Stakeholder perceptions on the Scientific and Technical Body'

- **09:05 – 09:15** (10 min) – Full talk, **Lyndsey Holland** 'New Zealand's Conservation Services Programme: using fisheries levy-based research to understand, manage and mitigate the impacts of commercial fishing on protected corals'
- **09:15 – 09:25** (10 min) – Full talk, **Craig Stuart** 'Comparative Analysis of Deep-Sea Coral and Sponge Video Annotations'
- **09:25 – 09:35** (10 min) - Full talk, **Kelly Martin** 'Mesophotic and Deep Benthic Community Restoration in the Gulf of Mexico following the Deepwater Horizon Oil Spill: Planning Outcomes and Implementation Progress'
- **09:35 – 09:45** (10 min) – Full talk, **Kristopher Benson** 'Organizing and finding meaning in complex data streams generated by restoration projects for Mesophotic and Deep Benthic Communities in the Gulf of Mexico following the Deepwater Horizon Oil Spill'
- **09:45 – 09:55** (10 min) – Full talk, **Lizzie Duncan** 'Key strategies and outcomes of the 2018 US West Coast Deep-Sea Coral Initiative'
- **09:55 – 09:58** (3 min) - Speed talk, **Janessy Frometa** 'Restoring the Gulf of Mexico's Mesophotic and Deep Sea Corals: species prioritization and fieldwork to date'
- **09:58 – 10:01** (3 min) – Speed talk, **Verena Häussermann** 'Cold-water coral forests (Cnidaria, Anthozoa and Hydrozoa) of Chilean Patagonia: unique deep-water emergent benthic communities threatened by aquaculture and climate change'
- **10:01 – 10:04** (3 min) – Speed talk, **Jordi Grinyo** 'Active and participatory ecological restoration of anthropogenically-impacted Benthic Ecosystems in the Mediterranean through partnership with local fishers: The Life ECOREST project'
- **10:04 – 10:07** (3 min) – Speed talk, **Heather Coleman** 'Prioritizing deep-sea corals as part of the National Strategy for Mapping, Exploring, and Characterizing U.S. Waters'
- **10:07 – 10:10** (3 min) - Speed talk, **Thomas Hourigan** 'Coral and sponge communities of the Aleutian Archipelago: Dense, diverse and vulnerable'
- **10:10 – 10:30** (20 min) – Panel Q&A with all speakers

10:30 – 11:00 Coffee (30 min)

11:00 – 12:45 POLICY, MANAGEMENT, AND CONSERVATION

Chairs: Georgios Kazanidis & Anna Gebruk

- **11:00 – 11:20** (20 min) - Keynote, **Telmo Morato** 'Improved deep-sea biodiversity assessments can inform conservation and sustainable management of deep-sea ecosystems'
- **11:20 – 11:30** (10 min) - Full talk, **Sandra Maier** 'The coldest of their kind: Cold-water coral research and management in Greenland'
- **11:30 – 11:40** (10 min) - Full talk, **Geoff Shester** 'Protecting Deep-Sea Corals from Non-trawl Groundfish Fishing Gears in the Southern California Bight, USA'
- **11:40 – 11:50** (10 min) - Full talk, **Megan Davies** 'Patterns of deepsea coral and sponge ecological monitoring groups on Northeast Pacific seamounts: Management Implications'
- **11:50 – 12:00** (10 min) - Full talk, **Tabitha Pearman** 'The Vulnerable Marine Ecosystems Project - South-West Atlantic deep sea'
- **12:00 – 12:10** (10 min) - Full talk, **Amy Baco-Taylor** 'Fisheries Impacts on Precious Coral Distributions and Population Genomics on Seamounts of the Northwestern Hawaiian Islands and Emperor Seamount Chain'
- **12:10 – 12:13** (3 min) - Speed talk, **Qian Liu** 'Deep-sea coral geochemistry and its implications for coral conservation'
- **12:13 – 12:16** (3 min) - Speed talk, **Guarani Cavalcanti** 'SISCAP Project – Testing new monitoring tools for cold-water coral environments in oil and gas E&P areas in Brazil'
- **12:16 – 12:19** (3 min) - Speed talk, **Anita Tullrot** 'Method development for cold-water coral reef habitat restoration in Sweden - the LIFE Lophelia project'
- **12:19 – 12:45** (26 min) - Panel Q&A with all speakers

Friday 2 June

08:45 – 10:30 MAPPING & ENVIRONMENTAL CONTROLS

Chairs: Rebecca Ross, Tabitha Pearman & Ryan Gasbarro

- **08:45 – 09:10** (25 min) - Keynote, **Veerle Huvenne** 'Location, location, location: habitat mapping of cold-water corals, and what we can learn from it'
- **09:10 – 09:20** (10 min) - Full talk, **Eliza Fragkopoulou** 'Global redistribution of cold-water coral species leading to widespread community turnover under climate change'
- **09:20 – 09:30** (10 min) - Full talk, **Jonatan Marquez** 'Joint species distribution modelling of the deep-sea benthic communities of the Norwegian and Barents Sea'
- **09:30 – 09:40** (10 min) - Full talk, **Nissa Kreidler** 'Distributions of Deep-Sea Coral and Sponge Species are primarily influenced by depth and water currents'
- **09:40 – 09:50** (10 min) - Full talk, **Arliss Winship** 'Determining the effects of sampling design and sample size on the accuracy and precision of deep-sea coral distribution models through computer simulations'
- **09:50 – 10:00** (10 min) - Full talk, **Matthew Poti** 'Predicting the distribution and biodiversity of deep-sea corals at regional scales using hierarchical community occupancy models'
- **10:00 – 10:03** (3 min) - Speed talk, **Ryan Gasbarro** 'Modeling climate change effects on the global distribution of framework-forming cold-water corals and reefs'
- **10:03 – 10:06** (3 min) - Speed talk, **David Price** 'Investigating cold-water coral communities found on submarine vertical walls (cliffs) around the Azores'
- **10:06 – 10:09** (3 min) - Speed talk, **Kelsey Archer Barnhill** 'Quantifying Live and Dead Proportions of *Solenosmilia variabilis* Colonies in New Zealand Waters'
- **10:09 – 10:30** (21 min) - Panel Q&A with all speakers

10:30 – 11:00 Coffee (30 min)

11:00 – 12:45 MAPPING & ENVIRONMENTAL CONTROLS

Chairs: Rebecca Ross, Tabitha Pearman & Ryan Gasbarro

- **11:00 – 11:25** (25 min) - Keynote, **Fanny Girard** 'Environmental and topographic influences on deep-sea coral and sponge community distribution'
- **11:25 – 11:35** (10 min) - Full talk, **Lisa Skein** 'Approaches to dealing with data paucity and class imbalance in cold-water coral predictive modelling: a case-study from the South Atlantic'
- **11:35 – 11:45** (10 min) - Full talk, **Laurence De Clippele** 'Using the novel CoMMa toolbox to map and characterize coral mounds across the Atlantic Ocean'
- **11:45 – 11:55** (10 min) - Full talk, **Savannah Goode** 'Predicted recovery of megabenthic communities on a New Zealand seamount up to 200 years post-fisheries closure'
- **11:55 – 12:05** (10 min) - Full talk, **Johanne Vad** 'Characterisation of coral and sponge community distribution and structure in the Davis Strait'
- **12:05 – 12:08** (3 min) - Speed talk, **Valeria Palummo** 'Effect of environmental and anthropogenic factors on the distribution and co-occurrence of cold-water corals'
- **12:08 – 12:11** (3 min) - Speed talk, **Lene Buhl-Mortensen** 'Cold-water coral reefs in the Mauritania/Senegal region'
- **12:11 – 12:14** (3 min) - Speed talk, **Julie Tourolle** 'MARLEY: An autonomous platform to monitor deep-sea coral behavioural phenology as a high-frequency essential biodiversity variable'

- **12:14 – 12:17** (3 min) - Speed talk, **Morgan Will** 'Validation of Species Distribution Models in the Mesophotic Zone of the Pinnacles Trend, Northeastern Gulf of Mexico'
- **12:17 – 12:20** (3 min) - Speed talk, **Larissa Oliveira** 'Analysis Of high-resolution photogrammetry And Terrain Descriptors to understand Cold-Water Coral Spatial Relationships'
- **12:20 – 12:45** (25 min) - Panel Q&A with all speakers

12:45 – 13:45 Lunch (1 hour)
13:45 – 14:15 Posters (30 min)

14:15 – 16:00 CORAL BIOGEOGRAPHY AND ASSOCIATED BIODIVERSITY

Chairs: Andrea Quattrini, Martha Nizinski, Covadonga Orejas

- **14:15 –14:40** (25 min) - Keynote, **Paris Stefanoudis** 'Biodiversity and functional shifts of reef benthic communities across depth in the Western Indian Ocean'
- **14:40 – 14:50** (10 min) - Full talk, **Jordi Grinyo** 'Community dynamics of a *Desmophyllum pertusum* reef on the Lofoten-Vesterålen shelf (Norway)'
- **14:50 – 15:00** (10 min) - Full talk, **Jill Bourque** 'Recovery trajectories of coral-associated macrofaunal communities impacted by the Deepwater Horizon oil spill a decade later'
- **15:00 – 15:10** (10 min) - Full talk, **Marion Boulard** 'Sea pen and related soft-bottom habitats as nurseries for four abundant groundfish taxa in a marine protected area'
- **15:10 – 15:20** (10 min) - Full talk, **Poppy Clark** 'Automated Identification of Surface Area to Evaluate Coral-Sponge Interactions'
- **15:20 – 15:30** (10 min) - Full talk, **Luke McCartin** 'Nuclear eDNA Sequencing to Study Mesophotic and Deep-sea Anthozoan Corals'
- **15:30 – 15:33** (3 min) - Speed talk, **Cristina Cedeño-Posso** 'Deep-sea corals in two of Colombia's newest marine protected areas'
- **15:33 – 15:36** (3 min) - Speed talk, **Hammoud El Vadhel '**The fauna associated with cold water corals in the border between Mauritania and Senegal'
- **15:36 – 15:39** (3 min) - Speed talk, **Daniela Pica** 'Global Distribution of Stylasterid Corals: Updated Insights from Family to Species Level'
- **15:39 – 15:41** (3 min) - Speed talk, **Valeria Palummo** 'Bamboo coral *Isidella elongata* (Cnidaria: Keratoisididae): New evidence on their ecological role and vulnerability in the Mediterranean Sea'
- **15:41 – 16:00** (19 min) - Panel Q&A with all speakers

16:00 – 16:30 Coffee (30 min)

16:30 – 18:00 CORAL BIOGEOGRAPHY AND ASSOCIATED BIODIVERSITY

Chairs: Andrea Quattrini, Martha Nizinski, Covadonga Orejas

- **16:30 – 16:40** (10 min) - Full talk, **Martha Nizinski**, 'Are there broad-scale patterns in diversity and abundance of deep-sea coral associates? A case study in the western North Atlantic.'
- **16:40 – 16:50** (10 min) - Full talk, **Samuel Vohsen** 'A Seascape Approach to the Microbial Biogeography of Mesophotic and Deep-sea Octocorals'
- **16:50 – 17:00** (10 min) - Full talk, **Hye-Won Moon** 'Diversity and distribution of black corals (Anthozoa: Antipatharia) from Korea with notes on a new cold-water species'
- **17:00 – 17:10** (10 min) - Full talk, **Teresa Cerqueira** 'Deep-sea coral microbiome responses to environmental changes'
- **17:10 – 17:20** (10 min) - Full talk, **Guadalupe Bribiesca-Contreras** 'Diversity of polymetallic nodule-associated corals in the Clarion-Clipperton Zone, Pacific Ocean'

- **17:20 – 17:30** (10 min) - Full talk, **Akacia Halliday-Isaac** 'Distribution and Diversity of Corallicolids in Deep-sea Octocorals of the North Atlantic'
- **17:30 – 17:33** (3 min) - Speed talk, **Meri Bilan** 'Coral communities along the canyon walls of Blanes Canyon (NW Mediterranean Sea)'
- **17:33 – 17:36** (3 min) - Speed talk, **Nicole Pittoors** 'Characterizing Biodiversity of Mesophotic Reef Benthos Using Autonomous Reef Monitoring Structures (ARMS)'
- **17:36 – 17:39** (3 min) - Speed talk, **Heidi Meyer** 'To Higher Places – *Gersemia rubiformis* using large demosponges as a perch'
- **17:39 – 17:42** (3 min) - Speed talk, **Erik Cordes** 'A brief survey of the cold-water coral reefs of the world'
- **17:42 – 18:00** (18 min) - Panel Q&A with all speakers

Workshops & Side-Events

ISDSC8 Workshops

Wednesday 31 May				Thursday 1 June			
13:45–15:30	Good practices for estimating damage to deep-sea coral and sponge habitat from existing bycatch data	**Image analysis made easy**: introduction to a new machine learning software for automatically measuring species area	BOEM **Town Hall**: 50 Years of Ocean Science for Decisions in the US Offshore	14:15-16:00	Applying data to the challenges of **restoration, protection, and management** of deep-sea corals	Creating Vital Metrics for Cold Water Corals: Establishing an **Essential Ocean Variable** (EOV) for Scleractinia and Stylasteridae	
15:30-16:00	Coffee			16:00-16:30	Coffee		
16:00-17:30	Good practices for estimating damage to deep-sea coral and sponge habitat from existing bycatch data	**Public engagement for ocean literacy**: approaches and implementation (**Dynamic Earth**)		16:30-18:00	**Restoration and Conservation** of Deep Sea Corals. CORDAP results, findings and discussion	Exploring Opportunities and Implications for Scientists under the **BBNJ Agreement**: A Roundtable Discussion	Advancing Achievements Through Increasing Collaboration in Ocean Sciences Research

Locations:

Pentland Room, JMCC – Conference Centre
Holyrood Room, JMCC – Conference Centre
Salisbury Room, JMCC – Conference Centre
Dynamic Earth

- **Good practices for estimating damage to deep-sea coral and sponge habitat from existing bycatch data**

Chair: Heather Coleman, NOAA

Date and time: Wednesday 31st May 13:45-17:30. Pentland Room (JMCC)

Description:

A common problem internationally is how to best interpret data on bycatch of deep-sea corals and sponges to understand and manage the effects of fishing gear on habitats. Therefore, this workshop is guided by the following goals: (1) Share current good practices regarding the use of fishery-dependent and fishery-independent bycatch data to improve our ability to locate and understand the effects of fishing gear on deep-sea corals and sponges; (2) Identify methods of reducing bycatch and gear interactions through commercial fishery management; and (3) Identify specific research questions and knowledge gaps that need to be addressed for the estimation of fishing impacts and development of management-based bycatch reduction. For this workshop, fishing gears to be considered include trawls, longlines, pots, traps, and others that touch on or near the seafloor. We consider bycatch as coral or sponge material that is brought on board. We hope that sharing international strategies for collecting and interpreting bycatch data will help scientists and managers improve methods of analysis that can

inform policies. Desired outcomes from this workshop include a set of relevant international references and a paper summarizing international strategies and agreed-upon good practices.

Format: hybrid

- Zoom Meeting Link: https://us02web.zoom.us/j/86151419783?pwd=d2pkWkJwNmRZWithbmJIT0dESG5NZz09
- Passcode: 577808

- **Image analysis made easy: introduction to a new machine learning software for automatically measuring species area**

Chairs: Poppy Clark, Abraham Smith, Laurence De Clippele

Date and time: Wednesday 31st May 13:45-15:30. Holyrood Room (JMCC)

Description:

This workshop will present an open-source and user-friendly machine learning tool capable of measuring species surface area from images. The workshop will demonstrate the tool's key features, such as its intuitive training process, in-built metrics calculator and model-sharing capabilities. During the workshop, attendees will be guided through the installation of the tool and gain first-hand experience in training models on a practice dataset.

Requirements: The workshop is open to all and no previous experience with machine learning or image analysis is needed. Please bring your laptop and charger.

Registration: Registration is not mandatory, but please submit a note of interest here.

Format: hybrid

- Zoom Meeting Link: https://ed-ac-uk.zoom.us/j/82148208637
- Passcode: L9buF2BJ

- **BOEM Town Hall: 50 Years of Ocean Science for Decisions in the US Offshore**

Chair: Jennifer Ewald, BOEM

Date and time: Wednesday 31st May 13:45-15:30. Salisbury Room (JMCC)

Description:

Since its inception in 1973, the Bureau of Ocean Energy Management's (BOEM) Environmental Studies Program (ESP) has provided valuable information to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments. The vision of BOEM's ESP is to realize ocean stewardship through science. This approach complements BOEM's mission of managing development of U.S. Outer Continental Shelf (OCS) energy and mineral resources in an environmentally and economically responsible way. The ESP also seeks to align the program with the broader stewardship role the Department of the Interior (DOI) plays in managing the Nation's public lands—the federal government and ocean users working cooperatively with mutual respect to achieve shared natural resource management goals. Dr. Rodney Cluck and his team will be presenting on the historical program and goals for future collaboration and scientific stewardship.
https://www.boem.gov/environment/environmental-studies-program-celebrates-golden-anniversary

Format: hybrid

- Zoom Meeting Link: https://us02web.zoom.us/j/85950834508?pwd=LzhrUFBzZUgvOXBSSTh3VmVoT3JEdz09
- Passcode: 107948

- **Public engagement for ocean literacy: approaches and implementation**

Chair: Hermione Cockburn, Dynamic Earth

Date and time: Wednesday 31st May 16:30-18:00. Dynamic Earth

Description:

This 1.5-hour workshop will explore different models for engaging public audiences with deep-sea science. The workshop is suitable for anyone with an interest in ocean literacy and will draw on examples from recent projects led by Dynamic Earth, Edinburgh's science centre. It will include ideas and examples of hands-on activities and also cover evaluation techniques.

Capacity: 24 people

Location: Dynamic Earth

Format: In-person at Dynamic Earth, registration via the link

- **Applying data to the challenges of restoration, protection, and management of deep sea corals**

Chair: Kristopher Benson, NOAA

Date and time: Thursday 1st June 14:15-16:00. Pentland Room (JMCC).

Description:

This workshop will seek input on applications of data compiled and generated in the first three years of ongoing projects to restore of deep sea coral communities in the Gulf of Mexico that were impacted by the Deepwater Horizon oil spill. Workshop conveners will provide in-depth examples of project team applications including gap analyses to prioritize and direct implementation of specific project activities in specific geographic and locations to meet project objectives and performance criteria. These internally-focused applications support establishment of monitoring, sampling, data collection, and data management standards; sequencing implementation mission and mobilization plans; and assessing progress towards project objectives and overall restoration outcomes. Conveners would like feedback from workshop participants on these self-reflective applications intended or performed by the project teams. Participants are also encouraged to consider and discuss the potential for externally-focused applications of these data as they are made public through open-access portals, and to explore this data management and evaluation effort as a model for others supporting the restoration, protection, and management of deep sea coral communities globally.

Format: hybrid

- Zoom Meeting Link: https://us02web.zoom.us/j/86151419783?pwd=d2pkWkJwNmRZWithbmJIT0dESG5NZz09
- Passcode: 577808

- **Creating Vital Metrics for Cold Water Corals: Establishing an Essential Ocean Variable (EOV) for Scleractinia and Stylasteridae**

Chair: Narissa Brax, Tom Hourigan, Ariane Buckenmeyer

Date and time: Thursday 1st June 14:15-16:00. Salisbury Room (JMCC)

Description:

To standardise deep sea stony coral (Scleractinia and Stylasteridae) data, the Global Ocean Observing System (GOOS) community is developing an Essential Ocean Variables (EOV) specification sheet, to complement the existing shallow hard coral EOV. This effort to monitor and understand the ocean environmental parameters for deep sea corals which are critical to ocean health and biodiversity, is guided in part by the United Nations Decade of Ocean Science for Sustainable Development. The Deep Ocean Observing Strategy (DOOS) and other efforts are helping to coordinate input, including both the national and international regulations and conservation issues driving coral observing needs, and the capabilities to deliver this information. The final specification sheet should ideally be adaptable to a broad range of research objectives and sampling methodologies, assisting researchers, resource managers, and policymakers in understanding deep sea coral ecosystems and informing conservation management efforts, while also supporting consistent data collection and analysis and interdisciplinary research. As part of this effort, we invite you to comment on the EOV specification sheet to provide feedback and suggestions, as well as to discuss current challenges and opportunities in deep sea coral research and conservation. This collaborative effort will aid in ensuring that the EOV specification sheet is comprehensive and widely applicable, and that it can support global monitoring and conservation.

Format: hybrid

- Zoom Meeting Link: https://us02web.zoom.us/j/85950834508?pwd=LzhrUFBzZUgvOXBSSTh3VmVoT3JEdz09
- Passcode: 107948

- **Restoration and Conservation of Deep Sea Corals. CORDAP results, findings and discussions**

Chair: Michelle Taylor, CORDAP

Date and time: Thursday 1st June 16:30-18:00. Pentland Room (JMCC)

Description:

Prior to the conference, CORDAP hosted a workshop on Restoration and Conservation of Deep Sea Corals. The workshop was a scoping study into deep sea corals, to identify gaps in knowledge regarding deep-sea corals and to develop a roadmap giving recommendations of priority future R&D investment areas and directions. The workshop at ISDSC8 will summarize these findings, and invites ISDSC8 delegates to join them in discussion around this with the aim a roadmap for developing this research area further.

Format: hybrid

- Zoom Meeting Link: https://us02web.zoom.us/j/86151419783?pwd=d2pkWkJwNmRZWithbmJIT0dESG5NZz09
- Passcode: 577808

- **Exploring Opportunities and Implications for Scientists under the BBNJ Agreement: A Roundtable Discussion**

Chair: Christine Gaebel, Deep-Ocean Stewardship Initiative (DOSI)

Date and time: Thursday 1st June 16:30-18:00. Holyrood Room (JMCC)

Description:

In response to growing global concern for marine biodiversity of areas beyond national jurisdiction (BBNJ), the international community came together to negotiate a new international agreement for the conservation and sustainable use of BBNJ. After five years of negotiations, the text of this new agreement was recently finalised in March 2023 and is now awaiting formal adoption. Given the recent finalisation of the BBNJ negotiations, the Deep-Ocean Stewardship Initiative (DOSI) and friends are hosting a roundtable discussion to bring together deep-sea scientists to explore the opportunities and implications for the scientific community under the new agreement. The event will begin with a series of brief presentations, followed by open round-table discussions designed to foster dialogue among attendees. All are welcome to attend and no prior knowledge of the BBNJ process is required.

Format: In-person.

- **Advancing Achievements Through Increasing Collaboration in Ocean Sciences Research**

Chair: Stephanie Sharuga, BOEM

Date and time: Thursday 1st June 16:30-18:00. Salisbury Room (JMCC)

Description:

At the Ocean Sciences Meeting 2022, a diverse group of scientists and resources managers from government agencies, academia, industry, and NGOs met to discuss collaboration in ocean sciences. Improving relationships and collaborations by sharing knowledge, capabilities, and resources promotes cross-boundary and interdisciplinary studies, which are becoming increasingly common and needed. Increased collaboration will help create and maintain synergies, as well as reduce repetition and redundancy in research and other initiatives. All of this will ensure the best scientific research is being done as efficiently and effectively as possible and will improve return on investment. This workshop is a continuation of discussions related to collaboration and aims to promote knowledge-sharing and discussions on how to increase collaboration in funding and carrying out ocean sciences.

Format: hybrid

- Zoom Meeting Link: https://us02web.zoom.us/j/85950834508?pwd=LzhrUFBzZUgvOXBSSTh3VmVoT3JEdz09
- Passcode: 107948

ISDSC8 Conference Dinner

To celebrate the rich history of Edinburgh in marine science and the 150-year anniversary of the Challenger Expeditions, we will hold the conference dinner in Dynamic Earth and visit the new permanent gallery, Discovering the Deep, which showcases the history of Edinburgh's own Charles Wyville Thomson, whose exploration of Scotland's marine environments in the 19th century launched the modern science of oceanography and deep-sea research.

Keynote address: Dr Erika Jones will guide us through the fascinating history of how deep-sea coral appears throughout humankind's first encounters with life in the ocean's depths.

Speaker

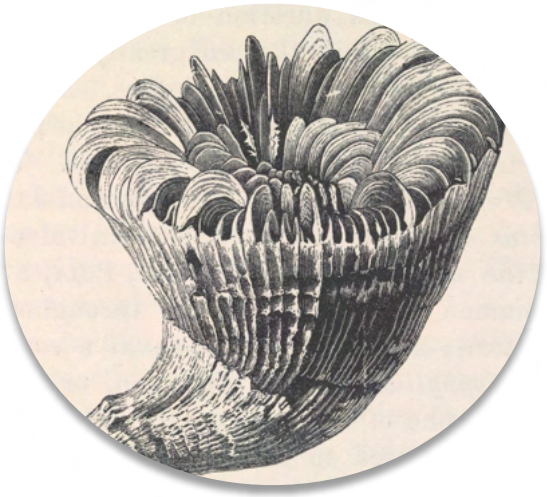
Dr Erika Jones is Curator of Navigation and Oceanography at the National Maritime Museum, Royal Museums Greenwich and Honorary Research Fellow at the Department of Science and Technology Studies, University College London. She is the author of *The Challenger Expedition: Exploring the Ocean's Depths* (National Maritime Museum, Greenwich: 2022) and co-editor of *Women in the History of Science: A Sourcebook* (UCL Press: 2023). Her work focuses on the history of oceanography in the 19th century and investigates the intersections between politics, science, technology and the exploration of the deep sea.

Title of the talk

'Beneath the waves there are many dominions yet to be visited and kingdoms to be discovered': Cold-water coral and the 19th-century quest to explore the ocean's depths

Abstract

Most corals were once thought to live in tropical water, close enough to the surface to receive sunlight. But with the help of submersibles and remotely operated vehicles, scientists have discovered vast forests of corals living in dark and cold areas of the ocean, up to 6,000 metres below the surface. The technological advances of the past 20 years have propelled our understanding of these inaccessible and vibrant habitats, yet cold-water coral has been a subject of scientific and public interest since the first human attempts to explore the deep sea. In this talk, I reveal how the environmental history of deep-sea coral is entwined with the aspirations of nineteenth-century naturalists, navies, engineers and empires to lay claim to knowledge of the ocean's depths.



Caryophyllia borealis (Caryophyllia smithii) on a telegraph cable
From: Depths of the Sea, 1873

ISDSC8 Symposium Keynotes

The opening Keynote Lecture of the 8th International Symposium on Deep-Sea Corals will be delivered by Prof. André Freiwald and Prof. Murray Roberts. The Keynote will reflect on the last 20 years of deep-sea coral reef research and exploration and looks forward to the challenges that need to be addressed.

Speakers

Murray Roberts is Professor of Marine Biology at the University of Edinburgh's School of GeoSciences. He leads the Changing Oceans research group, co-ordinates the European H2020 iAtlantic project and chairs St Abbs Marine Station & University Working Group. He is also a lead author of the 'Cold-Water Corals. The Biology and Geology of Deep-Sea Coral Habitats' book and a founder of Lophelia.org website.

Prof. **André Freiwald** is Director of Senckenberg am Meer, head of Marine Research Division and Marine Geology Section. His research focuses on cold-water corals, cool-water carbonates, and bioerosion.

Book of Abstracts

Session 1. Evolution, Taxonomy and Systematics

Type	N	Presenter	Title
Keynote	1	Catherine McFadden	Coral species, speciation and trait evolution: the promise of phylogenomics
Keynote	2	Claudia Francesca Vaga	Filling in the gaps: description of novel families of azooxanthellate corals (Anthozoa, Scleractinia) and new insights on the evolutionary history of the order
Full talk	1	Steven Auscavitch	A genetic reference library for the central Pacific Ocean deep-water Octocorallia and application in eDNA characterization of the benthos
Full talk	2	Meredith Everett	Application of RAD-tag sequencing to taxonomic resolution of the Plexauridae on the U.S. West Coast
Full talk	3	Adriana Patricia Rodriguez Bermudez	Unravelling the hidden diversity and biogeographical patterns of the golden octocoral *Plumarella*
Full talk	4	Tina Molodtsova	Tube anemones of the Northern Hemisphere, revised
Full talk	5	Declan Morrissey	'Bamboozled! Resolving deep evolutionary nodes within the phylogeny of bamboo corals (Octocorallia; Order Scleralcyonacea)
Full talk	6	Upasana Ganguly	Phylogenomic study of sea pens with focus on the evolutionary history of specialized rock-inhabiting sea pens
Full talk	7	Jaymes Awbrey	Evolution and Phylogenomics of 'Acanthogorgiidae' (Octocorallia: Malacalcyonacea)
Full talk	8	Jeremy Horowitz	Bathymetric evolution of black corals through deep time
Full talk	9	Adrien Tran Lu Y '	Colonial and solitary congeners? Comparative genomics of *Desmophyllum pertusum* and *D. dianthus*
Speed talk	1	Nelson Manrique-Rodríguez	Checklist of Corals from Colombia with Reference to Mesophotic and Deep-Sea Records
Speed talk	2	Roger Aires	Diversity and Ecology of deep-sea Zoantharia in the North Atlantic: preliminary results
Speed talk	3	Andrea Quattrini	Skimming and targeting genomes for systematics and population genetics of deep-sea corals'
Speed talk	4	Márcio Coelho	Sequencing of coral mitochondrial genomes: a new genetic resource based on long-read sequencing for genome assembly and to support species identification'
Speed talk	5	Tina Molodtsova	One of the deepest genera of Antipatharia: taxonomic position revealed and revised'
Speed talk	6	Mary Deere	What is that white branchy coral? Or: Challenges of in situ identification of octocorals'
Speed talk	7	Les Watling	Functional Morphology of Octocoral Polyps: First Looks'

Keynote Abstracts

1. Coral species, speciation and trait evolution: the promise of phylogenomics

Catherine McFadden[1]

Affiliations
Harvey Mudd College, United States[1]
Email: mcfadden@hmc.edu

Abstract
The earliest applications of molecular tools to coral systematics revealed extensive incongruence between morphological and genetic evidence for phylogenetic relationships. The recent development of methods that allow us to interrogate the entire genome have further illuminated this incongruence, leading to ongoing revisions at all ranks of coral taxonomy. More importantly, acceptance of a phylogeny based on genetic evidence has highlighted our lack of understanding of the evolutionary capacity of these organisms. Gross morphological characters such as growth form and skeletal composition—traits that have traditionally been considered to be conserved evolutionarily and therefore used to diagnose higher taxa—are much more labile than has been assumed. Some colony growth forms and skeletal compositions have evolved repeatedly throughout the coral tree of life. As a result, lineages that last shared a common ancestor in the pre-Cambrian may share distinctive homoplasies (e.g., *Isis and Keratoisis*) while closely related sister taxa differ radically in gross morphology (e.g., *Desmophyllum*). Such examples highlight the capacity of corals to adapt their morphology to a changing environment, and we now have the phylogenomic tools to begin to understand the genetic basis of this morphological lability. With the ongoing refinement of whole-genome sequencing technologies, studies of species boundaries, phylogeography and the mechanisms and drivers of speciation are also now becoming possible in corals, a group in which such studies have lagged far behind other taxa. Methods that use thousands rather than handfuls of genes to reconstruct the evolutionary history of lineages are allowing us to finally begin to understand genetic connectivity and reproductive barriers in the deep sea. As the genetic data necessary to discriminate populations become increasingly available, we now face the bigger challenges of interpretation and application of species concepts.

2. Filling in the gaps: description of novel families of azooxanthellate corals (Anthozoa, Scleractinia) and new insights on the evolutionary history of the order

Claudia Francesca Vaga[1], Isabela Galvão de Lossio e Seiblitz[1], Dr Stephen Douglas Cairns[2], Mr Randolph Quek[3], Dr Danwei Huang[3], Andrea Quattrini[2], Dr Marcel Visentini Kitahara[1]

Affiliations
University of São Paulo, Brazil[1],
Smithsonian Institution United States[2],
National University of Singapore[3]
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Abstract
Since the pioneer molecular studies, the systematics of scleractinian corals has been in revision. Despite their importance as engineers of shallow and deep-water complex ecosystems, reliable phylogenetic reconstructions and resolution of longstanding evolutionary questions of the order Scleractinia have been hampered by a substantial underrepresentation of azooxanthellate and deep-sea species and a paucity of available molecular markers. Endeavouring to fill this knowledge gap, we used hybrid enrichment and genome skimming sequencing methods to target 2,490 UCEs and exon loci for >200 scleractinian species, mainly azooxanthellate. Phylogenomic reconstructions were performed integrating available genomes and transcriptomes of zooxanthellate species, and fossil-

calibrated molecular clock analysis was performed to estimate the ages of the main lineages and of the origin of the order. Diversification rates and ancestral state of ecological characters were calculated to determine whether they have shifted across morphologically and ecologically diverse taxa. Moreover, the complete mitochondrial genome was retrieved for several species of interest to investigate the possible presence of taxonomically informative gene rearrangements. This study represents the first phylogenomic reconstruction of the order with even representation of symbiotic and non-symbiotic taxa. Several azooxanthellate genera and families were recovered as polyphyletic assemblages, with some novel clades that do not correspond with any of the extant valid families. Additional morphological observations, including microstructural analyses of the skeleton, aided in re-defining the synapomorphies applied to discern genera and families and describing the newly recovered clades through an integrative approach. Besides producing molecular data for numerous scleractinian species and genera whose phylogenetic positions were obscure previously, results from this study will be fundamental for addressing evolutionary questions of pressing relevance.

Full Talks

1. A genetic reference library for the central Pacific Ocean deep-water Octocorallia and application in eDNA characterization of the benthos

Steven Auscavitch[1], Meredith Everett[2], Erik Cordes[3], Randi Rotjan[1]

Affiliations

Department of Biology, Boston University, United States [1]
Northwest Fisheries Science Center, NOAA, United States[2]
Temple University, United States[3]
Email: steveaus@bu.edu

Abstract

Environmental DNA-based (eDNA) approaches can be powerful tools for deep ocean biological characterization and offer substantial insights to baseline biodiversity metrics of the deep-sea benthos in unexplored or data-deficient areas. However, the lack of reliable species-specific genetic reference libraries for organisms present in a geographic region or depth range can make interpretation of eDNA profiles challenging. To ameliorate this deficiency, we sought to compose the first Central Pacific library explicitly targeting a diverse and dominant group of hard-substrate fauna, the Octocorallia. Since 2015, recent efforts to explore and characterize the seafloor benthos in protected areas, sanctuaries, monuments, and areas beyond national jurisdiction across the central Pacific Ocean have yielded substantial numbers of octocoral collections, and an increasing number of which are paired with targeted eDNA sampling from seawater collected by remotely operated vehicles. Tissues for this assembly were obtained from a range of sources including recent field collections by the NOAA ship *Okeanos Explorer*, E/V *Nautilus*, and RV *Falkor*, as well as historical museum vouchers. We employed a combination of mitochondrial genetic markers (MutS, COI) and genome skimming methods to generate a composite mitogenome sequence library. In this first iteration, molecular operational taxonomic units were identified from 304 total voucher collections from deep-water octocorals in central Pacific waters between 130 and 3343 m depth. While the construction of this library is oriented toward refining eDNA characterization tools and identification of useful taxon-specific markers, these data also have the potential to expand the breadth and depth of understanding of octocoral evolutionary history in the region. Looking forward, robust reference libraries will be an important component of identifying baseline genetic biodiversity and the evaluation of potential impacts that deep-sea ferromanganese crust or nodule mining might have on or around seamounts and other submarine topographic rises in the central Pacific Ocean.

2. **Application of RAD-tag sequencing to taxonomic resolution of the Plexauridae on the U.S. West Coast**

Dr Meredith Everett[1]

Affiliations
Northwest Fisheries Science Center, NOAA United States[1]
Email: meredith.everett@noaa.gov

Abstract
Along the United States West Coast plexaurid gorgonians are abundant and diverse members of deep-sea coral communities, spanning multiple genera with overlapping morphology. These species occurring across a broad range of depths and many species may occur coast wide, with some species apparently occurring through the entire northeast Pacific. These corals can occur in a variety of habitat types, and have been observed as early returners to habitats after disturbance. This group however, is difficult to identify based on morphology alone, with some morphospecies currently appearing polyphyletic based on DNA sequencing of traditional mitochondrial markers, with other species complexes that cannot be distinguished using these markers alone. This is consistent with other findings in the family overall. In order to resolve the species boundaries and improve morphological identification resources for the plexaurid gorgonians in the Northeast Pacific, we have carried out RAD-tag sequencing in individuals spanning multiple genera and morphospecies from across U.S. West Coast. RAD-tags were obtained for 204 individuals including multiple species within the genera *Callistiphanus* (previously *Swiftia*), *Swiftia*, *Chromoplexaura*, and *Thesea*. Individuals were selected to represent multiple known morphospecies, as well as the multiple polyphyletic clades observed using the standard *MutS* molecular marker. Individuals from the species *Calcigorgia beringi* were included as an outgroup for phylogenetic analysis. These data have been used to better resolve taxonomic boundaries among individuals from the region using genome-wide markers, rather than mitochondrial data alone. Select individuals from within these identified groups have undergone morphological characterization to attempt to identify more distinct traits to facilitate morphological identification going forward. These combined results should help better resolve the taxonomy of plexaurid gorgonians within the region and provide additional identification resources for specimens collected in the future.

3. **Unravelling the hidden diversity and biogeographical patterns of the golden octocoral *Plumarella***

Adriana Patricia Rodriguez Bermudez[1], Stephen Douglas Cairns[2], Martha Nizinski[3], Andrea Quattrini[2]

Affiliations
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Smithsonian Institution United States[2]
NOAA National Marine Fisheries Services, Smithsonian Institution United States[3]
Email: ap.rodriguez21@uniandes.edu.co

Abstract
The golden octocoral genus *Plumarella* (Alcyonacea: Primnoidae) is relatively diverse and occurs on the continental slope in the Gulf of Mexico (GoM), and off the coasts of The Bahamas and southeastern United States (SEUS). Delimiting interspecific boundaries within the genus *Plumarella*, like many other octocoral genera, can be problematic using only morphological characters. Moreover, species of *Plumarella* occur sympatrically making differentiations between species difficult. Within this genus, two species complexes have been noted: 1) '*P. pellucida* species complex' that consists of *P. laxiramosa, P. pellucida, and P. pourtalesii* and 2*) 'P. pourtalesii* species complex' that consists of three varieties distinguished from one another by variation in sclerite thickness, colony size, and morphology

of the distal edges of the marginal scales. To assess species boundaries and population structure within *Plumarella* in this region, we reconstructed phylogenetic relationships using target capture of ultraconserved elements (UCEs) and exons. We found evidence to support the synonymy of several taxa as well as the presence of potential new species. Additionally, location and topographic features may influence structure of *Plumarella* populations. The project benefited from using target-capture enrichment to assess samples with small quantities of DNA (<1 ng per ul) and/or highly degraded DNA. This approach provides the opportunity to use specimens stored in museums, which makes available a valuable source of genetic information. Overall, our findings shed light on the species boundaries and phylogeographic structure within the genus *Plumarella* and demonstrate the importance of incorporating genetic data in taxonomic studies.

4. Tube anemones of the Northern Hemisphere, revised

Tina Molodtsova[1], Elizabeth Lipukhin[1], Viktoria Moskalenko[1], Ulyana Simakova[1]

Affiliations

Shirshov Institute of Oceanology RAS[1]

Email: tina@ocean.ru

Abstract

Tube anemones or Ceriantharia represent a group of solitary anemone-like anthozoans, now considered as a subclass. Adult Ceriantharia are typically bottom-dwelling and inhabit long, fibrous, slimy tubes, which gave rise to their vernacular name, 'tube anemones'. At the soft sedimented shelves and continental slopes tube anemones may form distinctive characteristic habitats, which attract fish and invertebrates as breeding and feeding grounds. Such biotopes are considered as vulnerable in some RFMOs. Species of different genera and even families of Ceriantharia are difficult to distinguish without collection and proper preservation. The entire body of tube anemone is necessary for morphological identification. However, because of their lifestyle, most species are difficult to collect properly by means other than SCUBA diving. This makes it challenging to study mesophotic or deep-sea Ceriantharia. We review the current knowledge and new data on tube anemones from the Northern Hemisphere. With a focus on new deep-sea and cold-water records, we discuss new genetic data, forms with unusual morphology and lifestyle, the validity of the currently used classification of Ceriantharia, and the integrity of the species previously reported as wide-spread. The work supported by RSF project 22-24-00873.

5. Bamboozled! Resolving deep evolutionary nodes within the phylogeny of bamboo corals (Octocorallia: Scleralcyonacea: Keratoisididae)

Declan Morrissey[1], Jessica D Gordon[2], Emma Saso[3], Jaret Bilewitch[4], Michelle L. Taylor[2], Vonda Hayes[5], Catherine S. McFadden[6], Andrea M. Quattrini[3], & A. Louise Allcock[1]

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Abstract

Keratoisididae is a globally distributed, and exclusively deep-sea, family of octocorals that contains species and genera that are polyphyletic. An alphanumeric system, based on a three-gene-region phylogeny, is widely used to describe the biodiversity within this family. That phylogeny identified 12 major groups although it did not have enough signal to explore the relationships among groups. Using increased phylogenomic resolution generated from Ultraconserved Elements and exons, we aim to resolve deeper nodes within the family and investigate the relationships among those predefined groups. In total, 109 libraries of conserved elements were generated from individuals representing both the genetic and morphological diversity of our keratoisidids. In addition, the conserved element data of 12 individuals from previous studies were included. Our taxon sampling included 11 of the 12 keratoisidid groups. We present two phylogenies, constructed from a 75% (231 loci) and 50% (1729 loci) taxon occupancy matrix respectively, using both Maximum Likelihood and Multiple Species Coalescence methods. These trees were congruent at deep nodes. As expected, S1 keratoisidids were recovered as a well-supported sister clade to the rest of the bamboo corals. S1 corals do not share the same mitochondrial gene arrangement found in other members of Keratoisididae. All other bamboo corals were recovered within two major clades. Clade I comprises individuals assigned to alphanumeric groups B1, C1, D1&D2, F1, H1, I4, and J3 while Clade II contains representatives from A1, I1, and M1. By combining genomics with already published morphological data, we provide evidence that group H1 is not monophyletic, and that the division between other groups – D1 and D2, and A1 and M1 – needs to be reconsidered. Overall, there is a lack of robust morphological markers within Keratoisididae, but subtle characters such as sclerite microstructure and ornamentation seem to be shared within groups and warrant further investigation as taxonomically diagnostic characters.

6. Phylogenomic study of sea pens with focus on the evolutionary history of specialized rock-inhabiting sea pens.

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Abstract

Sea pens (Superfamily Pennatuloidea) are a specialized group of octocorals evolved to live embedded in a soft-sedimented seafloor using their peduncles as anchors. Rock inhabiting sea pens ('rock pens'), first described in 2011, are so named because they have peduncles modified into suction cup-like structures that allow them to attach onto the surface of hard substrates, a behaviour previously unknown in sea pens. There are currently four species that have been identified as rock pens based on their peduncular morphology. Three of these are in the genus *Anthoptilum*, (Anthoptilidae) and one in the genus *Calibelemnon* (Scleroptilidae). Previous molecular phylogenetic studies have shown the monophyly of Pennatuloidea with polyphyly and paraphyly of several families within sea pens. Here, we present a phylogenomic study of sea pens, based on hundreds of ultraconserved elements (UCE) and compare these trees to those constructed using mitochondrial gene regions. We explore the evolutionary origin(s) of the rock pens. Our results show that the ancestral sea pen had a typical elongated peduncle, with the special suction cup-like adaptation evolving along a single derived lineage sister to the genus *Anthoptilum*. We suggest all known rock pen species be grouped into a single new genus in the family Anthoptilidae to reflect the phylogenetic history.

7. Evolution and Phylogenomics of 'Acanthogorgiidae' (Octocorallia: Malacalcyonacea)

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Abstract
Acanthogorgiidae *sensu* Bayer 1981 comprises >135 species in 5 genera that are found throughout the ocean and from the neritic zone to the lower bathyal zone (to ~2,500 m). Traditionally diagnosed features of acanthogorgiids are a thin coenenchyme, inability to retract their polyps, and the *en chevron* arrangement of polyp sclerites. Yet many acanthogorgiid species only weakly possess some of these traits (if at all), and the old and vague descriptions of the majority of the species highlight the need to better understand their evolutionary relationships. Previous molecular studies of octocoral evolution have suggested that Acanthogorgiidae is not monophyletic, but no thorough investigation focused on this family has previously been conducted. Here, we present the first comprehensive phylogenetic study of Acanthogorgiidae, including representatives of type species and all genera, using DNA sequences from the mitochondrial MutS gene and Ultra Conserved Elements (UCEs). Both datasets reject a monophyletic Acanthogorgiidae, though cladal support and resolution differs between them. *Acanthogorgia* species are divided among two clades in the mtMutS phylogeny but cluster together in the UCE phylogeny. These analyses provide evidence for the reorganization of acanthogorgiid taxa into multiple taxonomic groups.

8. Bathymetric evolution of black corals through deep time

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Abstract
Deep-sea lineages are generally thought to arise from shallow-water ancestors, but this hypothesis is based on a relatively small number of taxonomic groups. Anthozoans, which include corals and sea anemones, are significant contributors to the faunal diversity of the deep sea, but timing and mechanisms of their invasion into this biome remain uncertain. Here, we used a fully resolved, time-calibrated phylogeny for 83 black coral (Anthozoa: Antipatharia) species to investigate their bathymetric evolutionary history. We show that black corals originated in continental slope depths (~250–3,000 m depth) during the early Silurian and radiated into, and diversified within, both continental shelf (<250 m depth) and abyssal (>3,000 m depth) habitats. The appearance of morphological features that enhanced their ability to acquire nutrients coincided with their colonization into these novel depths. Our findings have important conservation implications, as the loss of the oldest and most species-poor slope lineages could erase millions of years of evolutionary history. Furthermore, the extinction of slope taxa could hinder the replenishment of abyssal populations.

9. Colonial and solitary congeners? Comparative genomics of *Desmophyllum pertusum* and *D. dianthus*

Dr Adrien Tran Lu Y [1], Mr Emilio Egal[1], Ms Christine Felix[1], Ms Florence Cornette[1], Dr Didier Aurelle[2], Dr Marcelo Visentini Kitahara[3], Dr Andrea Quattrini[4], Dr Cheryl Morrison[5], Dr Alexis Weinnig[5], Dr Eric Pante[6], Dr Jean-Marc Aury[7], Prof Murray Roberts[8], Dr Nicolas Bierne[9], Dr Sophie Arnaud-Haond[1]

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Abstract
Coral reefs are one of the most iconic and biodiverse marine ecosystems. Due to their remote locations, deep reefs remain less widely studied than their shallow counterparts, even though, ecologically, they provide similar ecosystem services and are widely distributed. In the Atlantic, these deep-sea coral reefs are mainly engineered by the colonial scleractinians, *Desmophyllum pertusum (Lophelia pertusa*), *Solenosmilia variabilis* and *Madrepora oculata*, which form dense and often mixed formations, providing habitat for many other species including fisheries targets. Although remote, these deep reefs are subject to anthropogenic pressures from deep-sea trawling, oil, mining exploitation and climate change. *Desmophyllum pertusum* is a well-known flagship species for the protection of these ecosystems against anthropogenic activities. Based mostly on a mitochondrial (mtDNA) phylogeny, *L. pertusa*, has recently been reclassified as *Desmophyllum*, a genus that previously harbored only solitary species, and a classification still under debate in the scientific community. Indeed, some molecular phylogenies based on mtDNA are still under debate mainly due to possible evolutionary caveats. One of them is the slow evolutionary rate of mtDNA, suggesting that this locus may not serve as appropriate evidence to merge those two genera. In this study, we propose to re-examine the relationship between *Desmophyllum* and *Lophelia* using whole-genome resequencing data and analysis on a subset of both species sourced throughout the Atlantic Basin, and closely-related taxa such as *Solenosmilia variabilis* and *Caryophyllia spp*, providing new insights of the genomic nature of these species and evolution of colonial versus solitary morphologies, traits that have distinguished major taxonomic lineages within the Scleractinia.

Speed Talks

1. Checklist of Corals from Colombia with Reference to Mesophotic and Deep Sea Records

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Abstract
During the last 25 years in Colombia, deep-sea corals species have been reported based on several mesophotic and deep-sea expeditions. Although many of these records have been published independently in different journals, there is no clear number of these organisms for Colombian waters despite the usefulness of this information for future research and decision makers. This work provides a checklist of corals (Anthozoan) from Colombia. A total of 243 valid species have been reported for the country with 66 species considered present or as morphotypes. 219 registered for the Caribbean Sea and 27 Pacific Ocean. Of these 243 species, 182 have been reported from mesophotic depths (30-150 m) and 61 species from deep waters (52 species in the bathyal zone 150-2,000 m and 9 species at abyssal depth >2,000). The corals reported in this checklist have been collected via deep-sea trawls and/or observed in video surveys obtained via drift cameras and remotely operated vehicle (ROV). Some cnidarians are species of concern included in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. Approximately 11.52% of the species present in Colombia are classified as threatened by the IUCN. Specifically, 28 species are listed, including five Critically Endangered (CR) reef-building species recorded on mesophotic reefs. Knowledge on deep sea species is scarce, which is why none are listed in the IUCN red list.

2. Diversity and Ecology of deep-sea Zoantharia in the North Atlantic: preliminary results

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Abstract
The deep sea, once considered untouchably remote, is changing with our shifting climate and growing human use of ocean resources. Emerging evidence shows that these changes will unequivocally impact productivity, biodiversity, and distribution of deep-sea fauna, of which we still have limited knowledge and is now a matter of urgency to improve our understanding of deep-sea biodiversity. Zoantharians (Cnidaria, Anthozoa, Hexacorallia, Zoantharia) are an order of benthic cnidarians that are found in most marine environments, from shallow tropical coral reefs to deep-sea ecosystems including seamounts, coral gardens, cold seeps, and hydrothermal vents. Nonetheless, the diversity and ecological role of deep-sea zoantharians remain largely unknown. The main objective of this project is to increase our understanding of deep-sea zoantharians, group that may have an important role in shaping deep-sea communities. Baseline data are also required for species distribution and habitat suitability models that map where species, habitats, and vulnerable marine ecosystems may occur, enabling the identification of biodiversity hotspots and the use of area-based management tools. For that achievement, it is required to use an innovative integrative taxonomy approach, including genetic, morphological and ecological datasets to describe the diversity and phylogeny of deep-sea zoantharians in the Atlantic Ocean. Samples previously collected, as well as from recent cruises ensure access to specimens from different deep-sea ecosystems that are generally difficult to obtain. Morphological characters and cnidome of the sampled specimens provide data about the diversity. In addition, a map created with up-to-date information about the current state of the art and knowledge about the diversity and distribution of these organisms helps to understand evolutive and ecological connections. The final results of this project will contribute to developing efficient management strategies concerning anthropogenic impacts in the deep ocean, including climate change and resource exploitation.

3. Skimming and targeting genomes for systematics and population genetics of deep-sea corals

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Abstract
New genomic approaches are advancing our knowledge of coral systematics and evolution. Combining genome skimming and target-capture enrichment with both contemporary and historical museum specimens can help us delimit species boundaries, discover cryptic species, resolve mis-identified museum specimens, advance systematic studies, and elucidate coral evolution and biogeography in the deep sea. Using genome skimming, a relatively low-cost method, we were able to assemble whole to partial mitogenomes and 1000s of nuclear loci from 171 dry and fluid-preserved coral specimens collected from 1886 to 2019. We further focused on two genera, *Callistephanus* and *Paramuricea*, which commonly occur in deep-sea habitats throughout the North Atlantic Ocean. Within *Callistephanus*, we were able to validate the identity of newly collected specimens with specimens of historical significance (e.g., identified by influential taxonomists E. Deichmann, F. Bayer) to begin resolving systematics of this challenging group. For *Paramuricea*, we constructed a new bait set that targets 1,704 loci with functions related to pressure and temperature tolerance, immunity, reproduction, and stress response. We sequenced 120 samples from closely-related *Paramuricea* spp. that occur in specific depth bands across the continental slope of the Gulf of Mexico to test whether these genes are under selection throughout the bathymetric range. Ultimately, we hope that these genomic approaches will aid in unlocking the utility of our natural history collections to better understand the evolution of corals in the deep sea.

4. Sequencing of coral mitochondrial genomes: a new genetic resource based on long-read sequencing for genome assembly and to support species identification

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Abstract
The advent of long-read sequencing technologies with ever-increasing accuracy and decreasing costs is a significant development for many genomic applications, including *de novo* genome assembly and structural variation analysis. The mitochondrial genomes of corals have a number of remarkable features that made past efforts to sequence and assemble complete circular sequences challenging, most notably the prevalence of different gene rearrangements across several lineages and the presence of Group I introns. Here, we present a new genetic resource based on Oxford Nanopore Sequencing (ONT) that overcomes these challenges and that can be widely applicable to large-scale sequencing of both Octocorallia and Scleractinia mitogenomes. We designed universal primers for

long-range PCR amplification of the mitogenomes of each coral group (PCR products > ~ 7,000 bp), which are then sequenced with a MinION portable sequencer using ONT barcoding protocols to pool samples and reduce the overall sequencing costs. A total of 19 octocoral and 10 scleractinian mitogenomes of over 20 different species spanning the coral tree of life were sequenced, assembled and annotated *de novo*, including several circalittoral and deep-sea coral species occurring in southern Portugal. In this talk, I will present the results of this sequencing study and explore the advantages and limitations of the methodology developed. With approximately 161 scleractinian and 144 octocoral species' mitogenomes sequenced to date (12% and 5% of the known diversity, respectively), the sequencing approach developed here represents a valuable resource to sequence coral mitogenomes and more broadly to study the evolution of the eukaryotic powerhouse. Importantly, it has the potential to tremendously increase the mitogenomic resources available for coral research from species identification and evolutionary genetics to conservation.

5. One of the deepest genera of Antipatharia: taxonomic position revealed and revised

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Abstract

The genus *Abyssopathes* Opresko, 2002 comprises deep-sea black corals known almost exclusively from lower bathyal and abyssal depths, mainly from seamounts covered by cobalt-rich crusts and areas of polymetallic nodules. The taxonomical position of the genus and its placement in the family Schizopathidae has been repeatedly questioned, but fruitlessly. Known only in extremely deep habitats, these corals have rarely been collected in a state suitable for morphological or molecular studies that could help to clarify their status. Recently, increasing attention has been paid to the study of fauna associated with deep-sea minerals. Using material of *Abyssopathes lyra* sampled during NOAA organized and implemented a Pacific-wide field campaign CAPSTONE, we transfer the genus *Abyssopathes* from the family Schizopathidae to the family Cladopathidae based on morphological and molecular data. Morphological data includes six mesenteries in the polyps, a unique pinnulation pattern, found only in genera within the Cladopathidae, and relatively short polyp tentacles, a feature typical of some cladopathids. Sequencing data consisting of 626 bp from the mitochondrial *cox1* gene showed that *Abyssopathes* is 99% identical to *Chrysopathes*, *Cladopathes, Heteropathes*, and *Trissopathes* (all Cladopathidae) in this gene region. Supported by RFS project #22-24-00873.

6. What is that white branchy coral? Or: Challenges of in situ identification of octocorals

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Abstract
Identification of deep-sea corals based solely on in situ imagery and video is unreliable. Diagnoses of coral species are based on morphological characters obtained from physical samples examined in a lab, which may not translate well to observations of living colonies in situ. Many descriptions were written 100 or more years ago and are overly vague or rely on too few characters for accurate identification at the species level. Variation in colony morphology based on age and size adds to the difficulty in identifying corals. Here we present a case study on a bamboo coral (family Keratoisididae) from the central North Pacific. During an expedition in 2015 we noted repeated observations of a colony morphology having an elongated main axis angled to the seafloor from which one to a few widely spaced short branches arose vertically, and called it the 'sparse brancher'. Our preliminary genetic data suggest this morphotype is a distinct species that has not previously been sequenced. The sparse brancher's colony morphology led to questions of how to identify long-lived corals that at different stages of life may resemble other species. For example, in this case, a colony starts as an unbranched whip and later branches to an unknown degree when older. We generated genetic and morphological data from 31 collected samples and examined approximately 100 in situ images to determine: Are there characteristics we can observe in situ that are not related to age, size or branching, that enable one to identify this species at different stages of life, or will it always require collection of a physical sample? To that end we are examining polyp shape, size, and density; internodal length; and branching point.

7. Functional Morphology of Octocoral Polyps: First Looks

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Abstract
The general morphology of octocoral polyps has been reviewed in invertebrate zoology textbooks as well as in more specialized volumes on octocoral taxonomy. Dissection of polyps and examination with standard light microscopy or with SEM, we noticed that the anatomy of polyps within the bamboo corals (Family Keratoisididae) was often quite different from that indicated in the general literature. Some of those observations have been published as part of new species descriptions. We subsequently employed a microCT unit to investigate the details of arrangement of tentacles, pharynx and mesenteries on contracted specimens that had been fixed with glutaraldehyde, post-fixed with OsO4, and embedded in resin. We discovered there is a complex interplay between the degree and method of contraction of the polyp for defense and the structure of the internal features such as the pharynx and mesenteries. Within the bamboo corals contracted polyps vary from those that contract to highly shortened stubs or volcano-like structures with the tentacles pulled into the upper section of the pharynx, to polyps that do not contract at all but whose heavily armed tentacles merely are pulled over the mouth region. The structure of the pharynx varies strongly with the mode of contraction. Some species have a short, funnel-like pharynx while others have the more typical long and tubular pharynx. A brief look at other families suggests that the degree of folding of the pharynx during contraction determines whether pharyngeal sclerites are present or not.

Session 2. Coral reproduction, biology and physiology

Type	N	Presenter	Title
Keynote	1	Meri Bilan	Bottom trawling induced sediment resuspension effects on physiology of six cold-water corals
Keynote	2	Franck Lartaud	Cold-water corals ecology and response to main threats – an overview of 10 years of experiment in a Mediterranean canyon
Keynote	3	Julia Johnstone	A review of current knowledge on reproductive and larval processes of deep-sea corals
Full talk	1	Inês Martins	Copper effects on cold-water octocorals under a climate change scenario: A land-based experiment towards environmental risk assessment for deep-sea mining
Full talk	2	Mathilde Chemel	Effects of temperature on cold-water coral holobiont in the Atlantic Ocean
Full talk	3	Joe Stewart	Stylasterid corals build aragonite skeletons in undersaturated water despite low pH at the site of calcification
Full talk	4	Jorge Corrales-Guerrero	Using natural analogues to evaluate the resilience of cold-water coral reefs to changes in environmental conditions
Full talk	5	Kathryn Murray	Behavioural and mucosal responses of the cup coral *Flabellum* (*Ulocyathus*) alabastrum to barite and bentonite sedimentation
Full talk	6	Maria Rakka	Resource acquisition of the deep-sea octocoral *Viminella flagellum* under ocean acidification and varying food availability
Full talk	7	Cristina Gutiérrez-Zárate	Assessing the Single and Multiple Effects of Warming, Acidification and Deoxygenation on the Ecophysiology of the Cold-Water Coral *Dendrophyllia cornigera*
Full talk	8	Marina Carreiro-Silva	Single and multiple stressor impacts of deep-sea mining and climate change on cold-water corals
Full talk	9	Ann I. Larsson	Turbulence affects larval vertical swimming in the cold-water coral *Lophelia pertusa*
Full talk	10	Ignacia Acevedo-Romo	Larval ecology of *Desmophyllum dianthus* in the Chilean fjords
Full talk	11	Christina Egger	Comparative study of reproductive traits of a West Atlantic Gorgonian (Paramuricea) species after recent speciation
Full talk	12	Jenny Beaumont	Reproductive mode, larval settlement and development of a New Zealand deep-sea stony coral, *Goniocorella dumosa*
Speed talk	1	Alfredo Veiga	A Multipurpose Aquaria Experimental Set Up Studying the Interaction of Environmental Stressors in a Cold-Water Coral Species
Speed talk	2	Giovanni Sanna	Phenotypic responses of *Desmophyllum pertusum* to oceanographic factors across the Atlantic'
Speed talk	3	Kristina Beck	Ontogenetic differences in the response of the cold-water coral *Caryophyllia huinayensis* to ocean acidification, warming and food availability'
Speed talk	4	Julia Johnstone	Antarctic deep-sea coral larvae may be resistant to end-century ocean warming'
Speed talk	5	Beatriz Arzeni	Speed talk, Beatriz Arzeni 'Multiple stressor impacts of deep-sea mining and ocean acidification on *Antipathella wollastoni* (Cnidaria: Antipatharia) under hyperbaric conditions
Speed talk	6	Lara M. Beckmann	Deepwater coral and sponge gardens in Alaska: Reproduction and recruitment in keystone species
Speed talk	7	Magali Zbinden	Pressurised aquaria for long-term experiments on deep-sea corals

Type	N	Presenter	Title
Speed talk	8	Lauren N. Rice	Methods for estimating the reproductive capacity of morphologically complex cold-water corals
Speed talk	9	Mathilde Chemel	Reproductive biology of the two main reef-building cold-water coral species (*Desmophyllum pertusum* and *Madrepora oculata*) in the Mediterranean Sea
Speed talk	10	Gal·la Edery	The importance of the sexual reproductive condition of octocorals for the success of ecological restoration
Speed talk	11	Ana Navarro Campoy	Early-life stages of the cold-water gorgonian coral *Primnoella chilensis*
Speed talk	12	Anaïs Sire de Vilar	Effects of various abiotic stressors on the early life stages of the cold-water coral *Lophelia pertusa*

Keynote Abstracts

1. Bottom trawling induced sediment resuspension effects on physiology of six cold-water corals

Meri Bilan[1], Andrea Gori[2], Jordi Grinyo[3], Marina Biel Cabanelas[4], Xenia Puigcerver Segarra[2], Andreu Santín[4], Stefano Piraino[5], Sergio Rossi[6], Pere Puig[4]

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Abstract

Bottom trawling causes significant changes in the marine environment. This fishing activity may extend its limits deeper than 1,000 m depth, where severe impacts have been recorded for a wide range of benthic communities, whose recovery rates are measured in decades. The benthic communities can experience direct impact such as immediate complete or partial removal when in contact with fishing gear, or indirect impact of increased suspended sediment concentration (SSC) resulting from resuspension caused by the fishing gear through the seafloor. The indirect impact can be long lasting and spread over larger areas, thus expanding the impact of bottom trawling outside the fishing ground limits. Submarine canyons are often surrounded by fishing grounds and they act as conduits for sediment transport between shallow and deep-sea areas. They are important habitat for CWCs, especially in the northwestern Mediterranean Sea, where a network of submarine canyons incise the continental margin. This study aimed at experimentally studying survival, growth and physiological responses of CWCs found on canyon walls of Blanes Canyon against bottom trawling related increase in SSC measured within canyons of the Catalan margin. The study included six CWCs and three SSC treatments (0, 7, $38 mg L^{-1}$) maintained for 9 months, while the physiological responses (respiration and excretion) were measured twice during that period. A photogrammetry approach was used to measure growth for octocoral and black coral species, while scleractinian species were evaluated based on buoyant weight technique. The results include first physiological records for *Leiopathes glaberrima*. *Desmophyllum pertusum* and *Madrepora oculata* showed higher vulnerability to increased

SSC as there was increased polyp mortality after 9 months of exposure. *Desmophyllum dianthus* and *Muriceides lepida* showed no change in response to increased SSC. The results suggest that indirect impact of bottom trawling may pose as a threat to colonial scleractinian corals.

2. Cold-water corals ecology and response to main threats – an overview of 10 years of experiment in a Mediterranean canyon

Franck Lartaud[1], Leïla Chapron[2], Mathilde Chemel[1], Pierre E.Galand[1], Anne-Leïla Meistertzheim[2], Vincent Mouchi[3], Erwan Peru[1], Audrey Pruski[1], Gilles Vétion[1]

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Abstract
Reef-building cold-water corals (CWC) act as ecological engineers and support a high biodiversity. Therefore, deep-sea reefs represent key ecosystems to preserve and/or restore. The Mediterranean Sea is known as the source of coral colonization of the North-East Atlantic populations, subsequent to glacial – interglacial cycles. Today, Mediterranean CWC populations face many threats, including fishing activities, plastic pollution and especially climate change as they already live close to their upper known temperature limit (*i.e.* 13°C). However, many knowledge gaps exist regarding their biology and ecology, making it difficult to project their response to global change. To fill these gaps, *in situ* experiments were conducted during 10 years in the Lacaze-Duthiers canyon (Gulf of Lion), using ROV and deployment-recovery techniques, on the reef-building corals *Desmophyllum pertusum* (former *Lophelia pertusa*) and *Madrepora oculata*. Growth, reproduction and coral microbiomes were analyzed at different temporal and spatial scales. In addition, laboratory experiments on the effect of temperature changes and exposure to plastic particles were conducted to forecast the consequences of a changing Mediterranean Sea. Coral physiology (growth, behaviour, energy reserves) and microbiome were investigated to assess their response at the holobiont level. An overview of these results will be presented. The two species display different habitat preferences, with a better health status of *M. oculata* at shallower depths. *Desmophyllum pertusum* appears more resilient to the current environmental dynamic, but is more sensitive than *M. oculata* to anthropogenic pressures. This could impact future canyon coral landscapes as *D. pertusum* forms the most abundant and widespread reefs to date.

3. A review of current knowledge on reproductive and larval processes of deep-sea corals

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Abstract

The presence of corals living in deep waters around the globe has been documented in various publications since the late 1800s, when the first research vessels set sail on multi-year voyages. Ecological research on these species however, only truly began some 100 years later. We now know that many species of deep-sea coral provide ecosystem services by creating complex habitat for thousands of associated species, and thus are major contributors to global marine biodiversity. Amongst the many vital ecological processes, reproduction provides a fundamental link between individuals and populations of these sessile organisms that enables the maintenance of current populations and provides means for expansion to new areas. While research on reproduction of deep-sea corals has increased in pace over the last twenty years, the field is still vastly understudied, with less than 4% of all species having any aspect of reproduction reported. This knowledge gap is significant because information on reproduction is critical to our understanding of species-specific capacity to recover from disturbances (e.g., fishing impacts, ocean warming, seafloor mining). It is important, therefore, to examine the current state of knowledge regarding deep-sea coral reproduction to identify recent advances and potential research priorities, which was the aim of the present study. This presentation covers the findings of this research review, covering deep-living species of corals in the orders Alcyonacea, Scleractinia, Antipatharia, Pennatulacea (class Anthozoa), and family Stylasteridae (class Hydrozoa).

Full Talks

1. Copper effects on cold-water octocorals under a climate change scenario: A land-based experiment towards environmental risk assessment for deep-sea mining

Inês Martins[1], Antonio Godinho[2], Teresa Cerqueira[1], Joana Goulart[1], Beatriz Mano[2],Raul Bettencourt[1], Joana Raimundo[4], Miguel Caetano[4],Marina Carreiro e Silva[2]

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Abstract

The commercial demand for metal resources has raised the interest of mining industry for deep-sea floor exploitation of mineral ores. The remobilization of metals, such as copper (Cu), trapped in the mining sediments, has been identified as a major threat for deep-sea benthic species. In parallel, there is a growing concern regarding ocean acidification (OA), driven by increasing atmospheric carbon dioxide concentrations and how metal toxicity and OA can interplay and impact deep-sea communities. To predict how the potential cumulative effects of Cu toxicity and climate change will impact deep-sea vulnerable communities such as cold-water corals (CWC), it´s important to assess the extent of organism's physiological adaptations to both stressors. Therefore, a land-based experiment was designed to expose two cold-water octocorals species, *Dentomuricea* aff.*meteor* and *Viminella flagellum*, to low seawater pH and high copper (Cu) concentrations scenarios. Four OA/Cu-contamination scenarios were used: (1) ambient pCO_2/pH level as measured *in situ* conditions (385 µatm/ pH 8.09); (2) high pCO_2/reduced pH (1,000 µatm/ pH 7.73); (3) ambient pCO_2/pH level and additional Cu concentration (60 µg/L); (4) high pCO_2/reduced pH and additional Cu concentration (60 µg/L). The pH/pCO_2 modification was achieved by bubbling seawater with either pure CO_2 (to increase pCO_2) or CO_2 low air (to decrease pCO_2). Respiration rates and metabolic (LDH, MDH, Hsp70, CA and RNA/DNA ratio), oxidative damage (SOD, GPx, CAT, LPO) and detoxification (GST) biomarkers were measured and RNA transcripts evaluated, to assess cold-water corals physiological response after the exposure period. Our results show that under a scenario of Cu-exposure/ocean acidification, both *D.*

aff.*meteor* and *V.flagellum* triggered distinct cellular responses, although with similar mortality rates. Herein, we discuss the cold-water octocorals sensitivity and physiological specificities to environmental risks such as deep-sea mining, metal contamination, as well as the cumulative impacts of climate change.

2. Effects of temperature on cold-water coral holobiont in the Atlantic Ocean

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Abstract

Cold-water coral (CWC) reefs are facing serious anthropogenic threats, particularly in submarine canyons, because of unsustainable fishing activities (e.g., trawling), pollution (by oil, seabed mining, plastics), and global changes (temperature increase, ocean acidification, deoxygenation). While recent works show that Mediterranean corals, which live in waters at 13 to 14 °C, are particularly sensitive to temperature rise, the impacts of increasing temperatures on corals from the NE Atlantic Ocean, living at lower temperatures (8 to 12 °C), are still not well documented. The aim of this study was to determine if Atlantic corals have the same response to changing sea water temperature as the Mediterranean population. Specifically, we investigated the impact of warming on the health of *Desmophyllum pertusum*, the most sensitive species in the Mediterranean Sea. Corals were exposed to temperatures corresponding to different warming scenarios (control, +3 °C and +5 °C), and the coral ecology was studied at the holobiont scale by measuring mortality, growth and microbiome diversity. We observed a significant reduction in survival at the highest temperature level, but no effect on polyp's growth. Bacterial community composition and diversity were both affected by elevated temperatures. Interestingly, differences in microbiome composition between colonies within a same treatment suggested specific bacterial signature associated with each colony. We conclude that Atlantic CWC have different physiological response to warming compared to the Mediterranean population, in terms of survival, growth response and specific bacterial community composition at the colony level.

3. Stylasterid corals build aragonite skeletons in undersaturated water despite low pH at the site of calcification

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Abstract

Anthropogenic carbon emissions are causing seawater pH to decline, yet its impact on marine calcifiers is uncertain. Scleractinian corals and coralline algae strongly elevate the pH of their calcifying fluid (CF) to promote calcification. Other organisms adopt less energetically demanding calcification approaches but restrict their habitat. Stylasterid corals occur widely (extending well below the carbonate saturation horizon) and precipitate both aragonite and high-Mg calcite, however, their mode of biocalcification and resilience to ocean acidification are unknown. Here we measure skeletal boron isotopes ($\delta^{11}B$),

B/Ca, and U/Ca to provide the first assessment of pH and rate of seawater flushing of stylasterid CF. Remarkably, both aragonitic and high-Mg calcitic stylasterids have low $\delta^{11}B$ values implying little modification of internal pH. Collectively, our results suggest stylasterids have low seawater exchange rates into the calcifying space or rely on organic molecule templating to facilitate calcification. Thus, despite occupying similar niches to Scleractinia, Stylasteridae exhibit highly contrasting biocalcification, calling into question their resilience to ocean acidification.

4. Using natural analogues to evaluate the resilience of cold-water coral reefs to changes in environmental conditions.

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Abstract

Current knowledge of the response of cold-water coral (CWC) reefs to ocean acidification and warming is limited and based mainly on observations from short-term perturbation experiments on a few coral species. It is difficult to correctly up-scale from these and predict effects of climate change on CWC reefs because laboratory experiments are run on a temporal scale of months to a year, which is unlikely to correctly elucidate how organisms that become several hundreds, if not thousands, of years old will respond to long-term changes in ocean chemistry and temperature. Here, we present two studies were small-scale vertical and horizontal gradients in carbonate chemistry, temperature and food availability around 5 Norwegian CWC reefs were used to assess how the interaction of multiple drivers affects the structure and functioning of CWC reefs. The first study compares species occurrences and the metabolic cost of survival of key species at the CWC reef at the LoVe Node 7 methane seep, with two near-by reefs. At Node 7 methane has been seeping since the establishment of the reefs 7,000-10,000 years ago. The second study surveyed the macro-fauna species composition along steep vertical fjord walls with well documented vertical gradients in carbonate chemistry and temperature. Multivariate statistics demonstrated a dominant role of temperature in structuring the wall reef communities, while carbonate chemistry and food availability only played sub-ordinate roles in this. At lower temperatures scleractinian corals, large sized gorgonians and sponges dominate and were replaced by small gorgonian corals and fan shaped sponges at higher temperatures. Further work has documented the influence of the methane seepage and associated elevated CO^2 levels on community structure of CWC reefs and elucidate the critical physiological traits enabling the existence of reefs in environments naturally enriched in CO^2.

5. Behavioural and mucosal responses of the cup coral *Flabellum* (*Ulocyathus*) alabastrum to barite and bentonite sedimentation

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Abstract

As oil and gas exploration expands in deep-sea environments, understanding the impacts of wastes produced by these activities is urgent. One of the main wastes produced by offshore drilling is the discharge of drill muds (commonly including barite and bentonite). Knowledge of the impacts of these materials on deep-sea corals is limited, and previous laboratory studies have focused on reef-building *Desmophyllum pertusum* (*Lophelia pertusa*). Here, we investigated the effects of barite and bentonite on the behaviour and mucus secretion of the solitary cup-coral *Flabellum* (*Ulocyathus*) *alabastrum*. A total of ninety-six live corals were exposed to one of three experimental treatments (barite/BA, bentonite/BE, barite and bentonite combined/BA+BE) or assigned as an untreated control. For 10 days, individuals were exposed to BA, BE, or BA+BE to reach a target sedimentation depth of 6.3 mm, a frequently referenced probable no-effects threshold. Time-lapse videos and photography were used to monitor behavioural changes and mucus production. After 10 days of sedimentation, half the individuals in the control and in each treatment were preserved for histological analyses. The remaining individuals were monitored for an additional 10-day recovery period. Data analyses show that *F. alabastrum* has a strong behavioural reaction in response to sedimentation of the experimental treatments, particularly in regards to the levels of polyp swelling. Visible mucus secretion was also observed in exposed individuals, and never in the controls. Overall, polyp reaction and mucus production were most severe in the BA+BE treatment, followed by exposure to BA alone, and BE alone. Despite the strong response observed, *F. alabastrum* showed a high recovery potential under the experimental conditions analyzed here. Histological analyses of potential differences of cnidae between treatments will also be discussed. Conclusions from this study indicate that sedimentation of common drill wastes below a 6.3 mm depth may cause observable changes in *F. alabastrum*.

6. Resource acquisition of the deep-sea octocoral *Viminella flagellum* under ocean acidification and varying food availability

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Abstract

Climate change is expected to impact deep-sea ecosystems through a variety of stressors, including ocean acidification and a decrease in food supply. Despite increasing concerns on the potential of deep-sea corals to withstand such changes, attention has mainly focused on scleractinian species. The objective of this study was to determine the impacts of ocean acidification and variable food availability on the whip coral *Viminella flagellum*, a common octocoral in deep-sea benthic communities in the

North Atlantic and Mediterranean. A multifactorial experiment was performed with live colonies of the species which were kept under two pCO_2 treatments (ambient and elevated levels projected for the end of the century by the IPCC) and three concentrations of live zooplankton prey corresponding to three food treatments (fasting, low and high) for six weeks. Provided food was enriched with stable isotopes (^{13}C and ^{15}N) to evaluate the ability of the species to acquire and incorporate C and N from the provided food in coral tissue. Prey capture, polyp activity and oxygen consumption were also determined throughout the experiment. Under conditions of high pCO_2, colonies displayed lower metabolic activity, a response that was more pronounced under fasting. Although there were no significant effects of pCO^2 on the incorporation of C and N in the coral tissue, higher food availability did not counteract the negative effects of ocean acidification on coral metabolism. To our knowledge, this is the first study to determine the effects of multiple climate change stressors to a deep-sea octocoral.

7. Assessing the Single and Multiple Effects of Warming, Acidification and Deoxygenation on the Ecophysiology of the Cold-Water Coral *Dendrophyllia cornigera*

Cristina Gutiérrez-Zárate[1], Alfredo Veiga[2], Andrea Gori[3], MartaÁlvarez[4], Rubén Acerbi[4], Marta M.Varela[4], Rodrigo Alba[4], Joaquín Valencia-Vila[4], Covadonga Orejas[1]

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Abstract

The currently available knowledge on the consequences of the ongoing global change for Cold-Water Coral (CWC) dominated ecosystems is still very limited. Global change projections show these ecosystems will be exposed to warming, acidification and deoxygenation. These stressors will act simultaneously but their possible interactions remain largely unknown. Hence, there is a need to investigate the combined effects of these stressors to achieve a better understanding of the effects of global change on the structure and functioning of deep-benthic ecosystems. To assess the single and combined effects of warming, acidification and deoxygenation on the CWC *Dendrophyllia cornigera*, we conducted a multi-stressor experiment at the Aquarium Finisterrae (A Coruña, Spain). Coral nubbins were exposed to eight experimental treatments, based on the current *in situ* conditions and the IPCC RCP 8.5 projections for the North Atlantic. Throughout 10 months of experimental time (May 2022-February 2023), several ecophysiological key traits were regularly monitored as response variables: skeletal growth, tissue coverage, respiration and excretion. The preliminary results that will be presented will be an important and novel contribution for a better understanding of the ecophysiology of this CWC species under different climate scenarios, as well as of its resilience to global change.

8. Single and multiple stressor impacts of deep-sea mining and climate change on cold-water corals

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Abstract

Assessing species' sensitivities to anthropogenic stressors is essential for the appropriate management and conservation of marine ecosystems. Mining for deep-sea mineral resources represents one of the most pressing threats to deep-sea ecosystems. These activities will occur in parallel to changes in deep-water mass properties, including ocean warming, acidification (OA), deoxygenation and reduced levels of food supply to the seafloor, predicted under future climate scenarios. Climate stress may reduce the recovery capacity of benthic communities following human activities, compromising ecosystem structure and function in the deep sea. Here, we present an overview of a series of aquaria-based experiments on different cold-water coral taxa (scleractinians, octocorals, antipatharians) to test the effects of suspended polymetallic sulphide (PMS) particles generated during potential mining of seafloor massive sulphide deposits from an inactive hydrothermal vent field in the Azores, northeast Atlantic. This stressor was tested alone or in combination with climate change scenarios: 1) A one-month experiment investigated the effects of different concentrations of PMS particles on the physiology of the octocoral *Dentomuricea* aff. *meteor*; 2) A medium-term experiment of 4 months investigated the cumulative effects of OA and reduced food supply, with a final one-week exposure to PMS particles, on the scleractinian *Desmophyllum dianthus*; 3) A recent exploratory experiment studied the response of the black coral *Antipathella wollastoni* to a short-term (8 hours) combined effects of OA and PMS particles under atmospheric and hyperbaric conditions. Taken together, experimental results show that while there were species-specific physiological responses, relatively low concentrations of PMS particles can impair coral physiology, likely from combined and potentially synergistic mechanical and toxicological effects, ultimately resulting in their death within a short period. These studies produce important data that can be incorporated into standards and guidelines for deep-sea mining industries and the International Seabed Authority (ISA)'s deep-sea mineral exploitation regulations.

9. Turbulence affects larval vertical swimming in the cold-water coral *Lophelia pertusa*

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Abstract

Vertical migration of marine larvae may drastically affect their dispersal, especially if they are spawned in the deep sea. Previous studies have shown that the planktonic larvae of the cold-water coral *Lophelia pertusa* in still water swim upwards at a speed of ca. 0.5 mm s^{-1} during a pre-competency period of 3–

5 weeks. This behavioral trait is thought to benefit dispersion of larvae as it promotes near surface drift in relatively strong currents. In the ocean however, larvae regularly encounter turbulent water movements potentially impeding their swimming ability. With no apparent stabilizing mechanism, it may be expected that the body orientation of these larvae, and consequently their directed swimming, is sensitive to perturbation by external forces. We investigated the effects of turbulence on vertical swimming of pre-competent *L. pertusa* larvae by exposing them to relevant turbulence intensities within a grid-stirred tank. Larval movement and water flow were simultaneously recorded, allowing for analysis of individual larval swimming velocities. We showed that the upwards directed swimming speed generally decreased with increasing turbulence, dropping to non-significant in turbulence levels occurring near ocean boundaries. Our results do however suggest that *L. pertusa* larvae maintain their upwards directed swimming, albeit at reduced speed, in a major part of the water column, thus allowing them to spend part of their planktonic phase in the uppermost ocean layer. This new insight into the behavior of *L. pertusa* larvae in their natural environment strengthens the notion of the species as one with strong potential for long-distance dispersal. Such information is vitally important when designing management strategies aimed at conserving and restoring *L. pertusa* reefs and the valuable ecosystems they sustain.

10. Larval ecology of *Desmophyllum dianthus* in the Chilean fjords

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Abstract

The study of cold-water corals (CWCs) has increased in the last few decades. These organisms are widespread across the oceans and many species are habitat-forming, which makes them play an important role in benthic deep-sea communities. However, despite the growing interest in recent years, knowledge in the biology and ecology of these organisms is still not well understood, especially regarding the reproductive and larval ecology. The difficulties of studying deep-sea species *in situ* and the challenges to keep them in aquaria systems greatly limit such studies. In sessile organisms such as CWCs, a better understanding of their planktonic stages through larval development, dispersal and recruitment are key to predicting the success and adaptation of the species in the face of present and upcoming anthropogenic impacts. Here we present results on the early life history of *Desmophyllum dianthus* collected from the Chilean fjords, where due to special conditions is possible to find this specie from diving depths. In this study adult corals were brought into aquaria prior to their spawning season and complete embryogenesis and larval development were observed and documented using light microscopy. This is the first part in a wider studying looking at fertilization, embryogenesis, larval development and settling in this globally widespread cold coral species.

11. Comparative study of reproductive traits of a West Atlantic Gorgonian (Paramuricea) species after recent speciation

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Abstract
Coral gardens of the Atlantic coast of southern Portugal comprise rich, multi-specific communities. The gorgonian *Paramuricea grayi* is a dominant species in circalittoral habitats around Cape St. Vincent, where yellow and purple color variants are found. Recent molecular work has shown that *P. grayi* is the sister species of the Mediterranean *P. clavata* and identified an additional speciation event within *P. grayi* congruent with the two color morphotypes which form two segregating lineages. We studied the reproductive and larval biology of the two color morphs of *P. grayi* in 2022 using coral biomass from fisheries' by-catch. Repeated nightly release of eggs from the purple color morph started three days after the new moon of September, with offspring showing three color variants. Eggs developed into embryos a few hours after fertilization and were found either embedded in mucus threads or adhered to other substrates due to their stickiness. Negatively photo tactic and slowly crawling larvae developed after 1-2 days and started swimming after 6 days. Settlement trials using several uncured artificial and natural substrates showed that the first settlement occurred after counterclockwise rotation and extensive substrate testing of the larvae at ~20 days with a clear preference for gorgonian skeleton. The yellow morphotype of *P. grayi* released positive buoyant eggs at the end of October. Buoyancy decreased during embryogenesis (1 day). Larvae were not photosensitive, swimming activity occurred in all dimensions and increased after 4-5 days. The first settlement, occurred after ~7 days, after comparatively fast swimming behavior. The asynchronous timing of reproduction and contrasting reproductive traits observed here for the two *P. grayi* color morphs lend further support to the recent genomics-based hypothesis that the lineages represent two reproductively isolated entities.

12. Reproductive mode, larval settlement and development of a New Zealand deep-sea stony coral, *Goniocorella dumosa*

Jenny Beaumont[1], Graeme Moss[1], Di Tracey[1], Vonda Cummings[1], Rhian Waller[2], Peter Marriott[1], Malcolm Clark[1]

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Abstract
Little is known of the reproductive traits and dispersal potential of many deep-sea corals, and in-aquarium spawning has been observed for very few species globally. Here, we document the first known observation of larval release by *Goniocorella dumosa,* a habitat-forming deep-sea scleractinian stony coral found in the New Zealand region. In contrast to previous understanding that *G. dumosa* were broadcast spawners, colonies of *G. dumosa* held in an aquarium released large (approx. 1.1 mm x 0.8 mm) free-swimming planula larvae. Further investigation confirmed that this species is a brooder, with up to 10 mature larvae found in single mature polyps. We describe the observed larval behaviour, settlement and post-larval growth and development of *G. dumosa*. The more limited dispersal potential of larvae from a brooding species compared to a broadcast spawning coral has significant implications for both population connectivity, and for the potential recovery of this species from disturbance by human activities. This in turn could influence management and protection strategies for *G. dumosa* and their habitat.

Speed Talks

1. A Multipurpose Aquaria Experimental Set Up Studying the Interaction of Environmental Stressors in a Cold-Water Coral Species

Alfredo Veiga[1], Cristina Gutiérrez-Zárate[2], Leo Domínguez[1], Fabián Gerpe[1], Alberto Rodríguez[1], Noelia Arias[1], Marta Álvarez[2], Rubén Acerbi[2], Juancho Movilla[3], Marta M.Varela[2], Rodrigo Alba[2], Joaquín Valencia-Vila[2], Andrea Gori[4], Covadonga Orejas[2]

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Abstract

Climate change is affecting not only the shallow areas of oceans and seas, but also the deep-sea realm. Cold-water corals (CWCs) are some of the most relevant ecosystem engineers in the deep sea and, although our understanding on how the alteration of environmental parameters might individually affect their physiology has broadened in the last decades, the combined effect of several of these altered conditions is still unknown. With the aim of understanding the possible interaction of higher temperature, lower pH and lower dissolved oxygen concentrations (DO) on CWCs, the Aquarium Finisterrae (A Coruña, Spain) has developed an experimental aquaria set up which allows to simultaneously manipulate these seawater parameters to investigate their effects on the physiological performance of these organisms. Within the research project iAtlantic, the system has been specifically used to simulate during ten months the IPCC scenarios for temperature, pH, and DO in order to study their effects on the ecophysiology of the CWC *Dendrophyllia cornigera*. The aquaria set up comprise 24 experimental aquaria under eight different treatments. A low-cost computer (Raspberry Pi) monitors and registers the data acquired by the temperature, pH, and DO probes. A homemade developed code allows the computer to act on a series of peripheral elements and so modify and adjust the target parameters in the aquaria. Control of pH and DO is performed by enabling solenoid valves that allow gas bubbling (CO^2 or N^2, respectively), whereas temperature control is performed by using heaters placed inside the tanks. The versatility of this system makes it a useful setup to carry on any experiment (at short, medium, or long term) with different kind of marine organisms and several simulated environmental factors.

2. Phenotypic responses of *Desmophyllum pertusum* to oceanographic factors across the Atlantic

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Abstract

Cold-water coral (CWC) reefs are formed through the growth and proliferation of corallites and colonies of a few constructional species, who are able to secrete calcium carbonate in the absence of light and photosynthetic symbionts. The sensitivity of these ecosystem engineers to ambient environmental

factors is highly relevant for the fate of the reefs they form and the communities they support, especially in widely distributed species exposed to a broad range of environmental conditions, such as *Desmophyllum pertusum* (*Lophelia pertusa*). Despite this importance, long-term, broad-scale variation in CWC growth parameters in response to environmental factors remains poorly known and challenging to investigate. In this study, we aimed to reveal general trends in oceanographic forcing of CWC growth, providing an alternative and complementary perspective to local and regional studies and laboratory experiments. Using *D. pertusum* skeletal samples collected from contrasting environmental settings across the Atlantic Ocean – covering a substantial portion of the species' environmental range – we measured biometric traits (corallite size, shape and budding) and analysed their relation to physiologically relevant seawater properties of the sampling sites (temperature, salinity, pH, dissolved oxygen and flow speed), compiled from the published literature. Among the investigated traits, corallite length and width and their relationship (aspect ratio) show the highest correlations to physicochemical factors, although general trends seem often concealed by high local variability. Furthermore, our results hint at the presence of peculiar regional adaptations of *D. pertusum* to its environmental setting, which should be further explored and compared.

3. Ontogenetic differences in the response of the cold-water coral *Caryophyllia huinayensis* to ocean acidification, warming and food availability

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Abstract

Cold-water corals (CWCs) have long been considered vulnerable to ocean acidification and/or warming, but this view has been challenged by recent findings. While most previous studies have addressed the short-term effects of single drivers on adult CWCs, little is known about the long-term and combined effects of acidification, warming and food availability on different life stages. Therefore, we conducted a six months aquarium experiment to investigate the responses in survival, somatic growth, calcification and respiration of early juvenile, late juvenile and adult life stages of *Caryophyllia huinayensis* to the single and interactive effects of aragonite saturation (0.8 and 2.5), temperature (11 and 15 °C) and food availability (8 and 87 µg C L^{-1}). The treatment levels reflect current ranges in the natural habitat of *C. huinayensis* in Comau Fjord, Chile. We observed a three months delay in response, particularly to the strongest drivers (elevated temperature and reduced feeding), presumably because the effects are only visible once energy reserves are depleted, suggesting that short-term experiments overestimate coral resilience. In the long-term, acidification alone had no effect, but warming and reduced food availability lowered their survival and calcification rates, both as single and combined drivers. The magnitude of change differed between life stages as calcification rates declined more in juvenile (by 70 %) than in adult corals (20 %). However, the latter had the highest mortality rate under elevated temperature (≥ 50%, both in the single and the combined treatment) that could not be compensated by increased food availability. Similarly, juvenile corals suffered health reduction and mortality under elevated temperature (0-50% mortality) that was lowered by elevated food availability (0-33%) across temperature treatments and juvenile life stages. Overall, our findings highlight the importance of considering interactive effects, appropriate duration of experiments and potential ontogenetic differences when investigating CWC susceptibility to climate change.

4. Antarctic deep-sea coral larvae may be resistant to end-century ocean warming

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Abstract
The Western Antarctic Peninsula is home to a diverse assemblage of deep-sea species and is warming faster than any other region in the Southern Hemisphere. This study investigated how larval development of the Antarctic cold-water coral *Flabellum impensum* was affected by temperatures consistent with ocean warming trends predicted for the twenty-first century. *F. impensum* larvae were cultured under four temperature conditions and scanning electron microscopy, transmission electron microscopy, and flow cytometry were used to compare settlement, mortality, development, deformity, and cellular health over the course of 44 days. While temperature did not impact settlement, mortality, or larval stress, the warmer treatments did have a significant impact on developmental rate. Samples exposed to warmer conditions developed faster than those in cooler conditions. Increased developmental rates were not accompanied by increased stress indicators such as deformity, mortality, or programmed cell death, suggesting that larval health was not negatively impacted by the rate change and may indicate that *F. impensum* larvae are tolerant of warming temperatures. Development and deformity assessments considered larval condition during the period between release and settlement, when larvae are thought to be especially sensitive to environmental impacts, and when the effects of those impacts on settlement or mortality may be particularly consequential for biogeography and population survival. These results suggest that larval development of *F. impensum* may be largely resistant to ocean warming trends predicted for the twenty-first century.

5. Multiple stressor impacts of deep-sea mining and ocean acidification on *Antipathella wollastoni* (Cnidaria: Antipatharia) under hyperbaric conditions

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Abstract
Deep-sea mining activities for mineral resource extraction generate sediment plumes that are expected to strongly impact benthic suspension feeders. These sensitive ecosystems are already threatened by climate change, making it important to test the combined effects of mining with predicted changes in seawater chemistry related to ocean acidification (OA). Furthermore, experimental studies to date have tested stressor effects at atmospheric conditions, giving an incomplete understanding on how physiological responses can be modulated by hydrostatic pressure. Here we describe an experiment simulating the effects of suspended polymetallic sulphide (PMS) particles, generated during potential mining activities and OA, under hyperbaric and atmospheric pressures, on the physiology of the black coral *Antipathella wollastoni*, a common inhabitant of island slopes in the Azores with a wide depth distribution (15-520 m). Corals were collected at depths between 27-40 m. Coral fragments were maintained in two 37-L aquaria for one week, half were kept under ambient pH (pCO^2=400 µatm/

pH=8.10), and half were acclimatized to a progressive decrease in pH to target conditions projected for 2,100 (IPCC 8.5, pCO^2=1,000 µatm/ pH=7.80). Coral fragments were then incubated, for 8 hours, in 8 experimental treatments in a fully crossed multifactorial experimental design with corals exposed to two pCO^2/pH conditions (ambient and IPCC 8.5 levels), two levels of PMS particles (0 and 10 mg/L), and two hydrostatic pressures (atmospheric and hyperbaric conditions (30bar, 300 m depth)). PMS particles were obtained from grinding inactive chimney rocks, from the Lucky Strike hydrothermal field in the Azores. Hyperbaric conditions were simulated with a pressure vessel IPOCAMP. The physiological conditions were measured at the whole-organism level (respiratory metabolism) and cellular levels (enzyme activity). Here we report the results obtained at the whole-organism level (respiratory metabolism) and discuss the potential consequences of mining activities to black coral habitats, and recommendations for mining industry operations.

6. Deepwater coral and sponge gardens in Alaska: Reproduction and recruitment in keystone species

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Abstract

Cold-water corals and sponges contribute significantly to the structure of the seafloor and provide habitats for a wide variety of other organisms, including commercially important species. Despite their essential role, these organisms are poorly understood compared to their tropical relatives. As a result of extensive seafloor mapping and the use of advanced technology in recent years, diverse and widely distributed coral and sponge gardens have been discovered in Alaskan waters. The presented project aims to get a comprehensive overview of the concrete ecological role and resilience of deep-sea corals and sponges in these environments by studying 1) recruitment processes in selected taxa of cold-water corals and sponges, 2) fertilization, 3) larval development and settlement behaviour in the Red Tree Coral, *Primnoa pacifica*, a dominant habitat-forming coral species, and 4) basic reproductive biology in selected sponge species. Sponge and coral tissues are examined histologically to study their reproductive structures and investigate their respective reproduction mode, sexuality, fecundity and periodicity. In addition, Autonomous Reef Monitoring Structures (ARMS) have been deployed within garden environments and will be examined for 3 consecutive years. These standardized collection devices provide a settling ground for larvae and other marine organisms, thus offering the unique potential to identify and study young corals and sponges and the overall garden biodiversity. Coral and sponge recruits settled on the plates are morphologically identified and analyzed for species diversity and potential population structure using genomic sequencing to provide information about spatial connectivity and the possible geographic origin of recruits. Understanding the reproduction and life histories of these organisms is the first step in concluding their potential resilience to a changing ocean. In addition, this information is essential to support the establishment of effective marine protected areas and provides the current state and baseline for corals and sponges in a changing ocean.

7. Pressurised aquaria for long-term experiments on deep-sea corals

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Abstract

The ARDECO project (Assessing Resilience of DEep COrals) aims at improving our understanding of the Ecology and Biology of deep-sea reef-building scleractinians (cold water corals), in the face of cumulative threats such as ocean warming, deoxygenation and acidification. One innovative aspect of the project is to achieve long-term incubations of these corals, using newly-designed aquaria which maintain pressure and temperature conditions similar to those prevailing *in situ*. Four identical aquaria were designed, of 6 L volume each, in order to run simultaneously control vs. treatment experiments (temperature and/or pH variations). Each aquarium may host 10-20 nubbins of coral colonies, each nubbin holding about 15-20 polyps. These mesocosms allow continuous renewal of seawater at about 10 L/hour flow rates, originating from a large reservoir (about 100 L) at atmospheric pressure, inside which pH is controlled. Working pressures range from atmospheric pressure to 30 MPa (3,000 m depth), and temperatures in the 5 to 15 °C range, and are set according to *in situ* conditions of the studied colonies. Additional features include a flow tunnel insuring internal stirring of the seawater, isobaric feeding (artemia larvae) in order to avoid repeated decompression stress, and visual access and illumination through PMMA conical viewports. Each device also includes a temperature-regulated filter situated downstream of the aquaria. Since aragonite dissolution increases with pressure, these pressurised aquaria shall provide a more realistic assessment of deep-sea scleractinian response to the cumulative impacts of acidification and warming.

8. Methods for estimating the reproductive capacity of morphologically complex cold-water corals

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Abstract

Cold-water corals face many external threats contributing to dislodgment, fragmentation, mortality, and reduced fitness. As corals contribute significantly to benthic habitat complexity, their loss ultimately contributes to the deterioration of deep-water benthic habitats. As a result, understanding the recovery potential of cold-water corals is crucial for assessing the resilience of these benthic communities. Importantly, reproduction underpins the recovery potential of cold-water corals. While some efforts have been made to resolve cold-water coral reproductive potential, a higher degree of resolution is necessary for better estimating their total reproductive output. Combining histological and morphological methodologies will allow us to examine the reproductive potential of cold-water corals more holistically. The purpose of this study is to quantify: fecundity, gamete size and stage, polyp density, and colony dimensionality from cold-water corals collected from various locations within the North-East Pacific. This will allow us to integrate both data streams and further estimate the reproductive capacity of individual colonies within a population. This research will investigate the intracolonial reproductive differences between polyps, total colonial dimensionality and outline a framework for calculating more accurately the total reproductive capacity of individual coral colonies within a population. To do this, cold-water coral samples from the Aleutian Islands and the Oregon

shelf will be examined. Initial results from the Aleutian Islands provide evidence that gametes mature asynchronously among polyps. Considering this result, we intend to utilize this information to inform our methodology while thoroughly analyzing seasonally collected samples of *Chromoplexaura marki* collected from the Oregon shelf. Doing so will allow us to build on previous research while continuing to better resolve our understanding of the reproductive capacity of cold-water corals using finer scale sampling. These results provide an avenue for expanding future research into reproductive efforts at a population scale.

9. Reproductive biology of the two main reef-building cold-water coral species (*Desmophyllum pertusum* and *Madrepora oculata*) in the Mediterranean Sea

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Abstract

Although cold-water coral (CWC) biology, physiology, and connectivity, have been extensively studied, few studies have so far focused on their reproductive biology. The reproductive biology of colonies of the reef-building *Lophelia pertusa* (Linnaeus 1758), now synonymised as *Desmophyllum pertusum*, and *Madrepora oculata*(Linnaeus 1758) from the Mediterranean Sea, an area particularly exposed to the effects of anthropogenic pressures, was investigated for the first time using histological techniques. Samples were collected from the Lacaze-Duthiers canyon in the Gulf of Lion, northwestern Mediterranean Sea, where the corals are living at 13 °C, close to their upper limit of thermal tolerance. The gametogenic cycle suggests a seasonal spawning of *D. pertusum* in autumn to early winter, similarly to population from the Gulf of Mexico. This period corresponds to the formation of storm-induced deep-sea water plumes, likely acting as a time giver for coral spawning and facilitates larval dispersal. *Madrepora oculata* shows continuous reproduction as already identified in eastern and western North Atlantic, with reproductive features of a species less opportunistic than *D. pertusum*, consistent with its other biological characteristics. The information provided on Mediterranean CWC reproduction traits will contribute to comprehensively understand differences in population's timing and so the endogenous or exogenous factors responsible for determining this periodicity.

10. The importance of the sexual reproductive condition of octocorals for the success of ecological restoration

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Abstract

Octocorals play an important role as ecosystem engineers in marine benthic communities. However, human activities are causing direct and indirect impacts to their populations over large geographic and bathymetric ranges. Assisted regeneration methods, such as coral transplantation, have been demonstrated as viable tools to speed up recovery of degraded shallow water coral populations. To date, several studies have reported survival and growth success in transplanted corals, but few have studied the effect of transplantation on coral reproductive potential. Here we evaluate the reproductive condition of two transplanted octocoral species, the *Eunicella singularis* in the shallow infralittoral of the Mediterranean and the deep-sea *Viminella flagellum* in the Atlantic. The reproductive condition of *E. singularis* was studied every year, for three years after fragmentation in different sizes and transplantation to 16-18 m, in Cap de Creus (NW Mediterranean), while in *V. flagellum*, the same colonies were studied before and after fragmentation and transplantation to 200 m depth in the Azores (NE Atlantic). Reproductive conditions were estimated by the diameter of sexual products, and number and volume per polyp. Results show that transplanted corals experienced a reduction in the reproductive condition in both species, with higher effect on males. The analyses of the effect of fragmentation on *E. singularis* showed contrasting results, with higher reproductive condition observed in smaller fragments for females and on larger fragments for male. In some *V. flagellum* female fragments, despite the lower oocyte output, were still fertile after transplantation. Moreover, the results suggest that both species may need more than three years to achieve a reproductive condition similar to their natural populations. It is therefore important to develop and refine techniques that improve the survivorship and sexual reproductive potential of transplanted corals to assure the long-term viability of restored populations with new recruits, genetic diversity, and gene flow.

11. Early-life stages of the cold-water gorgonian coral *Primnoella chilensis*

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Abstract

The discovery of extensive and biodiverse ecosystems formed by cold-water coral (CWCs) has called interest in these species during the last decades. From gorgonian and bamboo gardens in shallow and mesophotic reefs to deep-water reefs of scleractinian corals, many CWCs provide important three-dimensional structural habitat for a multitude of species. Despite their importance, many of these ecosystems are poorly understood. Chilean Patagonia is one of these ecosystems, where high abundances of different CWCs have been found. Nevertheless, this is not only one of the least studied marine regions worldwide, but it is also subject to intense fishing and aquaculture activities. One of the least known CWC endemic of this region is the sea whip *Primnoella chilensis*. Basic aspects of the biology of this species, such as early life stages, are not well known. Without this information, it is very difficult to predict the future of the populations o *P. chilensis* and how these are potentially affected by external stressors. For this study, we aimed to describe the timing and initial steps of spawning and embryogenesis of *P. chilensis*. To do so, we collected and maintained in aquaria colonies from the Comau Fjord, in the North Patagonian Zone. Specifically, we collected terminal snips of 10-12 cm from

32 different colonies by SCUBA between May 15-19th 2022. Previous histological work had suggested that spawning occurs between June and September and that this species could be a broadcast spawner, as no larvae has been observed in collected samples. Effectively, *P. chilensis* spawned between July 5th-14th, but contrary to expectations, this species turned out to be a brooder. Spawned larvae were big, negatively buoyant, and crawling. During the first days after spawning, the larvae settled and developed the first tentacles. These findings have important implications for the dispersal, connectivity, and ecology of the species.

12. Effects of various abiotic stressors on the early life stages of the cold-water coral *Lophelia pertusa*

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Abstract

The scleractinian cold-water coral *Lophelia pertusa* (*Desmophyllum pertusum*), forms three-dimensional reef structures creating complex habitats in the deep-sea, used as refuge and breeding grounds for many species. These *L. pertusa* reefs are at the forefront of threats from climate change and anthropogenic activities. While the effects of these threats on adult corals are well documented, little is known about the early life stages. Here we report the preliminary results of two experimental studies on the interactive effects of sediment plumes generated by bottom trawling with predicted changes in seawater chemistry related to ocean acidification (OA) and on the impact of microplastic pollution on the early life stages of *L. pertusa*. The cumulative effect of (OA) and bottom trawling was studied in a fully crossed experimental design with four treatments combining two scenarios of OA: two pCO^2 treatments (ambient and elevated levels projected for the end of the century) and natural benthic sediments at the concentrations of 0 and 5 mg/mL. These treatments were tested on embryos (2-4 cell stage) and on 12 days old larvae with a 24h exposure. The impact of microplastic pollution was investigated by using microplastics beads under three different treatments: no microplastics, 1,000 virgin microbeads /mL, 1,000 microbeads with biofilm /mL. These treatments were performed on 4 weeks old larvae with an exposure of 24h. Stressor effects on coral larvae were measured as survival rates, swimming behavior, morphometry, abnormalities for both experiments and also ingestion of microplastics. Results are discussed in the context of the potential consequences of the cumulative impacts of climate change and human impacts on the survival, dispersal potential and connectivity among *L. pertusa* populations. Understanding their vulnerability is also essential to aid management strategies to maintain the sustainability of the deep-sea coral ecosystems.

Session 3. Trophodynamics and Biogeochemical Cycling

Type	N	Presenter	Title
Keynote	1	Claudio Richter	Coupling of plankton, hydrodynamics and cold-water coral reefs
Keynote	2	Sandra Maier & Laurence De Clippele	Novel insights and approaches towards a deeper understanding of marine animal forest functioning
Full talk	1	Amanda Demopoulos	Trophic structure of deep-sea coral habitats along the U.S. Atlantic margin
Full talk	2	Beatriz Vihna	Trophic ecology of cold-water coral habitats of the Cabo Verde islands (NW Africa)
Full talk	3	Luis Greiffenhagen	Baseline ecological investigation of Fjordic Cold-Water Coral Reef Habitats: Biomass and Ecosystem Functions of five key-species comparing Sill Reefs to Wall Reefs
Speed talk	1	Evert de Froe	Food supply mechanisms towards a cold-water coral reef at Rockall Bank, North-East Atlantic Ocean.
Speed talk	2	Kostas Kiriakoulakis	Tracing particulate organic matter pathways in deep-sea ecosystems: Food supply and partitioning in Whittard canyon vulnerable marine ecosystems dominated by filter feeders
Speed talk	3	Wilder Greenman	Growth rates and trophic niches of deep-water corals in protected areas off Nova Scotia, Canada'
Speed talk	4	Anna van der Kaaden	Tiger reefs in the deep sea: self-organised regular patterns in cold-water coral reefs'
Speed talk	5	Narissa Bax	Uncovering the Blue Carbon Potential of the Burdwood Bank: Insights from Seafloor Ecosystem Engineers and Benthic Surveys

Keynote Abstracts

1. Coupling of plankton, hydrodynamics and cold-water coral reefs

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Abstract

Cold-water coral reefs are rich benthic ecosystems thriving in the oligotrophic deep-sea. How these oases are maintained in a desert ocean has fascinated coral scientists since Darwin. This lecture highlights the strategies by which CWC communities sponge up plankton; how hydrodynamics, zooplankton vertical migration and topography interact to cause local aggregations of zooplankton; and how these aggregations are intercepted by coral walls of mouths and tentacles. We will see that similar mechanisms fuel the productivity of deep and shallow-water suspension-feeder communities between the poles and the tropics, sustaining life in coral, sponge and ascidian animal forests. A potentially important feature governing CWC reefs are large-amplitude internal waves. These nonlinear solitary-like waves (or solitons) are generated by the ebb and flow of water across shallow topography and propagate along the density discontinuity (pycnocline) between warm/fresh surface and colder/saline

deep waters, with sometimes gargantuan dimensions. Dissipation of the solitons' energy in shoaling water enhances turbulent mixing, entrainment of sub-pycnocline material and pelagic-benthic coupling, with important repercussions for reef trophic dynamics, nutrient cycling and recruitment. Because solitons are ubiquitous in ocean, they may be an important yet so far understudied mechanism structuring benthic communities in oligotrophic waters.

2. Novel insights and approaches towards a deeper understanding of marine animal forest functioning

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Abstract

The deep sea is amongst the most food-limited habitats on Earth, as only a small fraction of the surface primary production is exported below 200 m water depth. At the same time, deep-sea ecosystems such as cold-water coral (CWC) reefs, coral gardens and sponge grounds are hotspots of biodiversity and biomass and provide essential ecosystem functions through carbon and nitrogen (CN) cycling and storage. In recent years, these ecosystem functions have been quantified by CN budgets at increasing precision and scale, from individual organisms (e.g. measurement of biomass and CN fluxes by ex-situ incubation), over reef patches (e.g. measurement of community respiration by in-situ aquatic eddy covariance) to entire reefs. For the latter, a novel approach integrates species (e.g. coral, sponge) surface area data from video surveys, species biomass, CN fluxes and multibeam data to produce reef-scale maps of biomass, CN stocks and CN turnover. These maps underline the paramount role of CWC reefs in the regional CN cycle and the paradox of how the reefs can be sustained in the resource-limited deep-sea. Here, we present this 'CN mapping approach', possible solutions to the CWC reef paradox, and methods to study these. For instance, stable isotope tracer experiments revealed that CWC reefs act as giant 'filter and recycling factories': Firstly, particles are effectively retained by the complex reef structure and diverse, well-adapted suspension feeders and secondly, metabolic waste products are closely recycled by the interacting reef fauna and microbiome. However, CWC reef functioning is threatened in the Anthropocene, by climate-induced changes in primary production, hydrodynamics, species distribution and dissolution of the carbonate reef structure. An integration of recently discovered trophic pathways into the reef 'CN maps' may provide crucial information on the resilience of CWC reefs today and in the future.

Full talks

1. Trophic structure of deep-sea coral habitats along the U.S. Atlantic margin

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Abstract

Deep-sea coral environments depend on the flux of organic matter transported via rapid currents for essential nutrients and food. While photosynthetically-derived particulate organic matter (POM) is a primary food subsidy for deep-sea corals in the U.S. mid-Atlantic canyons, broad-scale trophodynamic patterns across the region remain unknown. This study expands on our previous work by examining the spatial variability and interspecific patterns in the stable isotope ($\delta^{13}C$ and $\delta^{15}N$) values of corals and their associates and estimates the dominant nutritional resources across six deep-sea coral environments throughout U.S. Atlantic region. Our results also encompass mid-water species collected above an extensive *Desmophyllum pertusum* reef complex. POM isotopic composition overlapped among coral habitats, indicative of isotopic consistency in basal carbon sources. However, significant isotopic differences among feeding groups suggested spatial variability in the isotopic composition nutritional inputs and/or variation in food selection by suspension feeders in particular. Corals had lower isotopic values than sponges, which may be a function of food selection and/or differences in the composition and role of the microbiome. Mid-water communities exhibited reliance on surface-derived POM but were depleted in ^{15}N relative to benthic dwellers. Isotopic niches of mid-water pelagic feeders overlapped the greatest with suspension feeders residing on the seafloor, which may reflect assimilation of similar food resources at low trophic levels. Results will be presented within the broader context of previous trophic ecology studies conducted in the U.S. Atlantic and Gulf of Mexico, and will include newly developed isotope maps (i.e., isoscapes), illustrating faunal isotope variability over different spatial scales. Isoscapes provide road maps to understanding changing food resource use by residents with changing food availability, habitat use by migratory species, and decipher complex trophic relationships in deep-sea coral ecosystems.

2. Trophic ecology of cold-water coral habitats of the Cabo Verde islands (NW Africa)

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Abstract

Stable isotope analyses provide insights into the food sources, feeding strategies and trophic interactions of different habitats, being a good approach especially when direct observations are difficult, such as in cold-water coral (CWC) habitats. This study used stable carbon and nitrogen isotopes ($\delta^{13}C$ and $\delta^{15}N$) to investigate the trophic ecology of the unfathomed CWC community of the Cabo Verde archipelago (NW Africa, eastern Equatorial Atlantic Ocean). Samples were collected in the SW of the archipelago from 2100 to 1400 m depth at Cadamosto seamount and along the slopes of the islands of Fogo and Brava, during the iMirabilis2 expedition conducted in 2021 on board the Spanish Research Vessel Sarmiento de Gamboa. The most abundant CWC species and associated megabenthic fauna (Porifera, Echinodermata, Annelida and Crustacea) were collected as well as zooplankton. Particulate organic matter (POM), from sediment and water samples, was also collected to investigate its contribution as food source to the benthic megafauna. Our results reveal a food web fueled by organic matter from surface phytoplanktonic productivity ($\delta^{13}C$ of consumers ranging from-20.92 ± 0.30 to-

13.62 ± 4.81 ‰) and composed of four trophic levels (TL) ($\delta^{15}N$ of consumers ranging from 7.32 ± 0.66 to 18.30 ‰), with hexactinellid sponges displaying the highest $\delta^{15}N$ ratios (13.10 to 18.30 ‰). Zooplankton seems to be the most important food source to CWCs, in agreement to what has been observed for other Atlantic CWC habitats. Moreover, CWC epibionts occupy the same TL as their CWC host, suggesting the uptake of the same food sources and indicating a commensalism relationship between the two groups. Given the pristine status of the investigated Cabo Verde CWC community, understanding the baseline ecological functioning of CWCs and their associates in the region is fundamental for effective science-based management and conservation.

3. Baseline ecological investigation of Fjordic Cold-Water Coral Reef Habitats: Biomass and Ecosystem Functions of five key-species comparing Sill Reefs to Wall Reefs

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Abstract

This is the first study to map the biomass distribution and quantify the ecosystem functions of multiple cold-water coral (CWC) reefs within a fjord. For that, we specifically focus on the reef-building coral Desmophyllum pertusum (recently synonymised to *Lophelia pertusa),* and four CWC reef associated key filter-feeder species (*Geodia barretti, Acesta excavata, Mycale lingua* and, *Madrepora oculata)* within the Hardangerfjord, Norway, where CWC reefs exist both on walls and the sill in close proximity to each other. Using a methodology by De Clippele *et al.* 2021a, b, biomass was calculated from ROV video data. Coupled with high resolution terrain data, predictive maps were produced through a random forest model. Eventually, respiration data from the species enabled the estimation of carbon turnover and carbon stock as an ecosystem function. For a more holistic assessment of the CWC habitat, the contribution of dead framework and coral rubble was added. The results show that the studied habitat can be regarded as a hotspot of carbon turnover. Although *D. pertusum* made up most of the overall biomass, the associated filter feeders contribute substantially to carbon cycling within the habitat. Differentiating between sill reefs and the, still rather overlooked, wall reefs reveals that vertical habitat may have a relatively higher functional significance, e. g. carbon turnover (16.7 and 24.5 g m^{-2} y^{-1}, respectively), and host more suitable conditions for all species, except *D. pertusum*: The latter had a relative larger contribution when growing on the fjord's sill. Continued, further improved assessments of this type can provide a better understanding of the finescale distribution of these habitats and quantify their ecological role – which is both important for developing effective management strategies.

Speed talks

1. Food supply mechanisms towards a cold-water coral reef at Rockall Bank, North-East Atlantic Ocean.

Evert de Froe[1], Sandra Maier[2], Henriette Horn[3], George Wolff[4], Sabena Blackbird[4], Christian Mohn[5], Mads Schultz[6], Anna-Selma van der Kaaden[7], Chiu Cheng[8], Evi Wubben[9], Britt van Haastregt[7], Eva Friis Moller[10], Marc Lavaleye[7], Karline Soetaert[7], Gert-Jan Reichart[7], Dick van Oevelen[7]

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Abstract

Cold-water corals (CWCs) are important ecosystem engineers in the deep sea that provide habitat for numerous species and can form large coral mounds. These mounds influence surrounding currents and induce distinct hydrodynamic features, such as internal waves and episodic downwelling events that accelerate transport of organic matter towards the mounds, supplying the corals with food. To date, research on organic matter distribution at coral mounds has focused either on seasonal timescales or has provided single point snapshots. Data on food distribution at the timescale of a diurnal tidal cycle is currently limited. Here, we integrate physical, biogeochemical, and biological data throughout the water column along four stations on a transect over a CWC mound at Rockall Bank. The water column above the CWC mound was more dynamic than at other stations, with an internal wave passing at 300-meter depth. We suggest that there are three transport mechanisms that supply food to the CWC ecosystem. First, small phytodetritus particles are transported downwards to the seafloor by advection from internal waves, supplying high quality organic matter to the CWC reef community. Second, the shoaling of deeper nutrient-rich water into the surface water layer above the coral mound could stimulate diatom growth, which form fast-sinking aggregates. Third, evidence from lipid analysis indicates that zooplankton faecal pellets also enhance supply of organic matter to the reef communities. This study is the first to report organic matter quality and composition over a tidal cycle at a coral mound and provides evidence that fresh high-quality organic matter is transported towards a coral reef during a tidal cycle. Our study confirms that the CWC reef benthic community feeds on a variety of food sources, yet ultimately depends on surface primary production.

2. **Tracing particulate organic matter pathways in deep-sea ecosystems: Food supply and partitioning in Whittard canyon vulnerable marine ecosystems dominated by filter feeders.**

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Abstract

Near bottom (<15 m above bottom) suspended Particulate Organic Matter (POM^{susp}), *Acesta excavata* mussels and two species of Scleractinian cold water corals (CWCs), *Madrepora oculata* and *Lophelia pertusa*, were collected during two surveys in June 2014 and August-September 2015 from several

depths and branches of the Whittard Canyon System (WCS) in the Celtic Sea. The work aimed to investigate trophic dynamics and resource partitioning between overlapping filter feeding phyla in vulnerable deep-sea ecosystems. Specifically, elemental (OC, N), bulk isotopic ($\delta^{13}C$, $\delta^{15}N$), and lipid analyses from selected locations were carried out to a) characterise the nutritional quality and quantity of POM^{susp} and b) trace the organic matter signal to biological tissues. OC and molar C/N ratios of POM^{susp} were similar to previous studies for WCS, showing a typically marine signal. However $\delta^{13}C$ and $\delta^{15}N$ bulk isotopes of POM^{susp} were-27.5±1.8 ‰ and 11.9±3.4 ‰ respectively, showing an unusually 'light' signal. Additionally, the nutritional quality of POM^{susp}, approximated by relative amounts of polyunsaturated fatty acids, was low (PUFAs; 0.32±0.23% of total lipids). PCA with Simprof clustering showed distinct grouping between the lipid profiles of POM^{susp}, and *A. excavata* and CWCs tissues. Significant differences were detected between isotope signatures of POM^{susp}, *A. excavata* and CWCs. Several explanations are discussed, related to timing of sampling, potential internal recycling and trophic upgrading of the investigated filter feeders and/or the degrading impact of the complex and occasionally anthropogenically induced hydrodynamics of the areas sampled.

3. Growth rates and trophic niches of deep-water corals in protected areas off Nova Scotia, Canada

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Abstract

Beginning in the early 2000s, a series of Marine Protected Areas (MPAs) and coral/sponge conservation areas totaling over 60,000 km^2 have been established off Nova Scotia. Establishment of the coral and sponge conservation areas was initially based on concentration of biomass/abundance followed by more detailed ecological and biological analyses from *in situ* observations. During summer, 2022, a remotely operated vehicle (ROV)-enabled expedition aboard the industry vessel M/V *Atlantic Condor* surveyed areas off Nova Scotia, including the Stone Fence and Shortland Canyon within the Eastern Canyons Marine Refuge and the Gully MPA. Extensive seafloor video footage, paired with age/growth analyses and stable C and N isotopic analysis of collected samples provide new insights on the factors controlling deep-water coral (DWC) ecosystem dynamics. *Paragorgia arborea*, *Primnoa resedaeformis*, and *Keratoisis gravi* are the dominant DWC species observed in these areas. Based on growth ring skeletochronology, vertical growth rates for *Primnoa* average 1.8 cm/yr where growing on vertical outcrops (Gully and Shortland Canyon), 3.7 cm/yr where growing on boulder and gravel substrate (Stone Fence). These early results highlight substrate as an important driver of DWC population dynamics. Corals and sponges colonizing vertical outcrops also exhibit a distinct species zonation. *Paragorgia* most commonly occurs on outcrop ridge crests, where current speeds appear to be highest. *Primnoa* occupies the next top few meters of outcrop, whereas *Keratoisis* occurs lower down on the cliff face. Tissue $\delta^{15}N$ values of 8-9‰ are observed for *Paragorgia* and *Primnoa*, and ~10‰ for *Keratoisis*. Sponges growing among the corals have $\delta^{15}N$ values of up to 17‰ indicating that they occupy a higher trophic position than corals in these locations. Ongoing amino acid-specific isotope analysis will be used to examine the apparent trophic niche separation among these species.

4. Tiger reefs in the deep sea: self-organised regular patterns in cold-water coral reefs

Anna van der Kaaden[1,2], Sandra Maier[3], Laurence De Clippele[4], Johan van de Koppel[2], Sam Purkis[5], Max Rietkerk[1], Koen Siteur[6], Karline Soetaert[2], Dick van Oevelen[2]

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Abstract

Self-organized, regularly patterned ecosystems store more biomass and are more resilient than spatially uniform systems. Framework-forming cold-water corals are ecosystem engineers that build extensive reefs on the deep seafloor and provide critical habitat for increased biodiversity. We used variograms and Lomb-Scargle analysis of seven annotated video transects to analyse spatial patterns in live coral and dead coral (i.e., skeletal remains) cover at the Logachev Coral Mound Province (NE Atlantic Ocean). We found regular spatial patterning in live and dead coral distribution along these transects that point to self-organization of cold-water coral reefs. These self-organized patterns had length-scales between 50 m and 450 m. With this identification of cold-water corals as a self-organized system (nicknamed 'tiger reefs' after 'tiger bushes', the archetypical example of self-organization from the terrestrial realm), brings forward the hypothesis that, due to the patterned state, cold-water coral ecosystems may be more resilient to environmental change than previously expected. Live corals grow on dead coral framework that remains in the environment for extended periods of time, providing a template for spatial patterns, thus facilitating the recovery of living corals. Disturbances that remove the pattern template (e.g., ocean acidification and bottom trawling) are thus likely detrimental for cold-water coral recovery and restoration efforts can be more effective when following the regular patterns that are naturally present.

5. Uncovering the Blue Carbon Potential of the Burdwood Bank: Insights from Seafloor Ecosystem Engineers and Benthic Surveys

Narissa Bax[1], Ander de Lecea[2], Santiago Pineda-Metz[3], Betina Frinault[4], Alejandro Roman Gonzalez[5], Rachel Downey[6], Chester Sands[4], Simon Morley[4], David Barnes[4]

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Abstract

'Blue carbon' (CO2 stored in ocean habitats) and ecosystem engineers on the seafloor (carbon held in ocean life) are becoming increasingly relevant as conservation-policy frameworks, especially at high latitudes. The Burdwood Bank plateau is a productive section of the Patagonian Shelf Large Marine Ecosystem (LME), connecting marine life from the Scotia Arc, South America, and the sub-Antarctic. Many iconic marine mammals, birds, and fisheries depend on this high production, but there is

mounting evidence that it also benefits seabed benthic species. The Burdwood Bank may become a Marine Managed Area (MMA), a form of Marine Protected Area (MPA). Yet, better data are needed to define, classify, and manage benthic habitats there. In 2018, benthic surveys found 1) a huge number of cold water coral species, 2) many species residing at their Northernmost and Southernmost ranges, and 3) massive amounts of biological carbonate material. Long-term carbonate accumulation may imply a large marine ('blue') carbon sink. 2019 benthic surveys on the Eastern Burdwood Bank and Falkland Islands shelf clarified these findings and improved carbon storage and sequestration estimate potential. Estimates of carbon storage and sequestration capacity by abundant habitat-forming groups like Stylasteridae (lace), octocoral (soft), and scleractinian (cup) coral and sponge assemblages add to the conservation significance of this region, and the resulting seafloor biota insights illustrate an emerging basis for blue carbon research in the Falkland Islands, a potential biodiversity and blue carbon hotspot with a high estimated sequestration capacity. Blue carbon investigations in Antarctica suggest similar seafloor assemblages are carbon sinks and climate change feedback mechanisms.

Session 4. Geological Approaches

Type	N	Presenter	Title
Keynote	1	Norbert Frank	The Cold-Water Corals View of the Thermocline Atlantic since the Last Glacial Maximum
Keynote	2	Claudia Wienberg	Cold-water coral mounds - unique archives of reef growth in the geological past: What do we know after 25 years of research?
Full talk	1	Ashley Davis	Reconstructing the last millenium of ocean biogeochemistry around Aotearoa New Zealand using deep-sea black corals
Full talk	2	Daniel Sinclair	Trace Elements in Black Corals – Investigating Potential New Palaeoceanographic Proxies
Full talk	3	Evan Edinger	Calculating calcium carbonate production of a colonial scleractinian coral community in the northern Bay of Biscay: short-term and long-term estimates *
Full talk	4	Jürgen Titschack	AMOC-driven intermediate water-mass stratification favoured cold-water coral mound formation off Mauritania since the last glacial
Full talk	5	Dierk Hebbeln	Deglacial development of cold-water corals off northern Argentina driven by variability of the Atlantic Meridional Overturning Circulation
Full talk	6	Andy Wheeler	Are Submarine Canyons Refugia for Scleractinian Cold-water Corals in Glacial Periods?: Evidence from the Porcupine Bank Canyon, NE Atlantic
Speed talk	1	Frank Parrish	Elemental composition of the proteinaceous skeleton of Hawaiian Gold Coral (*Kulamanamana haumeaae*)
Speed talk	2	James Kershaw	Controls on stylasterid skeletal Mg/Ca and Li/Ca ratios
Speed talk	3	Lélia Matos	Deep-sea corals as archives of export production on a multiproxy study
Speed talk	4	Laura Piccirillo	Growth rates and ages of two deep-sea bamboo coral species from the Northwest Atlantic
Speed talk	5	Gervaise Barre	Evaluating the thermal adaptation of *Lophelia pertusa*: Insights from paleo-reconstructions and present-day thermal amplitude
Speed talk	6	Rodrigo da Costa Portilho Ramos	Cold-water coral response to past expansion of the shallow oxygen minimum zone off Angola margin
Speed talk	7	Narissa Bax	Exploring the Mesophotic Zone: Investigating Coral Gardens as Model Habitats in the Falkland Islands'
Speed talk	8	Chelsea Korpanty	Decline in cold-water coral growth promotes molluscan diversity: A paleontological perspective from a cold-water coral mound in the western Mediterranean Sea
Speed talk	9	Ruby Schwartz	Temporal Diversity Dynamics Of Benthic Invertebrates In A Quaternary Cold-Water Coral Mound: Alboran Sea (Mediterranean Sea)
Speed talk	10	Guillem Corbera	Intermediate water mass circulation variations during the last glacial cycle and its potential role in controlling cold-water coral mound development off Tunisia

Keynote Abstracts

1. The Cold-Water Corals View of the Thermocline Atlantic since the Last Glacial Maximum

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Abstract

Some 25 years ago with three enigmatic publications about the climate messages of deep-sea corals a journey started which led to many innovations. Today, thousands of studied deep-sea corals allow for a better understanding of the climate influence on the mid-depth Atlantic heat and carbon balance since the Last Glacial Maximum. Such corals are unique archives for absolute Th/U age determination as will be demonstrated here based on more than 900 precisely dated corals. It will be further demonstrated that cold-water coral reefs have hidden timescales of aggradation and stagnation, which will allow establishing first mathematical models and systematic reef sampling for climate research. While geochemical isotope tracers have revealed novel perspectives on past Atlantic Ocean dynamics and carbon cycling, only few systematic investigations exist. Here, the past ten years effort of research at Heidelberg University are presented to reveal the Atlantic thermocline temperature and ventilation history since the LGM. Corals Li/Mg temperatures demonstrate a deepening of the thermocline and horizontal displacements of water mass fronts during the deglaciation. Those changes are accompanied by fresh water releases into the North Atlantic traced through ^{234}U excess and a distinct ventilation difference of waters North and South of today's Azores Front. Lastly, Nd isotopes fingerprint both continental and hydrothermal Nd sources and advection of Nd through the basin scale boundary currents and recirculation gyres. Tina van de Flierdt and coworkers stated back in 2010 (GCA, 74, p6014–6032) for certain species of deep-sea corals, the growth rate allows time resolution that is comparable to ice cores. What if the Atlantics framework forming cold-water coral reefs are the 'ice sheets' of the upper thermocline ocean tracking the eddy driven flow of water closely related to the atmospheric wind forcing on times scales of years to decades for as long as millions of years?

2. Cold-water coral reefs and mounds in the oxygen minimum zones off West Africa

Claudia Wienberg[1], André Freiwald[2], Norbert Frank[3], Furu Mienis[4], Jürgen Titschack[1], Covadonga Orejas[5], Andrea Schröder-Ritzrau[3], Elvira Beisel[3], Leonardo Tamborrino[1], Ulrike Hanz[6], Sophia Stavrakoudis[1], Dierk Hebbeln[1]

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Abstract

The discoveries of large reefs within cold-water coral mound provinces revealed that the West African margin is a coral hotspot area in the Atlantic Ocean. The most striking observation is that cold-water

corals thrive in extensive oxygen minimum zones under extreme conditions. This points to a wide tolerance of cold-water corals in these regions to low oxygen concentrations of less than 1.5 mL L^{-1}. The coral mound provinces off Mauritania, Angola, and Namibia are located in the centre of the local oxygen minimum zones, and are characterised by highly productive, oxygen-depleted, and relatively warm environmental conditions. However, they differ considerably with respect to the present-day reef status and the timing of mound formation during the last glacial-interglacial cycle. Here, we present an overview about the regional oceanographic, bio-ecological, and geo-morphological settings of the three West African coral mound provinces and provide a detailed insight into their development during the last 70 kiloyears. This study is part of the new volume of the Springer-series 'Coral Reefs of the World' entitled 'Cold-Water Coral Reefs of the World.

Full talks

1. Reconstructing the last millennium of ocean biogeochemistry around Aotearoa New Zealand using deep-sea corals

Ashley Davis[1,2], Daniel Sinclair[2], Di Tracey[1], Erik Behrens[1], Stewart Fallon[3], John Hellstrom[4], Sarah Bury[1], Julie Brown[1], Amandine Sabadel[1,5], Nicholas Hitt[6]

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Abstract

Deep-sea corals (DSC) are valuable paleoarchives due to their global distribution, longevity, and radiometric datetability. They are particularly useful in mid-latitude oceanic regions such as Aotearoa New Zealand where high-resolution records from tropical corals and sediment cores are not available. Black corals (Order Antipatharia) incorporate the specific isotope values of the surface ocean particulate organic matter they ingest into their proteinaceous skeletons reflecting surface ocean biogeochemistry. NIWA houses an extensive collection of DSC from the Southwest Pacific making it valuble for paleoceanographic studies. New Zealand has the 5th largest EEZ which encompasses a particularly productive region where warm subtropical water mixes with cool subantarctic water rich in nitrogen and phosphorus compounds. High levels of primary production along the subtropical front (~40°S) act as a carbon sink and support several commercial fisheries. The 20th century 'spin-up' of the South Pacific Gyre is altering subtropical currents around New Zealand resulting in increased transport of warmer macronutrient-poor water further south. Water circulation changes can alter the distribution of nutrients and subsequently impact biological communities. Physical and biogeochemical oceanic processes naturally vary over time, however, there is still a lack of pre-instrumental era biogeochemical records. Here we present reconstructed bulk stable nitrogen ($\delta^{15}N$) and carbon ($\delta^{13}C$) isotopes from six black corals collected north and east of New Zealand to better understand historic biogeochemical variability. The isotopic records collectively cover the last millennium at yearly to decadal-scale resolution. Reconstructed $\delta^{15}N$ ranged from 7 to 14‰, and $\delta^{13}C$ between-18 and-15‰. Many of the coral $\delta^{15}N$ and $\delta^{13}C$ records covary, and the four higher resolution corals show prominent multidecadal variability, particularly in $\delta^{15}N$. Further work with compound-specific stable isotope analysis will help determine drivers in bulk isotope trends, and we are investigating the multi-decadal variability in climate models to determine if similar patterns are evident.

2. Trace Elements in Black Corals – Investigating Potential New Palaeoceanographic Proxies

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Abstract

Little is known about the dynamics of the deep ocean because of the difficulty and expense of monitoring this marine environment. One way to circumvent these limitations is to reconstruct ocean dynamics using natural archives of marine information. Marine sediment cores are the archives most commonly used for palaeoceanographic reconstruction, but the temporal resolution of reconstructions can be limited by slow sedimentation rates and/or bioturbation of marine sediments. Black corals (family Antipatharia) are a new high-resolution archive, potentially allowing continuous sub-decadal reconstruction of ocean dynamics over thousands of years. These deep-sea corals grow for millennia, depositing layers of proteinaceous skeleton that capture a geochemical 'signature' of the surrounding ocean or their food source (phytoplankton debris). Here we present an investigation into trace elements (particularly the transition metals) in black corals sampled from New Zealand waters, which have the potential to act as proxies for marine micronutrients or changes to the ocean currents that mix subpolar with subtropical waters in this region. We investigate both the spatial pattern of trace elements from multiple corals around New Zealand, as well as high-resolution time-series of trace elements within individual coral skeletons. While there is a high internal consistency of trace elements within coral skeletons, we do not find clear spatial patterns between specimens that match known gradients in trace element concentrations in the region. However, a number of trace elements (e.g. vanadium and uranium) show very strong correlations with each other both within and between specimens, hinting at underlying mechanisms of trace element uptake in the corals. A clear taxonomic control on some elements suggests that biology (e.g. species, size) may strongly influence uptake of some trace metals.

3. Calculating calcium carbonate production of a colonial scleractinian coral community in the northern Bay of Biscay: short-term and long-term estimates.

Evan Edinger[1], Inge van den Beld[2], Jean-François Bourillet[2], Sylvain Bermell[2], Norbert Frank[3], Stephan Jorry[2], Franck Lartaud[4], Lénaïck Menot[2]

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Abstract

Cold-water coral reefs and communities can be locally important calcium carbonate factories in continental shelf and slope environments, including submarine canyons. Here we present short-term and long-term estimates of coral carbonate production by colonial scleractinian coral communities in the 750-850 m depth range in Guilvinec Canyon, northern Bay of Biscay. Short-term (annual-decadal) estimates were calculated using local coral biomass, estimated as a product of coral size and abundance

from ROV video surveys, a locally generated species-specific regression between coral colony size and dry weight, and published daily or annual percent growth rates for *Lophelia pertusa (Desmophyllum pertusum)* and *Madrepora oculata*. A long-term estimate of carbonate accretion for the same reef was derived from a piston core through the same coral community. Average live colonial scleractinian carbonate biomass in the Guilvinec Canyon coral mounds was 153.9 ± 39.4 g $CaCO^3$ m^{-2}. Applying published growth rates, the average annual gross carbonate production was 7.04 ± 1.75 g $CaCO^3$ m^{-2} $y^{-1,}$ range 0-30.2 g $CaCO^3$ m^{-2} y^{-1}. This carbonate production rate was about one order of magnitude lower than previous estimates from the Norwegian shelf. A 2011 piston core through the mound was analyzed by CT-scan and subsampled for coral abundance. An age model from previous ^{14}C and U/Th ages of coral fragments in the core yielded a long-term average coral carbonate accretion rate of 78 g $CaCO^3$ m^{-2} y^{-1} over the past ~2150 y, range 40.8 (core-bottom) to 156.2 g $CaCO^3$ m^{-2} y^{-1} in the upper half, about 1-2 orders of magnitude lower than previous estimates from other regions. Low Recent carbonate accretion rates observed in the Guilvinec Canyon mounds could be attributable to recent declines in live coral cover, indicated by low abundance of live corals in ROV surveys from this site, compared to others in the Bay of Biscay.

4. AMOC-driven intermediate water-mass stratification favoured cold-water coral mound formation off Mauritania since the last glacial

Jürgen Titschack[1], Katharina Wetterauer[2], Jeroen Groeneveld[3], Claudia Wienberg[1], André Paul[1], Thomas Krengel[4], Norbert Frank[4], Yusuke Yokohama[5]

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Abstract

The Atlantic Meridional Overturning Circulation (AMOC) is a key component of the global climate system and the Atlantic oceanography and is considered to impact benthic ecosystems, such as cold-water coral ecosystems. Along the Mauritanian continental slope, the 240-km-long Mauritanian coral mound province (CMP) exhibits a highly diachronous coral mound formation. This study reconstructs spatiotemporal mound formation patterns and contemporaneous palaeoenvironmental conditions at a northern and southern study site within the CMP, using a benthic foraminifera/sediment-based multi-proxy approach (i.e., Mg/Ca, $d^{18}O^{seawater}$, Mn/Ca, and C^{org}). We find that during the last glacial and subsequent deglaciation, and potentially the warm periods MIS 5 and 7, even neighbouring coral mounds show temporally different developments, although almost all formed under comparable, well confined palaeoenvironmental conditions (i.e., temperature, salinity, oxygen, and food conditions). Records from four coral-mound cores and two cores from the adjacent seafloor suggest (i) an enhanced salinity-driven density differentiation of the glacial South and North Atlantic Central Water (gSACW, gNACW), (ii) the presence of the gSACW/gNACW water-mass boundary during phases of coral mound formation; and (iii) improved oxygen and food supply conditions at the coral mounds during their formation. Comparing all records to the TraCE-21k simulation further suggests that glacial phases of strong AMOC are associated with a southward NACW transport. In combination with an enhanced gNACW-gSACW density differentiation, the gNACW most likely passed under the gSACW, resulting in a well-defined pycnocline that improved oxygen conditions and organic matter amalgamation along their boundary, both favourable for coral mound formation. Instead, phases of weak AMOC indicate a northward flow of gSACW and its predominance off Mauritania, most likely associated with a loss of

the pycnocline and worsened environmental conditions hampering coral mound formation. Consequently, AMOC likely controlled thermocline water-mass stratification and coral mound formation off Mauritania during the last glacial.

5. Deglacial development of cold-water corals off northern Argentina driven by variability of the Atlantic Meridional Overturning Circulation

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Abstract

Along the northern Argentine margin, numerous cold-water coral mounds have been discovered. While information about the present-day structure and distribution of cold-water corals on these mounds is very limited, more information exists about their past development. Five sediment cores taken from these Argentine coral mounds between 990 m and 1300 m water depth revealed that *Bathelia candida* is the major framework-forming coral. Coral ages indicate three major coral growth periods that corresponded to intense mound formation phases: 17-15 kyr BP, 14-12 kyr BP, and 11-8 kyr BP. Especially the first two phases with highest mound aggradation rates of 110-170 cm kyr^{-1} coincided with major slowdowns in the Atlantic Meridional Overturning Circulation (AMOC). While the mound aggradation phase between 17 and 15 kyr BP has been found for all mounds at all depths investigated here (900 to 1300 m), the two youngest mound formation phases were limited to depths shallower than 1150 m. This observation might point to another steering factor provided by a deglacial sea-level rise-induced water column reorganisation additionally impacting on coral proliferation. Besides their obvious impact on coral development off Argentina, these large-scale paleoceanographic changes in AMOC strength and water column structure are merely the pacemaker rather than the direct control of coral development. With the corals being dependent on an efficient lateral food supply by strong hydrodynamics at the seabed, enhanced coral growth was most likely bound to the strength of the density gradient between the Antarctic Intermediate Water and the Upper Circumpolar Deep Water and the position of the interface between these two water masses. This boundary probably moved upslope during the deglaciation leaving only the shallower mounds within its reach after ~14 kyr BP.

6. Are Submarine Canyons Refugia for Scleractinian Cold-water Corals in Glacial Periods?: Evidence from the Porcupine Bank Canyon, NE Atlantic

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Abstract

It has been hypothesised that Holocene framework-forming cold-water corals re-colonised the NE Atlantic via coral larvae dispersed from the Mediterranean following current pathways facilitated by a strengthened Atlantic Meridional Overturning Circulation based on a compilation of biogeographic modelling and genetic studies. There is no published evidence framework-forming cold-water coral occurrences during glacial periods on the greater European continental Atlantic margin disproving this larval dispersion model. We present new, remotely operated vehicle-mounted vibrocores collected in the Porcupine Bank Canyon, 300 kilometres west of Ireland, from various geomorphological settings in the canyon: coral mound summits, coral rubble cores from the flat continental bank and along the slope and foot of the canyon. AMS ^{14}C and U/Th datings provide unprecedented evidence for scleractinian framework-forming corals colonising the Irish margin over the last glacial period to recent. Three-dimensional computed tomography from the cores reveal distinct patterns of reef development in different parts of the canyon in response to environmental conditions governed by changing climate. Scleractinian framework-forming cold-water corals thrive during the Holocene with rapid mound accumulation rates in the mid-Holocene (7.1-6.7 ka) although mound accumulation has slowed or halted since at least 5.6 ka BP. Results confirm that the Porcupine Bank Canyon was a cold-water coral refugia during glacial period and previous interglacial (MIS 4 and 5b (Midlandian) during 75.5 and 87.5 ka) with local tidal pumping and organic resuspension in the submarine canyon environment provided habitat for cold-water corals. This study proves that re-colonisation of cold-water corals in the NE Atlantic from the lower latitudes (40°N) to the higher latitudes (70°N) is not necessary and that recolonisation can occur locally from submarine canyon sites along the margin. On a broader scale, it highlights the conservation importance of submarine canyons as dynamic habitats of importance during changing climate conditions.

Speed talks

1. Elemental composition of the proteinaceous skeleton of Hawaiian Gold Coral (*Kulamanamana haumeaae*).

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Abstract

An X-ray fluorescence spectrometer (XRF) examined a range of cross-sections from 5 skeletons of Hawaiian gold coral. The toppled colonies collected during submersible dives included two live colonies from the slope of the Big Island of Hawai'i (2012) and three dead, weathered colonies from the summit of Cross Seamount (2007; 100 miles west of the Big Island). Using the mean radiometric radial growth rate of 0.041 mm/yr (Roark et al., 2006), the estimated ages of the cut skeletal sections ranged from 12.2 yr (at the live distal tips) to 712 yr (at the stump). Point scans of the most recent growth at the live tips of the colony (well away from any central carbonate host the zoanthid may have colonized) showed the core area predominately calcium (Ca 38.9%) and the laminar rings mostly bromine (Br 30.7%). Radial transect scans of the thicker branches and stumps (live and dead) all showed the primary elements to be calcium (36.6 to 41.6 %), bromine (24.1 to 26.8%), and phosphorus (15.3 to 17.4%), with levels of aluminum, sulfur, chlorine, and iodine at less than 10%. Looking across all the sections (n=16), calcium had a significant inverse relationship with phosphorus and bromine that was not attributable to age or site-related differences in the samples. This homogeneity for branch and stump

samples in gold coral is similar to prior XRF scans looking for age and site effects in protein skeletons of black coral (Espinoza et al. 2012, Order Antipatharia) from the Philippines and Indonesia. However, these revealed iodine, bromine, and chlorine as the primary elements with the inverse relationship identified between iodine and bromine.

2. Controls on stylasterid skeletal Mg/Ca and Li/Ca ratios

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Abstract

The Stylasteridae are a family of azooxanthellate corals which build carbonate skeletons from either aragonite, high-Mg calcite, or a mixture of both polymorphs. The inorganic geochemistry of stylasterid skeletons can record seawater conditions, suggesting stylasterids may be useful palaeoceanographic archives. Stylasterid skeletal Li/Mg correlates strongly with seawater temperature, and is consistent with Li/Mg ratios of other marine calcifiers including scleractinian corals and foraminifera [1]. However, our understanding of stylasterid skeletal Li/Mg is currently based on a small number of samples from a restricted range of ocean conditions. To address this, we present a significantly expanded database of stylasterid skeletal Mg/Ca and Li/Ca ratios, measured on samples from the Atlantic, Pacific and Southern Oceans. Coral samples were paired with nearby hydrographic data and span a wide range of conditions (0 ^{o}C < temperature < 30 ^{o}C), facilitating detailed exploration of the controls on Mg- and Li-incorporation into stylasterid skeletons. Stylasterid skeletal Li/Mg ratios are – when controlled for specimen mineralogy- strongly correlated with seawater temperature. However, our new data suggest a revised aragonitic stylasterid Li/Mg vs temperature relationship, and reveal striking differences between aragonitic stylasterid Li/Mg ratios and those of other aragonitic marine calcifiers, including scleractinian corals. These differences are driven primarily by variations in skeletal Mg-content. For instance, as seawater temperature increases, stylasterid Mg/Ca becomes consistently lower than scleractinian Mg/Ca. By comparing these two coral taxa, we examine the controls on Mg-incorporation into coral carbonate, and suggest that reconstruction of palaeotemperature using Li/Mg ratios should, where possible, be based on taxa-specific calibrations.

References

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3. Deep-sea corals as archives of export production on a multiproxy study

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Abstract

Carbon sequestration is the only tool recognized for climate remediation. It occurs as a natural consequence of primary production (PP), half of which comes from marine photosynthesis, and substantially from the microscopic marine realm of coastal upwelling regions. The West Iberian margin (part of the Canary Upwelling System) is ideal to study the impact of long-term climate variability on ocean carbon sequestration. Previous studies showed PP and export production to be influenced by climate change, but their records may be influenced by the use of proxies sensitive to dissolution/preservation conditions; possible decoupling between carbon fixation and sequestration; and under-representation of subsurface and intermediate depth processes. To better evaluate the impact of climate change on marine carbon sequestration effectiveness, IRMAPEx project will reconstruct the history of PP export combining traditional and novel proxies from archives distributed along different depths of the water column. This multiproxy approach integrates: diatom accumulation rates, assemblages' composition and transfer function PP estimation; planktonic foraminifera transfer functions; total organic carbon content and mass accumulation rates; and Ba/Ca ratios on several planktonic and benthic foraminifera species, and cold-water corals (CWC). The combination of PP export proxies from the deeper water levels (from deep dwelling foraminifera and CWC) and the sediment shall improve the reconstruction of carbon turnover and sequestration in the sediments. The reconstruction will focus time-slices of specific climatic boundary conditions since the Last Glacial Maximum. Modern data for the NW region suggest that coastal upwelling-related planktonic foraminifera species register the increase in water Ba/Ca, accompanying the upwelling center. Elementary changes found between surface and deeper species may reflect the vertical carbon export, though more data is still needed to confirm this finding. Additionally, CWC Ba/Ca appears to record the expected glacial-interglacial PP export decrease to intermediate waters, thus supporting the multiproxy study on regional carbon sequestration.

4. Growth rates and ages of two deep-sea bamboo coral species from the Northwest Atlantic

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Abstract

The bamboo corals *Acanella arbuscula* and *Keratoisis* sp. (*Keratoisis* cf. *flexibilis*) are conspicuous components of mud-bottom habitats in the Northwest Atlantic and Eastern Canadian Arctic. *A. arbuscula* is commonly observed and widespread, while *K. flexibilis* has only been observed in a few locations. Little is known about both species' growth rates and ages. To address this, colonies of *A. arbuscula* and *K. flexibilis* were collected using the 'Astrid' remotely operated vehicle (ROV) aboard the CCGS *Amundsen* in 2021. 10 *A. arbuscula* colonies were collected in the NW Labrador Sea at ~1,300 m and 12 *K. flexibilis* colonies were collected in SE Baffin Bay (Disko Fan) at ~900 m. Longevity and growth rates were determined from growth ring counts at the proteinaceous nodes of the coral skeletons using reflected light and fluorescence at magnifications up to 258x. Radiometrically validated specimens were compared with growth ring counts because both species exhibited major and minor growth banding; major rings represent annual growth in *A. arbuscula* while minor rings represent annual growth in *K. flexibilis*. To validate this, 21-L staining chambers were placed on top of live colonies using a ROV. Corals were stained *in situ* with 150 mg/L calcein solution for 4-7 hours, and will be collected in the future to analyze growth ring formation post-staining. Growth ring counts for *A. arbuscula* indicate

ages of 8-29 years, radial growth rates of 0.025-0.160 mm/year^{-1}, and linear growth rates of 1.9-16.1 mm/year^{-1}. Growth ring counts in *K. flexibilis* indicate ages of 89-168 years, radial growth rates of 0.007-0.027 mm/year^{-1}, and linear growth rates of 1.5-5.3 mm/year^{-1}. Growth rates for *K. flexibilis* were slow, likely due to cold bottom temperatures and limited food availability at Disko Fan. Longevity for *K. flexibilis* was also higher, meaning this species is more vulnerable than *A. arbuscula* to anthropogenic disturbances.

5. Evaluating the thermal adaptation of Lophelia pertusa: Insights from paleo-reconstructions and present-day thermal amplitude

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Abstract

Reef-building scleractinian cold-water corals (CWC) are engineer species that create 3D structures providing shelter for many organisms in the mostly barren seafloor landscape, making them important hotspots of biodiversity in the deep sea. Natural climatic cycles change CWC living conditions, affecting their habitat suitability through the ages. As human-induced global warming intensifies, understanding the impact of these changes on deep-sea ecosystems becomes increasingly important. During the biomineralization process, corals incorporate elements into their aragonite skeletons in different proportions depending on the environmental conditions. Thus, the chemical composition of modern and fossil coral skeletons can be indicative of the seawater conditions during their formation. The ratios of several major and trace elements, as well as some stable isotopic systems, can be used as proxies. The combination of CWCs' long lifespan, well-preserved aragonite skeleton, and ability to record environmental conditions make them a powerful tool for reconstructing past ocean conditions. Lophelia pertusa (LP) is the most commonly used species for paleo reconstructions due to its global distribution and distinctive morphology. While LP's live temperature range is typically cited as being between 4-12°C, the source of this information is elusive. Concomitantly, recent studies (based on Li/Mg-thermometry) suggest that LP may have survived below 4°C during the Last Glacial Maximum (LGM), indicating a possible regional thermal adaptation across millennia. To better define the current and past temperature range of LP, additional research efforts are required. The objective of this study is to investigate temporal changes of LP thermal amplitude in the Atlantic. For that, we will, on one hand, revise (and better constrain) the species' present-day thermal amplitude using data from oceanographic surveys and sampling expeditions, including CTD measurements. And, on the other hand, improve the reconstruction of LP's temperature range (and its variation) since the LGM by extending the available LP Li/Mg-thermometry record.

6. Cold-water coral response to past expansion of the shallow oxygen minimum zone off Angola margin

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Abstract
Expansion of the Oxygen Minimum Zones (OMZs) is among the most significant consequence of current global climate changes and brings concern about its potential impact on marine ecosystems, coastal economies, and climatic implications. Cold-water coral (CWC) reefs are considered vulnerable marine ecosystems and might be severely affected by further expansion of the OMZs. However, *Lophelia pertusa* have been found thriving under hypoxic conditions within the OMZs on the Mauritanian and Angolan margins. Off Angola, well-dated coral fragments indicate that CWCs developed at least over the last 50,000 years, although the oceanographic conditions and/or environmental parameters that have triggered this process remain unknown. In order to understand how CWCs can cope with low oxygen conditions and to identify the major environmental parameters related to regional coral development, we reconstruct the past oceanographic conditions from core collected within the OMZ off Angola. Our paleoceanographic record suggests an intensification of the OMZ off Angola induced by a warming of the subtropical South Atlantic over the last 50,000 years, which coincides with the growth periods of CWCs. Our records show that the occurrence of CWCs off Angola was closely related to increased bottom-water hydrodynamics and enhanced lateral transport of food possibly related to internal wave activity. The occurrence of CWCs on the Angola margin was followed by warming (up to 5°C) of the thermocline suggesting a positive influence of temperature that was not observed in the North Atlantic and Mediterranean Sea in the past. These results suggest that warming of the thermocline and enhanced food transport promoted by internal waves created favorable conditions for CWC development off Angola. Strong bottom-water hydrodynamics keep the food particles in suspension, which must be crucial for the CWCs to survive under hypoxia within the OMZ.

7. Exploring the Mesophotic Zone: Investigating Coral Gardens as Model Habitats in the Falkland Islands

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Abstract
This is the first study to investigate the mesophotic zone nearshore (30-150 m) in the Falkland Islands using Stylasteridae coral gardens as model habitats in order to gain a better understanding of the threats to remote biodiversity. The Falkland Conservation Zone is expected to have more than 50,000 square kilometres of mesophotic habitat, which will support a diverse range of plant and animal life. Despite the vastness of the area, the only scientific surveys conducted to investigate these depths have been inadvertent nearshore studies. For example, in 2021, while conducting ROV and drop camera surveys, we discovered gardens of stylasterid (lace) corals, *Errina cf antarctica*, below 40-50 metres. The coral gardens at Bird Island are most likely very old (100s to 100s of years), and as the amount of biodiversity in the ocean decreases, we must protect special places like Bird Island as well as the life that is delicately balanced on the seafloor.

8. Decline in cold-water coral growth promotes molluscan diversity: A paleontological perspective from a cold-water coral mound in the western Mediterranean Sea

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Abstract
Framework-forming scleractinian cold-water corals (CWCs) act as ecosystem engineers, building and supporting biodiversity hotspots in the deep sea worldwide. While spatial patterns and drivers of species distributions have been evaluated on modern CWC reefs, little is known about how reef diversity is affected by habitat variability over geologic time – the scale at which CWC reefs initiate, thrive, and decline. Using three CWC reef sediment cores as species diversity archives, we investigated temporal trends of molluscan diversity over the last ~13 kyr from a CWC mound in the Alboran Sea (western Mediterranean Sea) to evaluate (a) how spatial patterns of CWC-associated diversity are recorded in reef sediments, (b) the potential of CWC reefs as biodiversity hotspots when coral growth is flourishing and when it is not, and (c) which palaeoceanographic conditions or habitat characteristics may be driving biodiversity. Our results reveal that at the ecosystem scale ecological differences between CWC habitats are more pronounced than ecological signatures of molluscan assemblages associated with intervals of CWC framework (flourishing growth) or non-framework (negligible CWC growth). Within habitats, significant differences emerge between these assemblages with lower molluscan diversity associated with flourishing CWC growth. Significant negative correlations between molluscan diversity and palaeoceanographic conditions conducive for CWC growth and high aggradation rates also imply that CWC growth and relevant environmental conditions contribute to reduced molluscan diversity. These patterns detected over geologic time resemble those observed spatially across living CWC reefs today – where competition with resources, particularly food, prevents high reef biodiversity in the vicinity of dense living CWCs. Overall, our study demonstrates that (1) ecological paradigms of living CWCs are preserved in their sedimentary record, (2) flourishing CWC growth and conditions promoting CWC growth drive habitat-scale diversity patterns, and (3) a geological approach can be applied to study long-term diversity dynamics in CWC ecosystems.

9. Temporal Diversity Dynamics Of Benthic Invertebrates In A Quaternary Cold-Water Coral Mound: Alboran Sea (Mediterranean Sea)

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Abstract
Cold-water coral (CWC) reefs are recognized as biodiversity hotspots in the deep sea worldwide. With sufficient nutrients and a steady sediment supply, CWC reefs may build into CWC mounds over geologic time (hundreds to millions of years). On CWC mounds, living corals thrive near the mound tops where there is the most exposure to currents transporting nutrients. It is hypothesized that corals outcompete other benthic organisms for food and substrate at the mound tops, resulting in low diversity on mound tops and higher diversity downslope. Using a CWC reef sediment core, this project investigates the temporal diversity of benthic invertebrates on a CWC mound in the Alboran Sea (western Mediterranean Sea) over the last ~13,000 years. We have identified 5 primary invertebrate taxonomic groups: barnacles, brachiopods, bryozoans, echinoderms, and solitary corals. The specimens within these groups are being identified to the lowest possible taxonomic level. Overall, the fossil assemblage

contains the primary groups of invertebrates with high preservation potential (hard parts) found on living CWC reefs, suggesting that the fossil record is representative of living reefs. Group abundances vary with depth (time) in the core and do not align with patterns of reef growth or the diversity of mollusks (separate study). These findings suggest that the invertebrate assemblages studied here may not be driven by the same ecological factors as mollusks. Smaller sample sizes relative to mollusks and differences in mobility may influence abundance trends. Rank-order correlation analyses indicate that taxa abundances are not significantly correlated with mound aggradation rates, suggesting that abundance patterns are not significantly biased by sedimentation patterns of the CWC mound. Species identifications and assessment of diversity trends will provide further insights and means for comparison between these invertebrates and mollusks.

10. Intermediate water mass circulation variations during the last glacial cycle and its potential role in controlling cold-water coral mound development off Tunisia

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Abstract

In the Mediterranean Sea, the majority of thriving cold-water coral assemblages discovered to date are found in water depths bathed by the Levantine Intermediate Water (LIW). Alternatively, the depth and sharpness of the water mass interface found at the transition between the Atlantic Water (AW) and LIW has also been reported to have a relevant role in controlling coral mound development in this basin. Indeed, water mass interfaces display strong density gradients that tend to stimulate the accumulation of particulate organic matter, partly consisting of plankton. In addition, the interaction between two water masses might promote the formation of internal waves that spread along the interface, enhancing sediment resuspension and vertical mixing, to ultimately support an increased transfer of organic matter to the depths were growing coral mounds are found. However, due to sea-level changes and other paleoclimatic variations associated to glacial-interglacial cycles, AW-LIW interface's depth and intensity are likely to change through time. In this sense, gravity cores collected from on- and off-mound areas of the Tunisian Coral Mound Province during the Geomargen-2 Cruise are used to evaluate the changes in intermediate water mass circulation throughout the last glacial cycle and its potential effects on coral mound development. Particularly, we aim to use Nd isotopic analyses from both corals and fish teeth to describe the changes of water-mass influence in the area. In order to obtain a better understanding of the fluctuations in intensity and oxygenation of the water mass bathing the mounds, these analyses will be accompained with grainsize and U/Mn data extracted from foraminifera. As the analyses of the samples are currently underway, the preliminary data together with a corresponding discussion will be presented.

Session 5. Coral Biogeography and Associated Biodiversity

Type	N	Presenter	Title
Keynote	1	Paris Stefanoudis	Biodiversity and functional shifts of reef benthic communities across depth in the Western Indian Ocean
Full talk	1	Jordi Grinyo	Community dynamics of a *Desmophyllum pertusum* reef on the Lofoten-Vesterålen shelf (Norway)
Full talk	2	Jill Bourque	Recovery trajectories of coral-associated macrofaunal communities impacted by the Deepwater Horizon oil spill a decade later
Full talk	3	Marion Boulard	Sea pen and related soft-bottom habitats as nurseries for four abundant groundfish taxa in a marine protected area
Full talk	4	Poppy Clark	Automated Identification of Surface Area to Evaluate Coral-Sponge Interactions
Full talk	5	Luke McCartin	Nuclear eDNA Sequencing to Study Mesophotic and Deep-sea Anthozoan Corals
Full talk	6	Martha Nizinski	Are there broad-scale patterns in diversity and abundance of deep-sea coral associates? A case study in the western North Atlantic.
Full talk	7	Samuel Vohsen	A Seascape Approach to the Microbial Biogeography of Mesophotic and Deep-sea Octocorals
Full talk	8	Hye-Won Moon	Diversity and distribution of black corals (Anthozoa: Antipatharia) from Korea with notes on a new cold-water species
Full talk	9	Teresa Cerqueira	Deep-sea coral microbiome responses to environmental changes
Full talk	10	Guadalupe Bribiesca-Contreras	Diversity of polymetallic nodule-associated corals in the Clarion-Clipperton Zone, Pacific Ocean
Full talk	11	Akacia Halliday-Isaac	Distribution and Diversity of Corallicolids in Deep-sea Octocorals of the North Atlantic
Speed talk	1	Cristina Cedeño-Posso	Deep-sea corals in two of Colombia's newest marine protected areas
Speed talk	2	Hammoud El Vadhel	The fauna associated with cold water corals in the border between Mauritania and Senegal
Speed talk	3	Daniela Pica	Global Distribution of Stylasterid Corals: Updated Insights from Family to Species Level
Speed talk	4	Valeria Palummo	Bamboo coral *Isidella elongata* (Cnidaria: Keratoisididae): New evidence on their ecological role and vulnerability in the Mediterranean Sea
Speed talk	5	Meri Bilan	Coral communities along the canyon walls of Blanes Canyon (NW Mediterranean Sea)
Speed talk	6	Nicole Pittoors	Characterizing Biodiversity of Mesophotic Reef Benthos Using Autonomous Reef Monitoring Structures (ARMS)
Speed talk	7	Heidi Meyer	To Higher Places – *Gersemia rubiformis* using large demosponges as a perch
Speed talk	8	Erik Cordes	A brief survey of the cold-water coral reefs of the world

Keynote Abstracts

1. Biodiversity and functional shifts of reef benthic communities across depth in the Western Indian Ocean

Paris Stefanoudis[1], Fathimath Hana Amir[2], Farah Amjad[3], Mohamed Ahusan[2], Ayesha Bobat[4], Alain de Comarmond[5], Nico Fassbender[6], Marie-May Jeremie[5], Shafiya Naeem[2], Ramadhoine Ali[7], Kaveh Samimi-Namin[8], Sheena Talma[3], Lucy Woodall[9]

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Abstract

Reefs and corals below SCUBA diving depth (>30 m), such as those lying in mesophotic (~30-150 m), rariphotic (150-300 m), and upper bathyal waters (300 m-500 m) in the Western Indian Ocean are particularly underexplored, and this paucity of data often leads to their omission from conservation and management practices. Oceanographic surveys between 2018-2022 sought to address that knowledge gap by using a combination of snorkellers, divers, submersibles, and remotely operated vehicles to survey deep reefs between 0-500 m across coral atolls of three Large Ocean States: Comoros, the Seychelles, and Maldives. Here we focus on Seychelles, where we used a suite of taxonomic and trait-based analytical approaches to find distinct suites of benthic taxa and traits dominating different depths, mirroring concordant changes in environmental conditions such as light and food availability, with implications for reef resilience against disturbance. Comparing reef data from all three nations, we find that all reefs supported species of conservation concern and / or commercial interest, highlighting the importance of those ecosystems for conservation and human prosperity. Overall, our results highlight the unique nature of mesophotic, rariphotic and upper bathyal reefs and corals that requires their explicit consideration in conservation and management activities.

Full Talks

1. Community dynamics of a *Desmophyllum pertusum* reef on the Lofoten-Vesterålen shelf (Norway)

Jordi Grinyo[1], Jacopo Aguzzi[2], Francesco Ruscio[3], Tim W Nattkemper[4], Rafael García[5], Nuno Gracias[5], Ulrike Hanz[6], Furu Mienis[7]

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Abstract

Along the North Atlantic continental margin, highly diverse and structurally complex megabenthic communities, such as cold-water coral (CWC) reefs are common features. These communities have been widely impacted by fishing activities, and thus CWC reefs are identified as vulnerable marine ecosystems in need of protection. Recently, several deep-sea environments (e.g. mounds, canyons) hosting CWC reefs, have been integrated in Marine Protected Areas (MPA). However, few of these MPAs management plans account for the temporal variability in community dynamics. Long-term monitor strategies are required to elucidate these communities' dynamics and identify their main environmental drivers. The Lofoten-Vesterålen cabled video-observatory (LoVe), equipped with oceanographic multiparametric sensors, has been monitoring a *Desmophyllum pertusum* reef, located at 260 m depth for more than a decade. From October 2013 to January 2015 (except for summer 2014), 9990 still images were obtained, of which 1300 were analyzed manually with the BIIGLE software, and posteriorly used to train a mask convolutional neural network. Over 172933 organisms belonging to 29 different species were identified. Pandalid shrimp, crinoids and ophiuroids where the most abundant organisms, accounting for 89%, 2.4% and 2%, respectively. Non-metric multi-dimensional scaling analysis revealed that assemblage composition significantly changed among seasons: autumn assemblages were characterized by pandalid shrimps and pagurid crabs, winter assemblages were depicted by squat lobsters and crinoids, and spring assemblages were characterized by gorgonocephalid ophiuroids and the actinian *Prothoptea simplex*. Organism counts significantly decreased from October 2013 to January 2015. These shifts in community composition and decrease in organism abundance appeared to be linked to changes in primary productivity and the occurrence of different water masses. Our results highlight the importance of long-term monitoring approaches of megabenthos in iconic habitats based on multiparametric biological and oceanographic time-series, to acquire a more comprehensive portrait of their biodiversity and its dynamic turnover.

2. Recovery trajectories of coral-associated macrofaunal communities impacted by the Deepwater Horizon oil spill a decade later

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Abstract

The complex habitats created by deep-sea corals support distinct sediment communities, harboring significant biodiversity and enhanced abundances, contributing to the overall ecosystem health of the Gulf of Mexico (GOM). Following the 2010 Deepwater Horizon oil spill, multiple deep-sea coral habitats, including associated sediment communities, were impacted, and these injuries persisted with time since the spill. Initial site-specific community responses ranged from effects associated with organic enrichment, to those associated with toxicity correlated with high concentrations of hydrocarbons. Yearly sampling of macrofaunal communities between 2011 and 2017 at three sites revealed ongoing impacts characterized by high temporal variability in composition and abundance with the most heavily impacted sites exhibiting stronger correlations with time. Following the implementation of the Deepwater Horizon Natural Resource Damage Assessment Open Ocean restoration project for Mesophotic and Deep Benthic Communities Habitat Assessment and Evaluation, 2022 represented the first year these communities have been sampled since 2017, and the first year since 2011 to be accompanied by contaminant analyses to assess the status of recovery within these communities. Additional sediments from impacted Gloria, Biloxi, and Dauphin Domes and non-impacted St. Tammany

Rim Basin deep-sea coral habitats were assessed for macrofaunal abundance, diversity, and community structure, along with sediment geochemical and physical properties, including hydrocarbon and metal concentrations, stable isotopic composition, particle size, and organic content. The 2022 data will be discussed in the context of the previous analyses to establish current baselines and quantify temporal change and recovery trajectories that will inform future monitoring and restoration activities in the GOM.

3. Sea pen and related soft-bottom habitats as nurseries for four abundant groundfish taxa in a marine protected area

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Abstract

Although relationships between fishes and cold-water coral reefs have been well-studied, there are relatively few studies on fish relationships with habitat provided by smaller soft-bottom corals such as sea pens. To understand how groundfish use these biogenic habitats, we performed ROV and drop-camera surveys in 2017 and 2018 within the Laurentian Channel Marine Protected Area in eastern Canada, a largely low-relief soft-sediment environment. We compared the density and local size structure of four deep-sea fish (Redfish (*Sebastes* spp.), Marlin-Spike Grenadier (*Nezumia bairdii*), Longfin Hake (*Phycis chesteri*) and Witch Flounder (*Glyptocephalus cynoglossus*)) in seven non-structural and biogenic habitats dominated by sea anemones, sea pens and solitary scleractinian corals. We used generalized additive models to identify biotic and abiotic drivers of size for each fish taxon. We observed 19,243 fish within the 43.6 ha study area, of which 7,513 fish were measured. Small and large juveniles represented 99% of all fish measured, with a notable increase in average fish size in 2018 across all habitats. Fish densities associated with biogenic habitats were higher at night than during the day for all taxa except Witch Flounder. Time of day influenced fish size for Redfish only, with smaller juveniles found at night. Larger juveniles were associated with barren and non-CWC habitats and smaller juveniles with all CWC habitats for all taxa but Witch Flounder. The results suggest that 1) the Laurentian Channel is used as a nursery by four abundant groundfish taxa, 2) fish undergo diurnal and ontogenetic shifts in habitat use, and 3) sea pen provide habitat for early-life stages, and 4) fish-habitat associations appear to be facultative rather than obligate. Video surveys provided evidence that small and large juvenile fishes do not use the same microhabitats and that sea pens contribute significantly to juvenile fish habitat.

4. Automated Identification of Surface Area to Evaluate Coral-Sponge Interactions

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Abstract

The deep-sea sponge *Mycale lingua* has repeatedly been observed to grow within live *Lophelia pertusa* colonies. This raises concerns as to the potential of *M. lingua* to overgrow and out-compete *L. pertusa* under the shifting conditions of climate change. Due to the challenges associated with maintaining deep-sea species in aquaria, video and image data are instead utilised to gain insight into species interactions *in situ*. However, extracting information, such as species presence and/or surface area, can be prohibitively time-consuming and limits the scope of many studies. Machine learning algorithms can circumvent this analysis bottleneck, but their usage presents a barrier to researchers without coding experience. In this study a new and user-friendly machine learning tool, RootPainter, was used to overcome this barrier and investigate the relationship between *L. pertusa* and *M. lingua* at the Tisler reef in Norway. The dataset investigated contained 3,681 video frames, extracted from ROV transects of the East, Centre, and West of the reef, conducted in 2021. Development of a RootPainter model to identify live *L. pertusa* only required 15 hours of training on this dataset. For identification of *M. lingua*, a pre-developed RootPainter model was optimised to the dataset through 10 hours of training. These models were used to extract the surface area of both species in each video frame, allowing investigation of correlations between *L. pertusa* and *M. lingua* percentage cover across the reef. The variation in size of *M. lingua* individuals with percentage cover of *L. pertusa* was also evaluated. In depth analysis of these correlations and how they change in time and space will allow for a fuller understanding on how these species interact. The speed, ease, and accuracy of RootPainter could have huge implications for our ability to analyse large marine datasets, especially as working models can be shared between researchers.

5. Nuclear eDNA Sequencing to Study Mesophotic and Deep-sea Anthozoan Corals

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Abstract

Environmental DNA (eDNA) sequencing is proven to quantify biodiversity in the deep sea and complements conventional methods. To date, eDNA sequencing targeting deep-sea corals has utilized the mitochondrial MutS gene, which is unique to octocorals. Like mitochondrial genes, nuclear rRNA genes are present in high copy numbers in the genome and have substantial reference libraries. We designed new PCR primers for eDNA sequencing that amplify a hypervariable region of nuclear 28S rRNA present in all coral groups. These novel primers expand eDNA methodologies for deep-sea corals from targeting solely octocorals to sequencing scleractinians and black corals for the first time. We validated the performance of the primers by combining video imagery, DNA barcoding of collected specimens, and eDNA sampling during ROV dives at mesophotic and deep-sea coral communities in the Gulf of Mexico. We found that the primers produced more coral reads in eDNA samples collected at sites with the highest abundances of corals. Species observed in high abundances in video were detected using eDNA sequencing. However, there were discrepancies between the video and eDNA datasets. For example, at one sampling location we confidently detected eDNA from species that were not observed in video. These species are conspicuous and abundant at a nearby site ~40 meters deeper. Our finding that coral eDNA was most abundant and concordant with observations of high coral abundance emphasizes the potential use of eDNA sequencing for mapping the distribution of dense coral

communities. Discordance between eDNA sequencing data and video observations raises questions regarding the spatial resolution of eDNA data. However, this finding also emphasizes the method's complementarity and potential to detect species missed using conventional approaches. The new 28S rRNA primers are ideal for general use. They are less taxon-specific than mutS, and amplify eDNA from diverse coral communities at low and high abundances.

6. Are there broad-scale patterns in diversity and abundance of deep-sea coral associates? A case study in the western North Atlantic.

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Abstract

Structure-forming deep-sea corals provide a variety of microhabitats that support a diverse faunal assemblage comprising recreationally, commercially, and ecologically important species. Some mega-faunal species are strongly associated with certain fine-scale habitat attributes, while others use these habitats more opportunistically. Approximately 20 years ago, Buhl-Mortensen and Mortensen reviewed the sparse literature, supplemented with their recent observations, to assess the number of symbionts associated with deep-sea corals. At that time, direct observations of associated mobile species were limited and the nature of the relationship between the associated species and the corals was uncertain. Over the past few decades, interest in exploration and surveys of deep-sea coral habitats has increased significantly. High-resolution imagery of the larger charismatic megafauna found in association with deep-sea corals is frequently collected and these observations add to the overall knowledge of coral/associate relationships. Although extremely important, these data provide only a localized snapshot of an associate and its host coral. To better understand habitat utilization and population dynamics of the coral-associated fauna, examination of data over a broader scale is needed. Between 2012 and 2019, nine cruises, designed to locate, survey and characterize deep-sea coral habitats, were conducted in the western North Atlantic, ranging from Virginia to the Canadian border. Using images collected in 30 submarine canyons, we assessed the regional diversity, distribution and abundance of associates in relation to coral diversity, latitude, and depth. Data were then analyzed to determine if broad-scale patterns of coral associates were evident relative to these attributes over an extensive geographic range.

7. A Seascape Approach to the Microbial Biogeography of Mesophotic and Deep-sea Octocorals

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Abstract

Corals associate with a diverse consortium of microbes involved in various roles in coral health. Coral-associated microbiomes vary greatly between coral colonies and sampling locations with functional consequences on the coral host. However, the full extent of microbiome variability across the ranges of most coral species remains unknown, especially in octocorals and species from mesophotic and deep-sea habitats. Here we characterized the microbiomes of four octocoral species from mesophotic and

deep-sea habitats in the northern Gulf of Mexico, *Muricea pendula*, *Swiftia exserta, Callogorgia delta,* and *Paramuricea biscaya* using 16S metabarcoding. We tested for microbiome differentiation between and within species, examining the influence of the coral's genetic background and environmental factors that vary with depth (53 to 2224 meters deep) and geographic location (over 680 kilometers). Individual microbiomes in all coral species were often dominated by a single amplicon sequence variant – ASV (>50% relative abundance) whose abundance varied across the range of the host coral. These dominant ASVs included corallicolid apicomplexans, *Endozoicomonas*, members of the Mollicutes, and the BD1-7 clade of Spongiibacteraceae. Coral species, depth, and geographic location significantly affected microbiome composition, richness, and evenness as well as the abundances of specific microbial taxa. Differences in bottom water temperature and surface primary productivity could explain part of the microbiome variation associated with depth and geographic location, respectively. However the coral's genetic background was confounded with depth so its effect could not be determined. Altogether, this work demonstrates that the microbiomes of corals vary substantially across their ranges in ways that may have functional consequences, identifies important ecological drivers in mesophotic and deep-sea corals, and can inform restoration efforts.

8. Diversity and distribution of black corals (Anthozoa: Antipatharia) from Korea with notes on a new cold-water species

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Abstract
The specimens which have been collected in the coastal areas of Korea from 1965 to 2022 were examined for the taxonomic study of black corals (order Antipatharia). Previous studies have resulted in reporting 12 species and six genera belonging two families in Korea. In this study, we present one new species (*Antipathella* n. sp.) that is similar with *Antipathella subpinnata* (Ellis and Solander, 1786) from Mediterranean Sea based on morphological characteristics in densely branched colonies that can reach a height of 1 m or more. However, the new species is characterized by having larger spines in size (0.12-0.30 mm) and polyps arranged bilaterally. In addition to describing and illustrating the species, we have examined molecular information based on the partial sequences of the mitochondrial cytochrome coxidase subunit I (COI) and the Internal Transcribed Spacers (ITS) region of gene. Most of the black corals inhabit in the coastal areas of Jeju Island, the most southern part of Korea, and are mainly distributed on the vertical wall of rock from depth of 7-45m. In contrast, *Antipathella* n. sp. was found only in Ulleungdo and Dokdo Islands (East Sea) and formed patches at a depth of 30 m or deeper on relatively gentle slopes with strong currents. Therefore, this species might be affected by deep-sea or cold currents. In this study, we have also found that *Myriopathes lata* (Silberfeld, 1909) is one of the abundant species in Jeju Island and, unlike other black corals, a widespread one along the coastal areas of Korea by expending from southwestern sea to the eastern sea, up to Ulleungdo Island. The species composition and distribution of black corals provides critical baseline information to predict future environmental change in Korean waters.

9. Deep-sea coral microbiome responses to environmental changes

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Abstract

Predicted changes in seawater chemistry resulting from climate change will affect all marine life including the microbial dynamics and biogeochemical cycling in the ocean. In deep-sea ecosystems, cold-water corals (CWC) are bioengineer species considered vulnerable to such threats. Due to their heterotrophic feeding, broadly limited in nitrogen and carbon supply, these organisms rely on their microbial consortium to ensure their nutrition and health. Ocean acidification (OA) will likely alter the bacterial community structure, disturb symbiotic relationships and render the coral holobiont (the ecological unit formed by the coral and its associated microbiome) less resilient to disease. In the Azores region, the physiological responses of CWCs to different anthropogenic stressors have been studied using aquaria-based approaches. However, little is known about the effects of these stressors on the coral microbiome and how this modulates the physiological responses of corals. The present work explores the variation of the CWC microbiome across different host species to better understand the role of the holobiont in the corals' response to induced perturbations. A DNA metagenomic approach was employed to examine the bacterial community structure associated with scleractinian (*Desmophyllum dianthus*), antipatharian (*Antipathella wollastoni*) and octocoral (*Viminella flagellum*) species, which are key species in coral gardens of the Azores. CWCs were sampled: i) *in situ*, ii) after aquaria acclimatization, iii) under acidified conditions predicted for 2100 (IPCC 8.5; pCO2=1,000 µatm). Our analyses show that different coral taxa host distinct bacterial communities, and that the coral microbiomes undergo compositional changes after the transition to the aquaria and under OA conditions. This work provides a first evaluation of the microbiomes associated with CWCs in the Azores and produces valuable information for future studies to unravel the microbiome's importance for host fitness and the development of strategies to help build resilience in CWCs under environmental changes.

10. Diversity of polymetallic nodule-associated corals in the Clarion-Clipperton Zone, Pacific Ocean

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Abstract

The Clarion-Clipperton Zone (CCZ) represents a vast abyssal region (~6 million km^2) with abundant polymetallic nodules. These potato-sized mineral accretions contain valuable metals such as cobalt, nickel, and copper, which has promoted increasing exploration of the CCZ. While nodules are of commercial importance, they also represent an extensive source of hard substrate for marine sessile invertebrates. Many studies have focused on the sediment-associated fauna of this region, but only two quantitative studies have focused on the nodule fauna, which will be directly impacted by nodule removal associated with mining activities. Corals, including octocorals (Octocorallia) and black corals (Antipatharia), are commonly encountered associated to the nodules, although their abundances are much lower than sponges and bryozoans. Here, we present data from eight different cruises to the CCZ across different areas including the westernmost APEIs (Areas of Particular Environmental Interest 1, 4,

and 7), APEI 6, and the mining contract areas UK-1, OMS, USA-4 and NORI-D. Morphological characters as well as sequences from the COI, mtMutS, IGR4, and/or 28S genes were considered for delimiting and identifying species, and for inferring phylogenetic relationships. From these samples, 16 different octocorals, two anthipatharians, and a new species of scleractinian coral closely related to the family Deltocyathiidae were found directly attached to polymetallic nodules. One other species of scleractinian coral has been recorded in the CCZ (*Fungiacyathus (Fungiacyathus*) cf. *fragilis*), but this represents a free-living species found on soft sediments on a seamount. Thus, our findings of a cryptic coral fauna associated with polymetallic nodules, including for the first time a scleractinian coral, highlight the important role nodules play as unique habitats in remote areas of the deep ocean.

11. Distribution and Diversity of Corallicolids in Deep-sea Octocorals of the North Atlantic

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Abstract

Apicomplexans are a diverse group of animal parasites including the causative agents of globally important human diseases, such as malaria, and infections such as toxoplasmosis. A novel family of apicomplexans (Corallicolidae; type species *Corallicola aquarius*) has been documented in a wide diversity of coral species including scleractinians, octocorals and black corals from a broad range of habitats including shallow, mesophotic, and deep-sea depths. Most apicomplexans are parasites however the impact corallicolids have on their coral hosts and their ecological importance are still unknown. Interestingly, these apicomplexans are primarily found in healthy corals with genetic variants that are restricted to coral hosts within a taxonomic order and limited depth range. Most studies, however, have focused on scleractinians from shallow water while octocorals have a greater diversity in deeper waters. This indicates a larger need to further examine octocorals as potential hosts to expand our understanding of the ecology of this association. I examined the association between octocorals and corallicolids by sequencing the 18S rRNA gene of corallicolids from a variety of corals to determine phylogenetic patterns with host phylogeny, depth, and geography. I screened twenty-two species (fifty-seven colonies) of deep-sea octocorals from the southeastern coast of the US and the Caribbean. Fourteen coral species (forty-six colonies) from shallow species and corallicolid sequences from shallow and mesophotic species were also screened/included for comparison. Corallicolids were detected in twenty two individuals and nine species, with seven of those being previously undocumented hosts.A phylogenetic analysis revealed two potential clades: one with fidelity within its host taxon and another showing depth fidelity. These findings further our knowledge of the ecology of this host symbiont interaction by expanding the known host and depth range and adds support to the theory of there being both generalist and host restricted corallicolid lineages.

Speed talks

1. Deep-sea corals in two of Colombia's newest marine protected areas

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Abstract
Two deep-sea areas of conservation interest were explored during 2022, to generate baseline information about the epibenthic and demersal biodiversity between 1,500 and 3,000 m. New marine protected areas were designated as a result of these explorations: Cordillera Submarina Beata Marine Reserve, in the Colombian Caribbean, and the National District of Integrated Management Colinas y Lomas de la Cuenca Pacífico Norte, in the Colombian Pacific. Using the Caribbean bathymetry previously acquired by the Dirección General Marítima (DIMAR, in 2019) and the Pacific bathymetry freely available from GEBCO, geomorphological anomalies of interest were chosen to be explored in March and April 2022, using a remotely operated vehicle (R.O.V) with a range capacity of 3,000 m of depth. The resulting video-transects were analyzed, and snapshots were taken to identify major macrofauna groups, in this particular case, deep-sea corals. A total of 54 hours of video and 3751 frames were analyzed, identifying a total of 16 morphospecies or OTUs (Operational Taxonomic Unit) in Cordillera Submarina Beata Marine Reserve and 12 in DNMI Colinas y Lomas de la Cuenca Pacífico Norte. Representatives of two subclasses, Hexacorallia and Octocorallia, were found. The subclass Octocorallia was the most frequent in both areas. The analysis revealed the presence of species that are indicators of vulnerable marine ecosystems (cup corals and pennatulaceans) even though the substrate is distinctive in both areas; Cordillera Beata is a benthic habitat dominated by sedimentary bottoms and in the Pacific, the fauna is associated with boulders. Although this is the first approximation of the deep-water biodiversity for these areas, and the diversity of the system is probably underestimated, the results reported here provide an important contribution to the knowledge and conservation of previously unexplored deep-water systems of the Colombian territory.

2. The fauna associated with cold water corals in the border between Mauritania and Senegal

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Abstract
As part of the EAF-Nansen Programme, a habitat survey was conducted in the frontiers between Mauritania and Senegal on board the N/O Fridtjof Nansen in October 2021. This survey aimed to identify the occurrence of benthic habitats requiring particular management attention in areas subject to developments in the exploitation of gas resources.Here, we present preliminary results of the associated fauna with cold-water corals (CWC) through the analysis of 14 videos carried out on coral reefs occurring at 430 to 650 meters depth by using ROV.This analysis showed that the reefs offer habitat for many species. In total, 147 taxa have been identified belonging to 10 fauna groups. Fish was the most represented group with 45 taxa, followed by cnidaria and crustacea with 18 taxa each. In terms of occurrence, *Helicolenus dactylopterus* was the most common fish, with more than 260 observations. For the crustaceans the species, *Bathynectes piperitus* and *Eumunida bella* were the most common with more than 400 observations.The cnidarians were dominated by the octocoral *Acanthogorgia hirsuta* with more than 1200 observations and the bivalve *Acesta excavata* was the most common mollusk, with more than 78 records. Several of these species are known to be associated with *Lophelia* from other studies, and even though the studied reefs are in an oxygen minimum zone they are still an important habitat for many of the same associates.Ten coral species were identified, the most abundant was *Acanthogorgia hirsuta* followed by *Lophelia pertusa*, *Swiftia phaeton* and the black coral *Trissopathes*

sp. Analysis of the videos showed the presence of live and rich *Lophelia* reefs in area of development and exploitation of gas resources, and special attention should be taken to protect this rich and vulnerable habitat.

3. Global Distribution of Stylasterid Corals: Updated Insights from Family to Species Level

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Abstract

Stylasterid corals (Cnidaria: Stylasteridae) are a calcified hydrozoan family very diversified with 29 genera and 322 valid recent species. Over the past 40 years, numerous taxonomical studies have been published to unlock information about stylasterid diversity and in recent decades their importance as habitat-forming species in the deep sea has been highlighted. In most taxonomic studies, geographical distribution and bathymetric information have been updated with new records, revealing that stylasterid corals are distributed worldwide, except for the Arctic area, showing the most diversification in the New Caledonian-New Zealand region. They are more common on seamounts, ridges, and continental slopes of insular environments at depths ranging from 0 to 2789 m, even if their preferred range is 200-400 m. In the last decades, many new records came out from deep sea campaigns around the world giving new distributional information. However, if no voucher specimen is available, the identification of stylasterids is challenging, and the information often remains at the family level. This work provides an updated distribution analysis of the data from family to species level on a global scale. For the analysis, a database was built using all the data reported in the taxonomic papers that give a correct identification of the specimens and update of the synonymies. To this database were also added all records identified from museums, resulting in approximately 7,000 records. We used these datasets to update and go deeper in the knowledge of the global distribution of stylasterid corals, finding the hotspot of biodiversity, bathymetrical distribution along latitude and longitude, and endemism. Moreover, data obtained from three online databases (GBIF, OBIS, and NOAA), for a total of more than 50,000 records, were used to verify the presence of stylasterids in areas poorly studied confirming that other regions still needed to be better investigate.

4. Bamboo coral *Isidella elongata* (Cnidaria: Keratoisididae): New evidence on their ecological role and vulnerability in the Mediterranean Sea

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Abstract

Bamboo coral *Isidella elongata*, belonging to the family Keratoisididae, are considered habitat forming species, able to build essential habitat dwelling on the bathyal deep sea muddy bottom. This habitat may serve as a refuge and nursery ground for a variety of species, including those of commercial interest. However, due to their coexistence with commercially valuable fishery resources, they are severely impacted by trawling activities enough to cause a decrease in occurrence and population density. In addition, these species have been classified as indicators of Vulnerable Marine Ecosystems (VMEs), due

to their peculiar life-history traits (e.g. slow growth rate, late age of maturity, low recovery) and listed as Essential Fish Habitats (EFHs), as they include spawning, nursery, feeding grounds, and migratory corridors. This study investigates the importance of *Isidella elongata* together with other representative species of the muddy sediment, belonging to superfamily Antedonoidea and Pennatuloidea, in influencing the fish assemblages. Also, evidence of the anthropogenic impacts of trawling activities will be reported. In order to obtain data, ROV (Remotely Operated Vehicle) surveys were performed in the Northern part of the Strait of Sicily, mostly in areas characterized by muddy sediment, in a depth range between 415 and 635 m. By performing a Redundancy Analysis (RDA), this study examines the relationship between habitat forming species and associated fishes, focusing on areas with different densities of *Isidella elongata.* Preliminary results suggest that bamboo coral is a key species in the area and that their presence influences fish assemblages. Is evident that conservation actions are needed to safeguard these ecosystems in order to maintain marine biodiversity and these results will increase the information useful for this purpose.

5. Coral communities along the canyon walls of Blanes Canyon (NW Mediterranean Sea)

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Abstract

Submarine canyons are prolific areas in terms of deep-sea diversity, found on the continental margins. They are important conduits of particle transport between the shallow continental shelves and the deep-sea. Submarine canyons have a complex topography that interacts with the general circulation, generating specific hydrological processes, such as eddies, upwelling or downwelling and internal waves. Within the canyons, different substrate types can be found from soft sediment in the canyon axis to exposed hard and steep walls. The topographical and hydrological complexity of these features and the high substratum heterogeneity, provide good conditions CWC growth and dispersion. In the north-western Mediterranean Sea, submarine canyons are very common geomorphic features incising the continental margin, intercepting the Levantine Intermediate Water (LIW). This water mass is considered the main path of CWC distribution in the Mediterranean, flowing between 300-600 m depth and characterized by high density (<29 kg m^{-3}). Blanes canyon is found on the Catalan margin, NW Mediterranean Sea. It is located only 4 km from the coast, surrounded by important fishing grounds for many commercial interest species, including the blue and red deep-sea shrimp *Aristeus antennatus*. Although well studied from oceanographic and geological points of views, the extent of CWC communities within the canyon was still uncertain. This study provides a comprehensive and detailed description of megabenthic communities found in the canyon head and east canyon tributary. The most abundant animal group were corals, with colonial scleractinians found along the canyon head. Octocorals and black corals were the major contributors in the east canyon tributary. Overall, this study confirms Blanes Canyon as an important source of CWCs in the Mediterranean Sea, elaborating on the significance of substrate type, slope and water masses for coral growth in submarine canyons.

6. Characterizing Biodiversity of Mesophotic Reef Benthos Using Autonomous Reef Monitoring Structures (ARMS)

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Abstract

Most reef biodiversity is found within the benthos, yet the benthic cryptobiota that supports mesophotic coral reefs has yet to be fully characterized. Understanding the composition of these communities and how they are spatiotemporally connected is crucial for implementing effective management and restoration strategies that ensure resiliency against anthropogenic disturbances. Autonomous Reef Monitoring Structures (ARMS) integrate traditional and molecular techniques to determine spatiotemporal patterns of genetic and ecological connectivity of coral ecosystems. ARMS serve as a 3-dimensional settlement structure for recruits and are a quantitative, standardized sampling method comparable across sites and over time. The Flower Garden Banks National Marine Sanctuary (FGBNMS) is a recently expanded sanctuary comprised of 17 banks spanning 160 miles in the northwestern Gulf of Mexico (GoM) that hosts shallow and mesophotic reefs. In 2019, we deployed 36 ARMS across six banks within FGBNMS for two years to describe how these banks are vertically and horizontally connected within the sanctuary and to other reefs in the GoM and the greater Caribbean. DNA metabarcoding of mitochondrial cytochrome c oxidase subunit I (mtCOI) and ribosomal 18S RNA genes was applied to characterize cryptobenthic diversity associated with mesophotic reefs. We aim to measure species richness for each site (α diversity), the species pool for the entire region (γ diversity), and species turnover (ß diversity). We will present results on the community composition and connectivity across the targeted banks and discuss any driving and limiting factors.

7. To Higher Places – *Gersemia rubiformis* using large demosponges as a perch

Heidi Meyer[1], Andy Davies[2], Gjertrud Jensen[1], Yngve Klungseth Johansen[1], Anne Kari Sveistrup[1], Jonatan Marquez[1], Rebecca Ross[1], Pål Buhl-Mortensen[1], Genoveva Gonzalez-mirelis[1], Joana R. Xavier[3]

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Abstract

AUV and ROV images collected between 2016-2018 in scope of the Horizon 2020 SponGES project[1] revealed the soft coral *Gersemia rubiformis* to be highly abundant within the sponge ground on the arctic seamount, Schulz Bank. On the summit of the seamount (580 m depth), *G. rubiformis* displayed distinct spatial patterns and would regularly be perched on the large demosponges (*Geodia parva* and *Stelletta rhaphidiophora*), similar to observations from three other seamounts in the Central Arctic Ocean – Northern Mount, Central Mount, and Karasik Seamount (Morganti et al., 2022). In contrast, on the upper slopes of the Schulz Bank, *G. rubiformis* was commonly seen settled on soft sediment even if the large demosponges were present. Based on these observations, we hypothesize that the soft corals are actively settling on the large demosponges on the summit to gain better access to food supplies by being elevated above bottom, whereas slope habitats likely experience higher currents that provide enough food to the soft corals without the need for elevated positioning. To test this, we annotated

images containing *G. rubiformis* from slopes and summit of the Schulz Bank seamount. We then compared our results to images extracted from multiple sites obtained from the MAREANO project that contained both *Gersemia* sp. and *Geodia* sp. or *Stelletta* sp. to determine if this is a regular interaction. To the best of our knowledge, this is the first study to quantitatively examine the biotic interactions between *Gersemia* and the large demosponges. Our results further highlight the complex interspecific relationships at play in the deep sea and show how image-based surveys can act as an important resource when evaluating deep-sea communities for management and conservation.

[1] www.deepseasponges.org

8. A brief survey of the cold-water coral reefs of the world

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Abstract

In case you didn't already know, cold-water corals (CWC) form reef structures in continental margin and seamount settings at tropical, temperate, and even some polar latitudes. This global distribution makes them more wide-spread and abundant than shallow-water reefs, while their role in these regions is no less important than the influence that shallow-water coral reefs have on shallow, tropical systems. They create habitat structure, host endemic species, enhance elemental cycling, alter current flow, sequester carbon, and provide many other ecosystem services that we are just beginning to understand. With the help of collaborators around the world, we set out to compile a book that synthesizes recent and historical information, reveals new findings from reefs that have been discovered only recently, and presents key avenues for future research. Global distribution and environmental data are synthesized into an ensemble model that described the niche of key species of framework-forming corals. Using an algorithm to distinguish coral colony occurrence from coral reef and mound occurrence, we further describe the subset of conditions under which CWC form reefs. This effort reveals new areas that are highly likely to host undiscovered CWC reef habitats and provides a framework for future ocean exploration. We are on the cusp of understanding the critical role that CWC reefs play in the world ocean, and this study helps to set the stage for future efforts to determine their global impact and potential threats to the ecosystem services they provide.

Session 6. Policy, Management, and Conservation

Type	N	Presenter	Title
Keynote	1	Christine Gaebel	Integrating marine science under the BBNJ Agreement: Stakeholder perceptions on the Scientific and Technical Body
Keynote	2	Telmo Morato	Improved deep-sea biodiversity assessments can inform conservation and sustainable management of deep-sea ecosystems
Full talk	1	Lyndsey Holland	New Zealand's Conservation Services Programme: using fisheries levy-based research to understand, manage and mitigate the impacts of commercial fishing on protected corals
Full talk	2	Craig Stuart	Comparative Analysis of Deep-Sea Coral and Sponge Video Annotations
Full talk	3	Kelly Martin	Mesophotic and Deep Benthic Community Restoration in the Gulf of Mexico following the Deepwater Horizon Oil Spill: Planning Outcomes and Implementation Progress
Full talk	4	Kristopher Benson	Organizing and finding meaning in complex data streams generated by restoration projects for Mesophotic and Deep Benthic Communities in the Gulf of Mexico following the Deepwater Horizon Oil Spill
Full talk	5	Lizzie Duncan	Key strategies and outcomes of the 2018 US West Coast Deep-Sea Coral Initiative
Full talk	6	Sandra Maier	The coldest of their kind: Cold-water coral research and management in Greenland
Full talk	7	Geoff Shester	Protecting Deep-Sea Corals from Non-trawl Groundfish Fishing Gears in the Southern California Bight, USA
Full talk	8	Megan Davies	Patterns of deepsea coral and sponge ecological monitoring groups on Northeast Pacific seamounts: Management Implications
Full talk	9	Tabitha Pearman	The Vulnerable Marine Ecosystems Project - South-West Atlantic deep sea
Full talk	10	Amy Baco-Taylor	Fisheries Impacts on Precious Coral Distributions and Population Genomics on Seamounts of the Northwestern Hawaiian Islands and Emperor Seamount Chain
Speed talk	1	Janessy Frometa	Restoring the Gulf of Mexico's Mesophotic and Deep Sea Corals: species prioritization and fieldwork to date
Speed talk	2	Verena Häussermann	Cold-water coral forests (Cnidaria, Anthozoa and Hydrozoa) of Chilean Patagonia: unique deep-water emergent benthic communities threatened by aquaculture and climate change
Speed talk	3	Jordi Grinyo	Active and participatory ecological restoration of anthropogenically-impacted Benthic Ecosystems in the Mediterranean through partnership with local fishers: The Life ECOREST project
Speed talk	4	Heather Coleman	Prioritizing deep-sea corals as part of the National Strategy for Mapping, Exploring, and Characterizing U.S. Waters
Speed talk	5	Thomas Hourigan	Coral and sponge communities of the Aleutian Archipelago: Dense, diverse and vulnerable
Speed talk	6	Alicia Mateos Cardenas	Microplastics in cold-water corals in an Irish Special Area of Conservation
Speed talk	7	Qian Liu	Deep-sea coral geochemistry and its implications for coral conservation
Speed talk	8	Guarani Cavalcanti	SISCAP Project – Testing new monitoring tools for cold-water coral environments in oil and gas E&P areas in Brazil
Speed talk	9	Anita Tullrot	Method development for cold-water coral reef habitat restoration in Sweden - the LIFE *Lophelia* project

Keynote Abstracts

1. Integrating marine science under the BBNJ Agreement: Stakeholder perceptions on the Scientific and Technical Body

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Abstract
Areas beyond national jurisdiction (seabed, subsoil, and water column outside coastal state jurisdiction) account for over two-thirds of the global ocean and are home to diverse and unique marine biodiversity, including deep-sea corals. Biodiversity of areas beyond national jurisdiction (BBNJ) supports vital ecosystem services, yet is facing increasing pressure in what is now a rapidly changing ocean. In response to global concern for BBNJ, a new international agreement for the conservation and sustainable use of BBNJ (the BBNJ Agreement) was negotiated between 2018 and 2023. Notably, the BBNJ process is touted as being science-led, with the agreement calling for the use of best-available science within both its general principles and substantive provisions. However, while it is suggested that science will play an important role, it remains unclear how this will be operationalised in practice to support the uptake and integration of science within the decision-making process. To provide insights into the BBNJ science-policy interface, semi-structured interviews were conducted with forty BBNJ stakeholders, including individuals from state delegations, intergovernmental organisations, non-governmental organisations, and academia. Interview data subsequently underwent transcription and thematic content analysis to investigate the breadth and content of identified perceptions. The results highlight the wide-range of areas where scientific information will be required for implementation, as well as key considerations for integrating science under the BBNJ Agreement. These findings underscore the importance of fit-for-purpose institutional arrangements, including an effective Scientific and Technical Body (STB), and suggest that in order to fulfil the unique requirements set out in the BBNJ Agreement, a step-change is needed regarding the design of the STB. Key findings, including stakeholder views on existing STBs and preferred formation, functions, and guiding principles for BBNJ's STB, will be combined with observations drawn from the BBNJ negotiations, to highlight enabling conditions for integrating science under the BBNJ Agreement.

2. Improved deep-sea biodiversity assessments can inform conservation and sustainable management of deep-sea ecosystems

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Abstract
The deep-sea of the Azores is characterized by a complex marine seafloor home to rich benthic habitats, where hydrothermal vents, coral gardens and sponge grounds are commonly observed. These benthic habitats are, however, exposed to anthropogenic pressures, which can put their long-term preservation at risk. Identifying areas of ecological relevance is currently of upmost importance to inform management measures that would ensure the protection of the natural heritage in commitment with a sustainable use of marine resources. Thanks to the cost-effective video platform

Azor drift-cam and other ongoing collaborations, such as with the Eurofleets+ program, we have significantly increased our knowledge of the natural capital of the Azores deep sea. Over the past four years, almost 600 dives have been conducted at several seamounts, ridges and island slopes, resulting in over 550 hours of new deep-sea imagery, totaling approximately 400 kilometers of explored seafloor. We have found that the Azores is a hotspot of cold-water coral diversity in the NE Atlantic, with more than 180 species identified to date. We have discovered the largest assemblage of the very slowly growing black coral of the genus Leiopathes ever observed in the Atlantic, the densest octocoral garden of the bubble gum coral Paragorgia johnsoni, and large aggregations of the endemic hydrocoral Errina dabney, among others. Several of the areas explored meet the criteria to be considered VMEs due to the high structural complexity and functional importance of their benthic habitats, with high vulnerability to human activities and potentially slow recovery after disturbance. These improved assessments of the deep-sea biodiversity have enhanced our ability to develop systematic conservation planning approaches and inform the identification of priority areas for conservation. Indeed, these assessments have already informed the Regional Government of the Azores on the expansion of the existing network of Marine Protected Areas to achieve the 30% targets. Although substantial gaps in scientific knowledge still exist, the newly collected biodiversity data can be used to produce transparent, data-driven and science-based scenarios to inform conservation and sustainable management of deep-sea ecosystems.

Full Talks

1. New Zealand's Conservation Services Programme: using fisheries levy-based research to understand, manage and mitigate the impacts of commercial fishing on protected corals

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Abstract

There are more than 300 species of cold water corals in Aotearoa New Zealand, where they frequently occur as bycatch in deep-sea trawl fisheries despite their legally-protected status. The Department of Conservation, the agency mandated to implement the management and conservation of wildlife, administers the Conservation Services Programme (CSP). CSP uses cost-recovered levies from quota owners of commercial fish stocks to fund research into bycatch and the adverse environmental effects of fishing. As these effects include direct impacts on protected species, CSP manages a scientific research programme that seeks to better understand and mitigate the impacts of fishing on protected marine species, including on corals in four protected groups: all species in the orders Alcyonacea, Scleractinia, Antipatharia, and the family Stylasteridae. As the availability of funding from 'conservation service' levies is legally entrenched and dependable, CSP research outputs have increasingly contributed to a better understanding of fishing impacts on corals that can feed into conservation management. Past and ongoing coral research is varied, including connectivity, species distribution modelling, reproduction, genetics and diversity, and researchers benefit from decades of coral specimens and reports returned by fisheries observers. Now in its 26th year, this talk presents an overview of the coral research undertaken through CSP and discusses the unique programme model, outputs, challenges and future directions, for both research and coral conservation.

2. Comparative Analysis of Deep-Sea Coral and Sponge Video Annotations

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Abstract
The characterization of deep-sea coral and sponge (DSCS) communities is vital to our understanding of deep-sea ecosystems, their role as essential fish habitat, and changes in the biodiversity, distribution, and connectivity of benthic environments. Video annotation is a common methodology for characterizing DSCS communities. This requires individual analysts to review videos from quantitative visual surveys to identify, enumerate, and measure individual corals and sponges. However, video annotating is prone to observational bias, which may have significant implications for the accuracy and reliability of DSCS characterization results. In spite of this concern, the authors are not aware of any studies quantifying this bias. To address this, we conducted a comparative analysis study to identify potential bias between video analysts and determine the factors that may influence the degree of bias. Four video analysts with varying levels of video annotation experience, ranging from less than one year to more than ten years, reviewed nine quantitative transects from Daisy Bank, a known DSCS habitat off the West Coast of the United States. Each analyst reviewed the same transect videos in four separate rounds and received methodological training between each round to standardize methodologies and identification. For this study, three taxa of sponges were targeted; *Aphrocallistes vastus*, *Staurocalyptus* spp., and one similar to *Haliclona* spp. A set of criteria for identifying each species was determined and used to compare annotation results. The results of this study will improve our ability to accurately characterize DSCS communities and reduce inconsistencies across annotators and agencies involved in DSCS exploration. In addition, this study highlights the importance of experience and training in minimizing observational bias in DSCS identification.

3. Mesophotic and Deep Benthic Community Restoration in the Gulf of Mexico following the Deepwater Horizon Oil Spill: Planning Outcomes and Implementation Progress

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Abstract
Over 770 square miles of deep-sea habitat and 4 square miles of mesophotic habitat were injured by the 2010 Deepwater Horizon (DWH) oil spill in the northern Gulf of Mexico (GOM). In 2019, the U.S. agencies managing the Natural Resource Damage Assessment settlement and restoration process resulting from the oil spill released Open Ocean Restoration Plan 2 (OORP2), which selected four restoration projects focused on Mesophotic and Deep Benthic Communities (MDBC) in the northern GOM: Mapping, Ground-Truthing, and Predictive Habitat Modeling (MGM); Habitat Assessment and Evaluation (HAE); Coral Propagation Technique Development (CPT); and Active Management and Protection (AMP). Goals of this portfolio are to improve understanding of MDBC to inform management and ensure resiliency, to restore abundance and biomass of MDBC invertebrates and fish with a focus on high-density coral sites, and to actively manage valuable MDBC to protect against multiple threats and provide a framework for monitoring, education, and outreach. The projects began in 2020 with a two-year planning phase. Since then, the project teams have made significant progress in the planning and implementation of the projects. The planning phase concluded in 2022, and included stakeholder engagement, best-practices workshops, spatial prioritization, inventories and analyses of existing data,

initial field- and lab-based activities, development of technical reports, and the finalization of project management plans detailing activities to be carried out in an implementation phase that will extend through 2027. The implementation phase now in progress represents a substantial effort by multiple U.S. government agencies, academic and scientific institutions, and non-profit organizations to achieve the restoration goals of the DWH MDBC portfolio. This presentation will cover outcomes of restoration activities to date, objectives for the 2023 field season and beyond, and efforts to translate outcomes of the portfolio for general public and natural resource management audiences.

4. Organizing and finding meaning in complex data streams generated by restoration projects for Mesophotic and Deep Benthic Communities in the Gulf of Mexico following the Deepwater Horizon Oil Spill

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Abstract

Large teams of collaborating U.S. government natural resource management agencies and NGOs (academic and scientific institutions, non-profit organizations) are engaged in efforts to restore mesophotic and deep benthic communities (MDBC) in the Gulf of Mexico that were injured by the Deepwater Horizon oil spill. The complex structure and pioneering nature of the MDBC restoration portfolio has led to opportunistic use of a variety of resources and tools to meet specific needs for data management and dissemination. These resources support data access and use both within and between project teams as well as externally to the broader communities engaged in science and applications for restoration, protection, and management of these resources. This presentation will navigate the data management ecosystem established for the MDBC portfolio and explain its components, including the access and use of products and deliverables ranging from raw data to publications.

5. Key strategies and outcomes of the 2018 US West Coast Deep-Sea Coral Initiative

Lizzie Duncan[1], Chris Caldow[2], Elizabeth Clarke[3], Meredith Everett[3], Tom Laidig[4], Arliss Winship[5], Jenny Waddell[6], Eric Chavez[7], Caitlin Adams[8], Heather Coleman[9], Thomas Hourigan[9]

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Abstract

Arguably the largest challenge facing resource managers' efforts to balance sustainable ocean use and deep-sea habitat conservation is the lack of high resolution seafloor mapping and visual survey information. In an effort to address such knowledge gaps off the west coast of the United States, the National Oceanic and Atmospheric Administration (NOAA) Deep Sea Coral Research and Technology Program supported a 4 year research initiative that aimed to map, characterize, and conduct research on deep-sea coral and sponge (DSCS) habitats in waters off Washington, Oregon, and California. Known as the West Coast Deep-Sea Coral Initiative (WCDSCI), the main objectives included (1) gathering baseline information on benthic habitats in areas subject to fishing regulation changes, (2) improving our understanding of known relatively high DSCS bycatch 'hot spots'', and (3) exploring and assessing DSCS resources within NOAA National Marine Sanctuaries. Under consultation with the Pacific Fishery Management Council, these objectives were codified into the initiative's Science Plan which outlined the potential partners, strategies and targeted field and data projects. WCDSCI showcased an unprecedented level of collaboration among federal, state, and other agencies to which much of the success of the initiative is owed, particularly with respect to executing region-wide field missions and leveraging additional funding. A broad array of timely science and management objectives were addressed despite the challenges presented by the global pandemic. New information, tools, and discoveries made possible by WCDSCI will inform a number of high priority, multi-agency management issues for many years to come.

6. The coldest of their kind: Cold-water coral research and management in Greenland

Sandra Maier[1], Martin Blicher[1], Nanette Hammeken Arboe[2], Nadescha Zwerschke[1]

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Abstract

The seafloor around Greenland harbours diverse benthic ecosystems including thriving cold-water coral gardens and reefs, and sponge grounds. At the same time, the productive benthic ecosystem sustains large fisheries of prawn and halibut that form >80% of the Greenlandic national export value. Bottom trawling and rapid climate change likely have a detrimental effect on the these vulnerable marine ecosystems (VMEs); yet, large knowledge gaps on remain on VME distribution, functioning, and status, hampering effective marine spatial planning. To address these knowledge gaps, the Greenland Institute for Natural Resources (GINR) has initiated a large-scale and long-term benthic monitoring program in 2015, together with other Arctic and North Atlantic partners (INAMon, i.e. Initiating North Atlantic Benthos Monitoring). Here, we present the lessons we have learnt since, challenges and bottlenecks from a scientific, logistic and sociopolitical perspective, and an outlook to future plans and options for collaboration, to work towards conservation and management of the Arctic seafloor treasure.

7. Protecting Deep-Sea Corals from Non-trawl Groundfish Fishing Gears in the Southern California Bight, USA

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Abstract
The Southern California Bight, USA is renowned for its abundance and diversity of cold-water corals and sponges. Recognizing the importance of these diverse seafloor ecosystems, state and federal fishery managers have protected 99% of this region from bottom trawl fishing. To rebuild overfished cowcod rockfish (*Sebastes levis*), which were declared overfished in 1999, managers earlier closed large portions of the bight to all commercial and recreational groundfish fishing in what are called Cowcod Conservation Areas. Then, after successfully rebuilding the stock in 2019, managers began to consider reopening the areas to non-trawl fishing while establishing permanent protections for deep-sea corals. In response, recreational and commercial fishermen collaborated with the conservation organization Oceana to develop a consensus proposal that would repeal the Cowcod Conservation Areas while protecting areas known to contain deep-sea coral and sponge communities. The proposal was unanimously adopted by the Pacific Fishery Management Council in March 2023. The action establishes 8 Groundfish Closed Areas that combined total 12% of the previous Cowcod Conservation Areas and 48% of its documented coral occurrences. The protected areas range in depth from 31 to 1,790 meters. With existing bottom trawl prohibitions and state and federal marine reserves, the new protections establish a comprehensive approach for deep-sea coral conservation in the Southern California Bight. This action will also restore significant groundfish fishing opportunities in a collaborative fashion supported by conservation and fishing stakeholders. The adopted proposal, once approved by NOAA Fisheries is slated to go into effect in January 2024.

8. Patterns of deepsea coral and sponge ecological monitoring groups on Northeast Pacific seamounts: Management Implications

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Abstract
Off the Pacific coast of Canada, Marine Protected Areas (MPAs) safeguard more than 135,000 km^2 of deep-sea habitats, including at least 50 seamounts (i.e., SGaan Kinghlas-Bowie Seamount MPA and Tang.ɣwan-ḥačxʷiqak-Tsigis MPA). Current MPA management plans prioritize the conservation of cold-water corals and sponges (CWCS), however, given the size of the MPAs and number of seamounts, plans for baseline and long-term monitoring of conservation objectives must be efficient and cost-effective. Current methods are time-consuming and require significant expertise (e.g., characterizing only surveyed areas and identifying CWCS to lowest taxonomic level). To streamline monitoring processes, extrapolating distribution patterns to unsurveyed areas within the MPAs or grouping CWCS species into larger ecological monitoring groups (EMGs) are options. Here we use benthic imagery collected on nine seamounts to quantify if CWCS diversity and density patterns are synchronous across seamounts with differing environmental characteristics (e.g., summit depth, export productivity, and dissolved oxygen). We use a national EMG classification system (largely based on taxonomy and morphological traits) and investigate whether these EMGs exhibit the same patterns as their representative species. Preliminary findings indicate density and diversity patterns are asynchronous across seamounts. Additionally, we find that, in some cases, monitoring for the 9 EMGs may obscure many of the 80 species-level distribution responses to environmental variables, including highly vulnerable species. The lack of synchrony across seamounts, even those with similar characteristics, challenges the suitability of using patterns observed on surveyed seamounts to make inferences about unsurveyed seamounts. We highlight that low-resolution classifications can impact our understanding of how vulnerable species might be influenced by changing ocean conditions and may not be

appropriate for monitoring these MPAs depending upon conservation objectives. Given this context, we offer several recommendations for the long-term MPA monitoring plans in deep and remote settings.

9. The Vulnerable Marine Ecosystems Project- South-West Atlantic deep sea

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Abstract

Deep-sea environments face increasing anthropogenic pressure, especially vulnerable marine ecosystems (VMEs) that comprise species, communities and habitats with characteristics that make recovery from fishing impact difficult. This includes a variety of cold-water coral communities. Due to the value of services and biodiversity VMEs support, there is international legislation to identify, map and protect VMEs. Mapping VMEs is a key component in protection, facilitating marine spatial planning and area-based conservation strategies. However, mapping VMEs in deep-sea environments is challenging, especially in the SW Atlantic due to remoteness and being a funding-limited location. In the Falkland Islands, the main anthropogenic activity in the deep sea is a Marine Stewardship Council Certified seabed static longline fishery operating in water depths > 600 m. VME maps are needed to assess wider ecosystem impacts of the fishery. Consequently, the VME project was established and saw researchers, government fisheries and fishermen collaborating. To characterize and map cold-water coral VMEs, legacy data compiling imagery, bathymetry, oceanography and fisheries bycatch data were combined with data collected from an adapted longline camera. Random Forest and MaxEnt ensemble models were created from VME indicator taxa presence/absence data and a suite of terrain derivatives calculated from bathymetry and ocean chemistry data extracted from global models. Ensemble maps were compared with kernel density estimated biomass maps of VME indicator taxa, which were derived from fisheries bycatch data, and areas of congruence, indicative of potential VMEs identified. Mapping outputs fed into a VME vulnerability assessment that informed a VME strategy developed in collaboration with stakeholders. Adaptive management options varied based on triggers assessed through monitoring, facilitated by capacity building of fishermen and fisheries observers. The work exemplifies VME mapping methods in under-resourced regions and the importance of capacity building in enhancing the identification, mapping and protection of VMEs beyond research funding time scales.

10. Fisheries Impacts on Precious Coral Distributions and Population Genomics on Seamounts of the Northwestern Hawaiian Islands and Emperor Seamount Chain

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Abstract

Deep-sea precious corals in the octocoral family Coralliidae are among the dominant benthic megafauna at depths of 300-600 m on seamounts of the Northwestern Hawaiian Islands and lower

Emperor Seamount Chain. *Pleurocorallium secundum* and *Hemicorallium laauense* were once abundant enough on these seamounts to support a targeted coral fishery in the 1960s and 1970s. Significant trawl finfish fisheries were also occurring in the same time frame on the same seamounts. Because they had high enough abundance to support a targeted fishery for two decades, these two coralliid species must have been a key component of the baseline community on these seamounts and therefore provide an ideal indicator species for testing effects of large-scale disturbance and potential for recovery. Surveys were conducted at seamounts outside the US EEZ that are still actively fished by trawl, seamounts that were historically trawled but have been protected since the establishment of the US EEZ, and seamounts that have never been trawled, to determine population distributions and colony sizes. Samples were also collected for ongoing studies of population genetics of precious corals throughout the Archipelago. Both species had lower abundance, or were absent from, seamounts that have experienced trawling disturbance. Colony size data indicate smaller sizes for both species on disturbed seamounts. Data from 9 microsatellite loci for *H. laauense* show higher heterozygote deficits and higher F^{IS} values for recovering and trawled sites compared to unfished seamounts. Fished sites were more genetically similar to each other than to non-fished sites, suggesting protected recovering sites will be important for recovery of actively trawled areas. However high F^{IS} values indicate local recruitment from remnant populations will also need to be a critical consideration in high seas conservation and management. A pattern of isolation by distance was present across the Archipelago.

Speed Talks

1. Restoring the Gulf of Mexico's Mesophotic and Deep Sea Corals: species prioritization and fieldwork to date

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Abstract

Hydrocarbon exposure from the Deepwater Horizon oil spill occurred over extensive areas of mesophotic and deep-sea habitat in the northern Gulf of Mexico (nGoMx). Injury was documented for gorgonian octocorals at multiple sites near the wellhead at 1500 m depth, and below the surface oil slick at mesophotic depths of ~50-300 m. In response, federal trustees have developed projects and strategies to restore mesophotic and deep benthic communities (MDBC). Restoration will require significant resources and has few precedents. A ranking exercise based on coral injury and status of knowledge identified 42 deep-sea coral taxa known to be injured and/or present in areas of injury. Five species were recommended for coral propagation through this process: *Swiftia exserta, Muricea pendula,* and *Thesea nivea* in the mesophotic zone, and *Paramuricea biscaya* and Paramuricea sp. B3 in the deep-sea. The assessment of genetic knowledge expanded the list of coral taxa identified in the literature review to include all deepwater coral species reported in the nGoMx. Results revealed at least six mesophotic octocoral genera with major gaps in genetic data. These taxa are being targeted for sampling, along with deep-sea coral genera impacted by the spill (e.g. Paramuricea, Bathypathes). Population-level genetic/genomic data (e.g. RAD-seq, target capture, microsatellites) are most useful

for connectivity and species delimitation studies, and this type of information is more common for deep-sea coral genera such as Desmophyllum, Callogorgia, Leiopathes, and Bathypathes. A combined review of both analyses helped to identify many other coral taxa that warrant closer examination. To date, six cruises have been conducted to collect live coral samples for propagation and preserved genetic samples for genome skimming and population connectivity analyses. Cruises in 2023 will focus on deep-sea surveys and collect deep sea corals for propagation and observation in the lab.

2. Cold-water coral forests (Cnidaria, Anthozoa and Hydrozoa) of Chilean Patagonia: unique deep-water emergent benthic communities threatened by aquaculture and climate change

Verena Häussermann[1], Jürgen Laudien[2], Ignacia Acevedo-Romo[3], Ana Navarro Campoy[4], Thomas Heran[2], Rhian Waller[5], Javier Sellanes[6], Günter Försterra[3]

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Abstract

With its numerous fjords, channels and islands, Chilean Patagonia (41°42'S, 73°02'W to 56°29'S, 68°44'W) has a coastline of more than 100,000 km, making it one of the most rugged coastal regions and one of the least studied marine systems in the world. Over the past two decades, we have photographed and sampled hard bottom macroinvertebrates at more than 500 sites along the Chilean Patagonian coast using SCUBA divers and video footage from a remotely operated vehicle (ROV). We documented rich and extensive sublittoral so-called 'marine animal forests' formed by bioengineer species that include three categories of cold-water coral (CWC) forests: Stony coral banks, hydrocoral reefs and gorgonian forests, composed of nine CWC genera. Seven of the species/genera reach into the shallows, while they occur at much greater depths along the exposed Chilean coast north of 42°S. All CWC forests are restricted to specific regions of Patagonia, which can be divided into three provinces (Northern, Central and Southern Patagonia) consisting of 13 eco-regions. Four of the CWC species belong to one of the threat categories defined at national level. This is mainly due to local threats such as aquaculture, industrialization projects, fishing and invertebrate harvesting, as well as climate change including ocean acidification. The main current problems for CWCs are eutrophication (in combination with elevated temperatures, radiation, and reduced rainfall due to climate change, leading to strong algae blooms followed by hypoxia events), and increased sedimentation. A decade ago, we documented strong mortalities of the CWCs *Desmophyllum dianthus* and *Errina antarctica*, which have not recovered to date, and a sharp decline in densities of *Primnoella chilensis* forests. We report on the newly revealed life cycles of three of these bioengineering CWC species as an elementary component of population conservation and derive measures for the protection and restoration of CWC forests.

3. Active and participatory ecological restoration of anthropogenically-impacted Benthic Ecosystems in the Mediterranean through partnership with local fishers: The Life ECOREST project

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Abstract

The effects of recurrent industrial fishing are widespread in the Mediterranean Sea. In the Catalan margin (NW Mediterranean Sea), over 90% of benthic habitats between depths of 50 to 800 m have been impacted by bottom trawling. This has led to reduction in the structural complexity and biodiversity of benthic ecosystems, with negative effects on ecosystem function and services. To address this situation, scientists partnered with local Fishery Associations established 14 permanent no-take fishing reserves (total surface of 29,022 ha) between 100 to 400 m depth along the northern and central Catalan margin. Monitoring surveys have revealed that these communities' ability to recover from human impacts, is extremely slow as they are formed by long-lived, slow-growing species, with limited recruitment. As such, it is suspected that full ecosystem recovery of benthic communities and commercial stocks will take decades to centuries (especially for those in deep-sea realms) unless active efforts are made to accelerate ecosystem recovery. While most active restoration interventions in the deep-sea to date have been too limited in scale to adequately offset ecosystem damage, the Life ECOREST project will rapidly upscale, while reducing the costs of, the restoration efforts in the Catalan margin by partnering with fishers and relevant stakeholders. For the next 4 years, 8 Catalan Fisheries Associations (FAs) (controlling 320 vessels) will recover habitat forming sessile organisms (mainly anthozoans and sponges) accidentally caught in their fishing gear. Recovered organisms will be held in FAs aquaria before being transplanted to the no-take reserves using adaptations of the 'badminton' method. Simultaneously, restoration interventions are being monitored by stationary landers every 6 months and using mobile platforms (ROVs and AUVs) that can sample larger spatial areas. Our preliminary results on restored sessile species density and associated megafauna are promising and indicate the effectiveness of this restoration initiative.

4. Prioritizing deep-sea corals as part of the National Strategy for Mapping, Exploring, and Characterizing U.S. Waters

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Abstract

The National Ocean Mapping, Exploration, and Characterization (NOMEC) strategy within the U.S. Exclusive Economic Zone (EEZ) established an approach to leverage assets and investments across federal agencies, industry, academia, NGOs, and philanthropic partners to improve knowledge of the deep seafloor, sub-bottom, and water column,The following National Strategy and Implementation Plan for Mapping, Exploring, and Characterizing the EEZ help coordinate federal policy and actions across ocean agencies. They also enhance collaboration with non-federal partners and stakeholders, and facilitate cooperative deep-sea (>40 m) data collection to satisfy mutual agency needs and interests. Such activities span exploratory initial assessments to more comprehensive characterization in support of research, resource management, and policy-making. Better identification and characterization of deep-sea coral and sponge habitats are important for sound fisheries management. As such, the NOAA Fisheries' Deep Sea Coral Research & Technology Program played a lead role in drafting the benthic ecology section of the 2022 Strategic Priorities for Ocean Exploration and Characterization of the U.S. EEZ. This report also identifies thematic and geographic priorities along with relevant data needs and challenges for the water column, cultural heritage, marine resources, and geohazards. Addressing these priorities will support ecosystem management and inform ocean-based solutions to biodiversity and deep-sea habitat loss, while simultaneously meeting additional science and data needs for a variety of applications. This presentation will describe the prioritization process and results, with emphasis on their relevance for corals and sponges, which will help improve multi-sectoral collaborative exploration and characterization.

5. Coral and sponge communities of the Aleutian Archipelago: Dense, diverse and vulnerable

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Abstract

The Aleutian Archipelago in U.S. waters stretches 1,900 km and supports rich coral and sponge habitats, as well as important fisheries. The region is home to over 100 coral species and over 120 species of sponges. The discovery of 'coral gardens' led to the protection of six small coral garden marine reserves from all bottom-contact fishing in 2006, along with groundbreaking precautionary measures to freeze the footprint of bottom trawl fishing throughout the archipelago. Despite these management steps, fisheries bycatch of corals and sponges has remained high in certain locations and fisheries. In 2012 and 2014, the U.S. National Oceanic and Atmospheric Administration (NOAA) Deep Sea Coral Research & Technology Program and Alaska Fisheries Science Center conducted 216 stereo drop-camera transects throughout the Archipelago using a stratified random sampling protocol approach between depths of 50 to 900 m. Analysis of these surveys, along with 75 additional Aleutian camera surveys conducted for other purposes, have now revealed an additional 51 high-density coral and sponge communities (> 1 coral or sponge/m^2). Many, but not all of these new high-density areas are currently protected from bottom trawling – the major current threat; but potential future deep-sea mining for critical mineral resources could add to stressors. This poster presents an initial characterization of these

communities and implications for their conservation. All coral and sponge data from camera transects and trawl surveys are available through NOAA's data portal (https://deepseacoraldata.noaa.gov/) and the Ocean Biodiversity Information System (OBIS).

6. Microplastics in cold-water corals in an Irish Special Area of Conservation

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Abstract

Microplastic pollution is ubiquitous and marine systems have especially been studied for their presence. To date, microplastic studies on the deep sea have mainly focused on sediment cores and biota species such as fish and lobsters. Preliminary video data collected by a Remotely Operated Vehicle (ROV) previously showed that large plastic items are abundant, especially fishing items, in deep water Irish coral reefs from the Porcupine Seabight, currently listed as Special Area of Conservation (SAC). However, there is a data gap in the presence of microplastics in cold-water corals of such deep waters. In this study, we show for the first time the presence of microplastics in species of cold-water corals (*Leiopathes* sp. and *Lophelia pertusa*) collected at five sites at depths ranging from 893 to 948 m. Corals were examined on the surface of the coral skeleton and inside the stomach cavity of polyps after tissue digestion. The results from this novel study will be presented showing the different microplastic concentrations accumulated outside/inside the corals, a comparative analysis among species and any potential effects of environmental variables. Overall, cold water coral reefs are a habitat identified for monitoring under the EU Habitats Directive. Therefore, the results from this study aim to inform national (Irish) and European policy on ocean pollution.

7. Deep-sea coral geochemistry and its implications for coral conservation

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Abstract

Deep-sea corals play a crucial role in creating habitats that support deep marine biodiversity. However, these corals are under threat from ongoing environmental change (e.g., ocean acidification and global warming) and direct anthropogenic activities (e.g., deep-sea mining and bottom trawling). Consequently, deep-sea corals have been designated as indicator species for classifying vulnerable marine ecosystems (UNGA Resolution 64/72), thus their conservation will play a key role in maintaining

a thriving ocean. The skeletal chemistry of deep-sea corals can provide important insights into their growth behaviour, the environmental conditions in which they formed, and potential impacts of human activities. At the University of Bristol, we explore the stable isotope ratios and trace elements concentrations of deep-sea corals and use radiometric dating techniques to reconstruct where and when ancient corals lived. We use these data to understand deep-sea coral growth rates, habitat controls, and adaption with changing environment. The use of deep-sea corals as 'biosensors' also provides key insight into ocean environmental changes in the past beyond instrumental records (e.g., ocean temperature and carbon cycling). We use this information and other paleoceanographic archives to further explore and understand the drivers limiting deep-sea coral habitat viability (temperature, seawater pH, food supply, oxygen content). The implications of these findings for coral conservation include determining habitats and coral taxa that will be most vulnerable to future change, thus guiding restoration efforts in response to the long longevity of deep-sea corals. We seek to engage policy makers and stakeholders to identify the key questions and research needed to safeguard deep-sea coral ecosystems.

8. SISCAP Project – Testing new monitoring tools for cold-water coral environments in oil and gas E&P areas in Brazil

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Abstract

SISCAP- Surveillance system of cold-water corals (CWC) – is a research project that aims to test and establish a set of tools/methods to monitor CWC environments in the vicinity of many oil and gas activities. The scope complies with the environmental licensing process of Marlim and Voador oil fields revitalization, which were developed in the 1980's and will run until 2040's. The area has the greatest known abundance of CWC mounds or reefs in Campos Basin (SE Brazil), occupying 4.6 million m^2 of the sea floor. Two approaches are proposed: a long-term regional monitoring (4 years) to evaluate natural variations and cumulative impacts; and a short-medium term itinerant monitoring (weeks to months) aiming to assess the impacts of installation and decommissioning of subsea structures. Both approaches will use landers to evaluate the space-time dynamics; ROV images and 3-D photogrammetry for CWC structural complexity and biodiversity; eDNA analysis (water and sediment) of biological community; and biological markers (physiological and molecular) and microbiomes to evaluate organism's health (corals and octocorals). In the study area, CWC mounds occur from 550-1,000 m depths and vary in dimension, shape, and associated fauna. Based on these characteristics and on the distribution of subsea structures (close and far) seven locations were selected in three depth-ranges for the regional monitoring. The itinerant monitoring will evaluate CWC mounds located near a unique subsea activity as well as mounds surrounded by several subsea activities over time for cumulative impacts, all along with control areas. A field experiment is also planned with artificially provoked sediment resuspension to evaluate effects on a CWC mound. The sampling design was defined and will be executed in partnership with researchers of the Brazilian CWC Researchers Network.

9. Method development for cold-water coral reef habitat restoration in Sweden - the LIFE *Lophelia* project

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Abstract

In the Natura 2000 area Kosterfjorden-Väderöfjorden, four of six known coral reefs are dead. The coral *Lophelia pertusa* (syn. *Desmophyllum pertusum*) occurs in all the Atlantic Ocean and the Mediterranean, but is declining. The main objective for the EU Life project LIFE *Lophelia* is to develop a cost-effective method to restore *Lophelia* reef habitats. The high biodiversity of *Lophelia* reefs provide important ecosystem services. Fishermen have long targeted reef areas, and 30–50% of the reefs in Scandinavia are estimated to be damaged by bottom trawling. Three of the known *Lophelia* reefs in Sweden are protected from trawling since 2001, and three reefs since 2015. Recovery by new recruitment has occurred after the trawling inhibition at one site that still has erect dead coral skeletons left. Coral larvae depend on elevated hard substrates to settle. The LIFE *Lophelia* project will restore reef areas by deployment of artificial reefs (ARs). Adding elevated substrates will allow natural recovery to take place through larval settlement. The method developed will build on studies of larval behaviour, and settlement preferences to several materials including metallurgical slag. Different models of ARs are tested in a laboratory flow channel to study their hydrodynamic performance. The objective is to find the optimal design and material of AR structures to maximise the contact rate and attachment rate of *Lophelia pertusa* larvae. Conservation actions include detailed mapping of environmental conditions, geographical distribution, bottom topography, live parts of reef area and associated biodiversity to establish a baseline. All type of fishing gear was banned at the restoration sites in October 2021. If successful, we will transfer the results of the project to other stakeholders within the European Union by publishing a technical handbook describing the restoration method.

Sessions 7. Seascape Genomics and Connectivity

Type	N	Presenter	Title
Keynote	1	Santiago Herrera	Seascape Genomics Reveals Metapopulation Connectivity Networks of Deep-Sea Corals in the Northern Gulf of Mexico'
Keynote	2	Sophie Araund-Haond	Seascape genomics: merging habitat and biophysical modelling with genomic data to improve conservation and restoration plans
Full talk	1	Cheryl Morrison	Can high genetic connectivity and deep water refugia save a keystone species, the red tree coral (*Primnoa pacifica*) in SE Alaska, from a reproductive dead end?
Full talk	2	Alexis Weinnig	Genomic differentiation among *Desmophyllum pertusum* populations from Continental margins of the United States'
Full talk	3	Maria Belen Arias	Connectivity patterns are species dependent in Southern Ocean deep-sea corals
Full talk	4	Jessica Gordon	Population and Seascape Genomics of the Deep-sea Octocoral *Acanella arbuscula*
Speed talk	1	Oenone Scott	A Practical Guide to Ocean Models for use in Ecological Study
Speed talk	2	Syrmalenia Kotronaki	Population genomics of the black coral *Antipathes furcata (*Cnidaria: Antipatharia) in the mesophotic Gulf of Mexico

Keynote Abstracts

1. Seascape Genomics Reveals Metapopulation Connectivity Networks of Deep-Sea Corals in the Northern Gulf of Mexico

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Abstract

Understanding the spatial patterns of diversity and metapopulation connectivity of marine organisms is necessary to restore and conserve vulnerable ecosystems in the face of global ocean change and other anthropogenic disturbances. Determining larval dispersal's scale, rate, and directionality is central to understanding how coral metapopulations are interconnected and their degree of resilience. Over the last six years, we have investigated the metapopulation connectivity of multiple species of mesophotic and deep-sea corals in the northern Gulf of Mexico. We quantify population structuring and connectivity by integrating population genomics, seascape ecology, high-resolution ocean circulation modeling, and larval dispersal simulations. Our findings suggest that genetic diversity is strongly structured by environmental factors that covary with depth and that larval dispersal among

connected populations is generally asymmetric due to dominant ocean circulation patterns. Understanding connectivity has allowed us to predict unsampled populations in some intermediate locations that likely serve as stepping-stones for dispersal. Further, we identified distant coral populations that serve as sources of larvae for areas impacted by the 2010 Deepwater Horizon oil spill. These results can be utilized in management decisions to conserve and restore benthic habitats in the Gulf of Mexico. Our work illustrates that managing plans for marine protected areas in the deep sea should incorporate knowledge of connectivity networks and environmental patterns that shape the seascape of benthic ecosystems.

2. Seascape genomics: merging habitat and biophysical modelling with genomic data to improve conservation and restoration plans

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Abstract

The spatial distribution and persistence of a large number of deep-sea species are threatened by ongoing anthropogenic activities and climate change. Despite their remote position, reef building cold-water corals and the ecosystem they support are severely impacted by anthropogenic activities and threatened by climate change. Informed measures of management and conservation, as well as possible restoration plans, shall seek to maintain and enable evolutionary processes in networks of metapopulations, particularly connectivity and environmental adaptation. Seascape genomics provides an accurate framework to combine high density genome scan data with present, and simulated future, environmental data, including biophysical and habitat models. Global scale seascape genomics analyses require a comprehensive knowledge of the present day and forecasted distribution of diversity at all ecosystem levels, including intraspecific diversity at the genome scale. Here, I propose a short introduction to seascape genomics, with a few examples illustrating how this field is expected to increasingly inform conservation and management strategies, in part thanks to the growing availability of reference genomes for a broad spectrum of non-model organisms. Such resource was recently made available for the two species building cold-water coral reefs along European coasts, *Madrepora oculata* and *Lophelia pertusa* (*Desmophyllum pertusum*), and completed by whole genome sequencing on a comprehensive set of samples, allowing for high-density genome scan analysis. I will then summarize the preliminary seascape genomics data obtained on these two species, combining the newly produced population genomics information with recently developed biophysical and habitat (both present and forecasted) models. The aim of this talk is to open the debate on both the prospects to improve spatial management strategies and future collaborative restoration efforts (including possible private – public partnerships) through this integrative framework, and the still existing knowledge gaps which need to be overcome.

Full Talks

1. Can high genetic connectivity and deep water refugia save a keystone species, the red tree coral (*Primnoa pacifica*) in SE Alaska, from a reproductive dead end?

Cheryl Morrison[1], Meredith Everett[2], Colleen Young[3], Rhian Waller[4], Robert P. Stone[5]

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Abstract

Red tree corals (RTC), *Primnoa pacifica*, are the dominant structure-forming coral species in the Gulf of Alaska (GOA). Red tree corals serve as important habitat to fishes and invertebrates, yet this long-lived species is highly susceptible to disturbance from fisheries, and as such, some protection has been afforded to several offshore populations in the GOA. Red tree corals are often a dominant component of emergent fjord communities in southeastern Alaska, occurring as shallow as six meters. The variable combination of tides, storms, freshwater discharge, shallow sills, plus complex passageways to the sea may restrict larval exchange between offshore and fjord *P. pacifica* populations, creating divergent, self-sustaining populations that are likely living close to their ecological and reproductive limits and therefore may be highly vulnerable to disturbance and environmental variability. We assessed putative population structuring among *P. pacifica* populations from three offshore GOA populations (Dixon Entrance, Shutter Ridge, the Fairweather Ground) and three fjords (Tracy Arm, Endicott Arm and Glacier Bay National Park and Preserve) using nuclear microsatellites and high-throughput restriction-site associated DNA (RAD) sequencing. Over 400 discreet, geo-referenced samples of *P. pacifica* were collected via remotely operated vehicles or SCUBA divers between 2011-2016. Both genetic datasets revealed high levels of genetic diversity within populations and evidence of substantial connectivity, suggesting recent genetic exchange between offshore and fjord populations. Additionally, small colonies found settled adjacent to large heavily damaged colonies at Dixon Entrance were genetically identical, suggesting clonal reproduction is possible for this species. Although waters in the GOA are likely to continue to warm, this study suggests that high standing genetic variation and strong genetic connections among fjord and offshore populations may allow for possible adaptation to environmental stressors and replenishment from deeper water refugia following disturbance.

2. Genomic differentiation among *Desmophyllum pertusum* populations from Continental margins of the United States

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Abstract

The connectivity and genetic structuring of populations throughout the species range influence a species' resilience and probability of recovery from anthropogenic impacts. By gaining a comprehensive understanding of population connectivity, more effective management can be prioritized. To assess the connectivity and population genetic structure of a common reef-forming cold-water coral species, *Desmophyllum pertusum* (formerly *Lophelia pertusa*), we performed Restriction-site Associated DNA Sequencing (RADseq) on individuals from ten populations ranging in the Atlantic Ocean from the New England intercanyons, off the southeastern coast of the United States (SEUS), to the Gulf of Mexico (GOM), and off the Pacific coast of California. A total of 105 individuals and 2774 single-nucleotide polymorphisms (SNPs) were used to assess genetic differentiation. Results indicated high connectivity among populations along the SEUS, yet these populations were differentiated from those to the north off New England and in Norfolk Canyon, to the south in the GOM, and most notably all Atlantic populations were distinctly differentiated from the Pacific population. Interestingly, the Norfolk Canyon and GOM populations exhibited low levels of genetic differentiation, corroborating previous microsatellite analyses, and signifying past gene flow between these populations. Increasing the sample sizes from existing populations and including additional sampling sites over a larger geographic range (e.g., Caribbean, Northeastern Atlantic Ocean) would help define potential source populations and reveal fine scale connectivity patterns among *D. pertusum* populations.

3. Connectivity patterns are species dependent in Southern Ocean deep-sea corals

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Abstract

Primnoidae is a dominant family of cold-water corals present in both deep-sea and polar regions. It is known that cold-water corals face multiple pressures, including climate change and removal from fisheries. The Southern Ocean is one of the most rapidly warming regions, threatening sessile organisms, such as corals. Despite their ecological role, little is known about the genetic diversity, dispersal, gene flow, and population connectivity, all of which are important information to consider in the design of ecologically relevant networks of Marine Protected Areas. We used Ultra Conserved Element data to screen for single nucleotide polymorphisms (SNPs) and investigate the genetic diversity, structure, and connectivity of four cold-water corals: *Primnoella chilensis*, *Dasystenella acanthina*, *Thouarella viridis* and *Thouarella nov. sp*.Over 300 specimens were collected from six areas covering different bathymetrical ranges, spanning ca. 9,000 km. We obtained 1,940 to 3,822 SNPs across the spp. The highest genetic diversity was identified in *T. viridis* and *T. nov. sp*. Across the four species, samples collected below 900 m presented the highest genetic diversity; consequently, they might cope better to future impacts. Genetic structure was identified in *P. chilensis* and *D. acanthina* separating the populations into two distinct genetic clusters segregated by depth. Specimens inhabiting 320 to800 m formed a single cluster (Shallow-cluster), whilst those at 900 to 1,200 m formed another (Deep-cluster). *T. viridis* and *T. nov. sp.* revealed connectivity patterns across ca. 9,000 km around Antarctica. Our results highlight species level variation in connectivity. Some species have genetic differences and gene flow occurring between isobaths in the deep-sea (shallow vs deep). Panmixia was identified among distant locations, supporting the idea of a large open circumpolar population in the Southern

Ocean for other species. Essential information on reproductive strategies for these species is unclear, thus, further studies are needed to understand what factor influences their genetic differences.

4. Population and Seascape Genomics of the Deep-sea Octocoral *Acanella arbuscula*

Jessica Gordon[1], Maria Belen Arias[2], Vonda Wareham-Hayes[3], Andrea Quattrini[4], Alex Rogers[5], Kerry Howell[6], Michelle Taylor[1]

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Abstract

Large gardens of *Acanella arbuscula* growing in soft sediments are uprooted and destroyed when contact with fishing gear occurs. These octocorals are ecologically important, because *A. arbuscula* are known to host species of ophiuroid sea star, polychaete, nematode, copepod, anemones, barnacle, and crinoid feather star. They are often found in association with commercially important redfish (*Sebastes* spp.). To investigate population connectivity of *A. arbuscula* across the North Atlantic, specimens were collected at multiple depth bands from nearly its entire geographic range from Newfoundland and Labrador (Canada), Greenland, Scotland, Ireland, and Spain. Population structure was inferred from the analysis of single nucleotide polymorphisms (SNPs) generated through high throughput sequencing of ultra-conserved elements (UCEs). Furthermore, the 5,783 SNPs were used to test the depth differentiation hypothesis across the North Atlantic which proposes that there is greater genetic differentiation across depth ranges as opposed to geographical distance. Sites within all depth bands in Canada and Greenland were well connected and exhibited high relative levels of gene flow to the deepest sites in Scotland, Ireland, and Spain. Shallower sites in Scotland and Ireland were well connected to each other but isolated from the rest of the study sites with nearly zero gene flow to the Canadian and deeper European sites. The shallowest site in Spain formed a genetically distinct population with very little geneflow to the other European sites and Canada. An investigation into the possibility of cryptic species forming the genetically distinct isolated populations is being conducted. Additionally, local adaptation to temperature, phosphate, nitrate, pH, oxygenation, chlorophyll concentration, and salinity was tested against UCE marker allelic frequency. Twelve UCE loci showed significant evidence of local adaptation in *A. arbuscula* populations in response to sea floor temperature. The main driver of local adaptation in *Acanella* across the environmental variables tested was sea floor temperature.

Speed Talks

1. A Practical Guide to Ocean Models for use in Ecological Study

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Abstract

There are many barriers to accessing and observing deep sea coral, such as the costs of expeditions, limited numbers of research vessels, and a lack of technology that can be deployed to gather long-term observational data. These barriers are directly reflected in knowledge gaps e.g., the population structure and connectivity is totally unknown for most species. Larval dispersal models, which use ocean models and particle simulators to estimate where coral larvae may settle, are a very useful proxy for estimating connectivity of coral species. However, when it comes to selecting which ocean model to use, there is very little practical guidance available for biologists or ecologists, as most interfaces are designed with oceanographers in mind. This gap is a significant barrier for non-oceanographers looking to use ocean models and the corresponding suite of research approaches. In this talk, I will summarise the factors that should be considered when selecting model(s) to use for a study and describe an analytical approach for evaluating how accurately models replicate ocean conditions. This talk is designed as a starting place for biologists and ecologists looking to incorporate ocean models into their studies. In short, it summarises everything I wish I'd known before I started to work with an ocean model.

2. Population genomics of the black coral *Antipathes furcata* (Cnidaria: Antipatharia) in the mesophotic Gulf of Mexico

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Abstract

Despite their importance as ecosystem engineers, our knowledge on coral species inhabiting depths below the euphotic zone is still limited. As a result of their inaccessibility, deep-sea corals haven't benefited from the molecular revolution as much as their shallower relatives. Their population genetics can provide valuable insight into the processes of population maintenance and replenishment following environmental disturbance. Genetic connectivity is often used as a proxy for population resilience, however the environmental factors that shape genetic connectivity below the euphotic zone are poorly understood. Black corals are a particularly understudied taxon. With respect to their population genetics, there are very few studies, most of which are based on low-resolution markers. We explored the population genomics of the black coral *Antipathes furcata* in the mesophotic northwestern Gulf of Mexico, an area where corals are particularly vulnerable to oil exposure given the anthropogenic activity. Focusing on areas currently protected or being considered for protection, we used Restriction-site Associated DNA sequencing (RADseq) to survey the genetic diversity of 168 *A. furcata* colonies collected from seven sites and to elucidate patterns of population genetic structure. Our analysis indicated the presence of two distinct genetic clusters across 260km. Geographic distance is not a genetic-structuring factor, but there is a strong correlation between depth and genetic connectivity of these populations. Corals from sites of similar depth are more closely related despite their geographic distance. The role of depth as a genetic-structuring factor for *A. furcata* is consistent with other mesophotic and deep-sea corals. Future objectives include quantifying the connectivity among *A. furcata* populations and investigating the presence of clones, as well as other environmental parameters that might impact small-scale genetic structure. Overall, the results of our research will significantly facilitate conservation efforts by highlighting depth as a crucial factor to be taken into account.

Session 8. Habitat Mapping and Environmental Controls

Type	N	Presenter	Title
Keynote	1	Veerle Huvenne	Location, location, location: habitat mapping of cold-water corals, and what we can learn from it
Keynote	2	Fanny Girard	Environmental and topographic influences on deep-sea coral and sponge community distribution
Full talk	1	Eliza Fragkopoulou	Global redistribution of cold-water coral species leading to widespread community turnover under climate change
Full talk	2	Jonatan Marquez	Joint species distribution modelling of the deep-sea benthic communities of the Norwegian and Barents Sea
Full talk	3	Nissa Kreidler	Distributions of Deep-Sea Coral and Sponge Species are primarily influenced by depth and water currents
Full talk	4	Arliss Winship	Determining the effects of sampling design and sample size on the accuracy and precision of deep-sea coral distribution models through computer simulations
Full talk	5	Matthew Poti	Predicting the distribution and biodiversity of deep-sea corals at regional scales using hierarchical community occupancy models
Full talk	6	Lisa Skein	Approaches to dealing with data paucity and class imbalance in cold-water coral predictive modelling: a case-study from the South Atlantic
Full talk	7	Laurence De Clippele	Using the novel CoMMa toolbox to map and characterize coral mounds across the Atlantic Ocean
Full talk	8	Savannah Goode	Predicted recovery of megabenthic communities on a New Zealand seamount up to 200 years post-fisheries closure
Full talk	8	Johanne Vad	Characterisation of coral and sponge community distribution and structure in the Davis Strait
Speed talk	1	Ryan Gasbarro	Modelling climate change effects on the global distribution of framework-forming cold-water corals and reefs
Speed talk	2	David Price	Investigating cold-water coral communities found on submarine vertical walls (cliffs) around the Azores
Speed talk	3	Kelsey Archer Barnhill	Quantifying Live and Dead Proportions of *Solenosmilia variabilis* Colonies in New Zealand Waters
Speed talk	4	Valeria Palummo	Effect of environmental and anthropogenic factors on the distribution and co-occurrence of cold-water corals
Speed talk	5	Sidi Mohamed Mohamed Moctar	Cold-water coral reefs in the Mauritania/Senegal region
Speed talk	6	Julie Tourolle	MARLEY: An autonomous platform to monitor deep-sea coral behavioural phenology as a high-frequency essential biodiversity variable
Speed talk	7	Morgan Will	Evaluation of spatial distribution models of mesophotic coral species in the northeastern Gulf of Mexico
Speed talk	8	Larissa Oliveira	Analysis Of high-resolution photogrammetry And Terrain Descriptors to understand Cold-Water Coral Spatial Relationships

Keynote Abstracts

1. Location, location, location: habitat mapping of cold-water corals, and what we can learn from it

Veerle Huvenne[1]

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Abstract

Ever since the first discoveries of cold-water corals, people have had the tendency to place their findings on a map. However, comprehensive habitat mapping of cold-water corals only started with the expansion in cold-water coral research 20-25 years ago, and was co-driven by the arrival of new technologies that enabled a more extensive and detailed mapping of the terrain, the coral environment, and the corals themselves. Considerable progress has been made since, and approaches have evolved from human data interpretation and manual habitat delineation, to automated seafloor classification and machine learning, supported by a rapidly increasing use of marine robotics. As a result, new coral habitats have been discovered, mapped and characterised, in locations that were previously inaccessible. Cold-water coral habitat maps now range from global scales to individual colonies. They provide insights in the environmental requirements of various coral species, spatial patterns of their occurrence, and estimates of their future range. Furthermore, they are an unmissable component for marine spatial planning and conservation. As new techniques are developed, and more extensive sets of environmental drivers are included in the analyses, cold-water coral habitat maps no longer simply illustrate spatial distributions, but increasingly enable quantification of those spatial patterns, creating insights into the actual environmental and biological processes that cause these patterns.This presentation will provide a state-of-the-art of cold-water coral habitat mapping: it will review the key advances that were made in the field over the last two decades, discussing which insights they have provided into cold-water coral ecology. It will balance advantages and pitfalls of the different approaches, illustrating that no size fits all. It will highlight the most exciting recent developments, and contrast them to the knowledge gaps that still exist, initiating the discussion on where the field could go next.

2. Environmental and topographic influences on deep-sea coral and sponge community distribution

Fanny Girard[1], David W. Caress[1], Jennifer B. Paduan[1], Steven Y. Litvin[1], Amanda Kahn[2], Andrew DeVogelaere[3], Erica Burton[3], Emma Flattery[1], Eric Martin[1], Giancarlo Troni[1], Christopher Lovera[1], James P. Barry[1]

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Abstract

Understanding the spatial distribution of marine organisms in relation to topography and environmental conditions is key for ecosystem-based management and conservation. In particular, there is an acute need to map the distribution of vulnerable marine ecosystems, including deep-sea coral and sponge

(DSCS) aggregations. However, understanding the link between seabed topography and species distribution requires precise alignment of seabed mapping and biological sampling, often difficult to achieve in the deep sea. Using multiple subsea platforms and imaging methods, we mapped the spatial distribution of DSCSs on Sur Ridge (800-1250 m depth; off Central California) at several scales: 1) Foundation species (DSCS) and mobile megafauna communities were mapped over the entire ridge using ~100 video transects conducted by remotely operated vehicle (ROV). Community distribution was related to 1-m scale bathymetry, substratum type, and environmental conditions (*i.e.*, oxygen and temperature); 2) the distribution of species that accounted for the majority of the variability among identified assemblages was characterized at a ~5 mm scale from photomosaics built using 3-meter altitude ROV surveys covering roughly 100 x 100 m. Terrain variables extracted from 2-cm and 5-cm scale topography obtained simultaneously from subsea lidar and multibeam sonar, respectively, were then related to species distribution. Five distinct assemblages of foundation and mobile fauna were identified and occupied distinct habitats. DSCS assemblages were primarily structured by depth and slope, and secondarily by substratum type and bathymetric complexity. In addition to these factors, assemblages of mobile fauna varied significantly with the diversity and, to a lesser extent, density of foundation species, emphasizing the ecological importance of thriving DSCS aggregations. This study shows that considering environmental conditions (depth-dependent oxygen concentration and temperature) and topography across multiple spatial scales and resolutions is paramount to understand the distribution of DSCS communities, and better protect and manage these vulnerable ecosystems

Full Talks

1. Global redistribution of cold-water coral species leading to widespread community turnover under climate change

Eliza Fragkopoulou[1], Lidiane Gouvêa[1], Viktoria Balogh[1], Mark J. Costello[2], Miguel B. Araújo[3], Olivier De Clerck[4], Ester A. Serrão[1], Jorge Assis[1]

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Abstract

Future climate change is anticipated to drive the redistribution of marine biodiversity. For species that structure essential habitats, climate change effects can be magnified into losses of ecosystem functioning, with direct consequences for the numerous ecological and economic services provided. Cold-water corals, in particular, are vulnerable marine ecosystems that are increasingly threatened by environmental change and localized disturbances, notably fishery trawling. However, projections of the direction and intensity of net changes in their global patterns are lacking, precluding well-informed management strategies. Here, we use machine learning in species distribution modelling to forecast global changes in richness and community composition (i.e., persistence, extinction, and turnover) of approx. 900 species of cold-water corals, under contrasting Shared Socioeconomic Pathway (SSP; decade 2090-2100) scenarios: one aligned with the Paris Agreement (SSP1-1.9) and another of substantially higher emissions (SSP5-8.5). Models anticipate a generalized trend of poleward and depth-related shifts at the species level, particularly pronounced under SSP5-8.5, which translated into significant net changes in global patterns of cold-water coral distributions. The largest changes in

community composition were projected for the Arctic due to poleward expansions, and for the temperate regions of the Atlantic and Pacific Oceans, the Mediterranean Sea and along Australian and South American coastlines due to range losses as habitats become unsuitable. We show that climate change may strongly restructure the distribution of cold-water coral assemblages, with potentially significant consequences for the productivity and functioning of marine ecosystems, particularly if climate forcing surpasses the Paris Agreement expectations. The projected patterns pinpoint key refugial areas for marine conservation, which serve as baselines for well-informed management strategies in the face of climate change.

2. **Joint species distribution modelling of the deep-sea benthic communities of the Norwegian and Barents Sea**

Jonatan Marquez[1], Rebecca Ross[1], Margaret Dolan[2], Pål Buhl-Mortensen[1], Genoveva Gonzalez-mirelis[1]

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Abstract
Understanding the environmental and biotic conditions that drive the distribution of species and communities is fundamental for identifying vulnerable ecosystems and developing effective protection plans, but this is especially challenging in the deep-sea benthos. This is because many deep-sea benthic species are rare or sparsely distributed, and data collection is costly. Therefore, modelling techniques that strive to maximize the amount of information extracted from the available data have high potential moving forward. We use Hierarchical Modelling of Species Communities (HMSC), a Bayesian joint species distribution modelling approach which simultaneously uses information on environmental variables, taxonomy, study design, and spatial structures to jointly model multiple species within a community. By jointly modelling multiple species within a community, HMSC is able to quantify the effects of important known and unknown (latent) variables at both species and community levels, while also providing information about species associations. By estimating species and community level patterns simultaneously, the model allows data-poor species to 'borrow' information from similar species, thereby improving their estimates. We use data collected through the MAREANO project, which covers large areas of the Norwegian and Barents Sea. We found high variation in the effects of different environmental variables between subregions, with the Norwegian Sea showing a higher degree of ecosystem complexity than the Barents Sea. We also identified groups of species showing positive and negative associations after removing the effects of environmental variables, allowing us to explore potential biotic interactions in the deep-sea. Lastly, we use the modelled environmental niches and species associations to map the predicted distributions of rare and common habitat-forming species, identify spatial patterns of species richness and discuss potential regions of common profile.

3. **Distributions of Deep-Sea Coral and Sponge Species are primarily influenced by depth and water currents**

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Abstract

Deep-Sea Coral and Sponge Species (DSCS) are signature taxa of deep-water habitats, however the ecological mechanisms that drive their distributions can be difficult to uncover due to the challenges of surveying deep-water ecosystems and limited oceanographic data. Many studies use various readily-available, bathymetrically-derived variables to predict DSCS distributions, but biogeophysical variables (e.g., current velocity, current direction, food abundance, and dissolved oxygen) from oceanographic models are less common in DSCS distribution models. This study utilizes available DSCS occurrence data from submersible dives, bathymetry-derived variables, and biogeophysical variable estimates from an oceanographic model (ROMS/NEMURO) to make predictions for three DSCS (*Antipathes dendochristos, Plumarella longispina,* and an unidentified *Porifera* sp.) in the Southern California Bight. Predictive models were developed using Generalized Additive Models (GAM) that accounted for spatial autocorrelation as well as Maxent models for comparison. Although food availability was hypothesized to be a strong driver of DSCS distributions, current direction played a larger role in predictions, pointing to other important ecological processes that may determine DSCS occurrences. Both GAMs and Maxent models performed well when predicting known occurrences, but differed in their predicted distributions in previously-unsampled areas. These results emphasize the importance of model choice and the need for more ground-truthing. The proportion of potential DSCS habitat found in existing protected areas was low for some taxa, suggesting that other areas should be explored for potential protection. Given the importance of DSCS for multiple demersal fish species of commercial or conservation concerns, this research can aid habitat management, the evaluation of existing protected areas, and prioritization of locations for future DSCS research in the Southern California Bight.

4. Determining the effects of sampling design and sample size on the accuracy and precision of deep-sea coral distribution models through computer simulations

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Abstract

Spatial sampling design and sample size are fundamental considerations in the estimation and mapping of deep-sea coral occurrence and abundance. To maximize the accuracy and precision of model-based inferences from species distribution models, data should ideally be collected following basic principles of sampling design, for example spatial or environmental balance. In this study we conducted computer simulations to test the performance of alternative spatial sampling designs and sample sizes in terms of the accuracy and precision of predictions from a species distribution model. We used a mesophotic and deep benthic community mapping project in the Gulf of Mexico as a case study. Hypothetical 'true' distributions were posed for deep-sea coral species of interest, and datasets were simulated from those distributions as though they had been collected according to alternative sampling designs with different levels of balance, randomness, coverage, and bias. A generalized additive model was then fit to the simulated datasets to estimate the species' distributions, and the model estimates were compared to the true distributions. The simulation-testing framework allowed the quantification of differences in model performance arising from differences in sample size and design. The results of this study will be

used to design actual data collection on upcoming cruises in the Gulf of Mexico to map the occurrence and abundance of deep-sea corals for restoration and management as part of the Deep Water Horizon Natural Resource Damage Assessment Mapping, Ground-truthing, and Modeling project.

5. **Predicting the distribution and biodiversity of deep-sea corals at regional scales using hierarchical community occupancy models**

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Abstract
Species distribution models have become an important tool for identifying potential spatial distributions of deep-sea corals from limited survey data. These models estimate species-environment relationships from occurrence data (e.g., presence, presence-absence, abundance) and environmental covariates (e.g., measures of seafloor topography and oceanography) and use these relationships to predict and map the occurrence of a species across an area of interest. This information has been used to support conservation and management decisions, including for offshore energy development, fisheries management, and protected area designation. However, because of their dependence on records from historical databases and concerns over the reliability of absence data, many of the existing species distribution models for deep-sea corals have relied on presence-background data and have been restricted to inference of relative probability of occurrence (i.e., habitat suitability). Presence-background models are also prone to confounding the estimated probability of occurrence with sampling effort. In two recent studies funded by the U.S. Bureau of Ocean Energy Management (BOEM), our goal was to predict and map the distribution and biodiversity of deep-sea corals at regional scales using absolute estimates of occurrence and richness. Deep-sea corals are sessile, slow-growing, and long-lived, making them ideal candidates for occupancy models that use presence-absence data to estimate imperfect detection and probability of occurrence. We implemented hierarchical community occupancy models (i.e., multiple taxa were modeled jointly) to estimate the probability of occurrence and diversity (i.e., richness) for 28 genera of deep-sea corals in the Gulf of Mexico and 23 genera of deep-sea corals off the southeast U.S. coast. As expected, we found that common taxa had higher probabilities of detection and occurrence than rare taxa. Hierarchical community occupancy models are an important tool to account for detectability and uncertainty, as needed to inform the biodiversity conservation of deep-sea corals or similar organisms.

6. **Approaches to dealing with data paucity and class imbalance in cold-water coral predictive modelling: a case-study from the South Atlantic**

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Abstract

Species Distribution Modelling (SDM) is increasingly used to understand the responses of cold-water corals (CWCs) to environmental factors and predict likely CWC distribution across unsampled areas. This is especially valuable in complex deep-sea environments like seamounts that are exposed to multiple anthropogenic pressures and require protection of vulnerable taxa with ecological importance. Accuracy of predictive models is influenced by the quality of environmental data and availability of CWC occurrence records to train and validate model predictions. Although the quality and resolution of physical environmental data have increased notably in recent years, owing to advances in survey technology, sampling effort of deep-sea taxa in regions like the South Atlantic lags behind, often resulting in smaller datasets of species occurrence.In this study, we perform predictive SDM of the CWC *Enallopsammia rostrata*for a section of Walvis Ridge in the South Atlantic, namely Ewing Seamount and the Valdivia Bank complex. Using presence-only approaches with Maxent and Random Forest, we apply methods specifically designed to compensate for class imbalance, sampling bias and smaller occurrence datasets. Initial modelling included eight benthic terrain variables derived from multibeam echosounder (MBES) data at a resolution of 200 m^2, and preliminary model outputs show good agreement with the distribution of *E. rostrata* on seamounts elsewhere. These patterns will be clarified with further modelling based on additional oceanographic variables derived from a high-resolution hydrodynamic model, before final ensemble modelling with the best performing individual models. This work (1) illustrates the value of SDM in predictive mapping for data-poor areas, (2) shares lessons on modelling with smaller datasets, (3) demonstrates the importance of using appropriate high-resolution environmental variables, and finally (4) highlights the need for greater biological sampling effort in the South Atlantic deep-sea.

7. Using the novel CoMMa toolbox to map and characterize coral mounds across the Atlantic Ocean

Laurence De Clippele[1], Joana Gafeira[2], Riccardo Arosio[3], Veerle Huvenne[4], Stefan Ragnarsson[5], Tina Kutti[5], Ann I. Larsson[6], Derek Sowers[7], Markus Diesing[8], Iason-Zois Gazis[9], Jens Greinert[9], Dierk Hebbeln[10], Claudia Wienberg[10], Jürgen Titschack[10], Andy Wheeler[3], Christian Mohn[11], Kirstin Burmeister[12], Franziska Schwarzkopf[9], Covadonga Orejas[19], Murray Roberts[1]

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Abstract

Cold-water coral reefs and mounds come in many different shapes and sizes. They form under specific environmental conditions that are not yet fully understood but are known to be controlled by a complex interplay of physical, chemical and biological factors. In the Atlantic Ocean, many reef and mound complexes are engineered by stony corals such as *Desmophyllum pertusum (a.k.a. Lophelia pertusa*) and *Madrepora oculata*. Knowledge of their formation, spatial distribution, 'health' status (e.g. with dead or living framework forming corals) and role (e.g., concerning the Carbon Cycle) are important to inform effective conservation and marine spatial management in a changing ocean. However, manual mapping and characterisation of these features can be incredibly time-consuming, especially when large amounts of cold-water coral mounds are found in a single area. Therefore, the novel CoMMa (Coral Mound Mapping version a) ArcPro toolbox was developed to overcome this barrier. The toolbox lets you pre-process the datasets and semiautomatically delineate and characterise the mounds. Characteristics such as the area, width, length, width/length ratio, vertical relief, BPI, orientation, shape compactness, shape complexity, depth range, geomorphon presence, texture and volume can easily and quickly be extracted. This study applied the toolbox to multibeam bathymetry datasets collected in Norway, the UK, Ireland, Iceland, the US, Angola, Namibia and Mexico. To understand what drives differences in the geomorphology of coral mounds, the CoMMa toolbox data was integrated with temperature, salinity, current speed, current direction and zonal velocity data extracted from the VIKING20X and INALT20 models. Furthermore, to increase the confidence of delineated features being cold-water coral mounds, a random forest modelling approach was used with the extracted geomorphological characteristics and coral presence data (e.g., from video data) to identify which mounds are more or less likely to be 'living' cold-water coral mounds.

8. Predicted recovery of megabenthic communities on a New Zealand seamount up to 200 years post-fisheries closure

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Abstract

Bottom trawling is the most severe disturbance currently affecting deep-seafloor environments. Seamount benthos are especially vulnerable to trawling impacts as they can be dominated by deep-sea corals that are easily damaged/removed by fishing gear. However, the extent to which communities on seamounts that are closed to fishing can recover from earlier trawling impacts is uncertain. Previous studies have hypothesised that any post-trawling recovery of such communities will probably be initially patchy, recolonised by surviving remnant populations, and may take several decades or more to occur. A fine-scale approach is thus needed to understand and determine the spatio-temporal dynamics of recovery on seamounts. We studied a New Zealand seamount that was heavily trawled in the 1990s before being protected in 2001. Pre-fishing, this seamount likely hosted a large area of cold-water coral reef, primarily *Solenosmilia variabilis* and *Madrepora oculata*, like nearby untrawled seamounts. We investigated and predicted the recovery potential of these species and their associated communities by combining imagery-derived benthic community data collected over repeat surveys from 2001-2020 with

fine-scale (25m grid resolution) environmental data (depth, curvature, backscatter, trawl footprint, trawl timing) to develop joint-species distribution models. Spatial occurrences and abundances of 36 taxa were predicted as a function of post-fisheries closure time up to 200 years. We used a fuzzy clustering approach to identify communities, then described and predicted post-closure changes in their spatial configurations and compositions using spatial patch metrics to investigate recovery dynamics. Overall, results highlighted differences in potential recovery capacities between taxa and indicated spatial patch metrics may be useful predictors of post-disturbance responses. Both reef species were predicted to occupy increasing contiguous areas on the summit and ridge ~100 years post-closure, suggestive of recovery potential on these timescales. The implications of these findings for the spatial management of deep-sea corals will be discussed.

9. Characterisation of coral and sponge community distribution and structure in the Davis Strait

Johanne Vad[1], Jason Cleland[1], Laurence De Clippele[1], Evert de Froe[2], Georgios Kazanidis[3], George Wolff[4], Dick van Oevelen[2], Erica Head[5], Ellen Kenchington[5], David Coté[5], Murray Roberts[1]

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Abstract

Coral gardens (dominated by large *Primnoa resedaeformis*, *Alcyonacea* and *Anthomastus sp*) and sponge grounds (composed by a wide range of species including *Geodia spp* and *Polymastia spp*) are known to occur along the continental slope in the Northwest Atlantic, and specifically in the Davis Strait. Yet, the spatial distribution of coral and sponge biomass in the region is highly variable, and our understanding of the environmental conditions that control benthic biomass distribution is limited. Here, we apply cumulative abundance profile analysis, a statistical method initially developed for terrestrial ecology studies, to characterise the coral and sponge community composition and size structure in the Davis Strait and relate changes in benthic biomass to environmental conditions. In the summers of 2018 and 2019, two scientific expeditions on board the *CCGS Amundsen* were conducted in the Davis Strait. During these cruises, water sampling, video sampling as well as biological sampling through the deployment of a rock dredge was conducted. In addition, benthic landers equipped with sediment traps and sensors measuring temperature, salinity, pressure, oxygen, turbidity as well as current speed and direction were successfully deployed and recovered. In total, 1,458 coral and sponge size measurements were extracted from 228 video stills and converted to mass estimations, using dredged physical samples. Overall, 4 coral and 17 sponge morphotypes were considered in our analysis. Coral biomass averaged at 19±134 g/m^2 across sites but reached a maximum of 2,329 g/m^2. Sponge biomass averaged at 154±9 g/m^2 across sites but reached a maximum of 5,863 g/m^2. The cumulative abundance profile analysis revealed that while coral and sponge distribution was overall driven by substrate type, community size structure seemed controlled by hydrographic conditions. These results highlight the need to consider not just community composition but also size structure when analysing beta-diversity patterns in deep-sea habitats.

Speed Talks

1. Modeling climate change effects on the global distribution of framework-forming cold-water corals and reefs

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Abstract

Cold-water coral (CWC) reefs are a critical deep-sea ecosystem that augment biodiversity and biogeochemical cycling within the ocean interior but are facing imminent threats from climate change. Climate models have projected changes in CWC distributions at regional and basin-wide scales, but global models for climate-change-induced distribution changes are lacking. In addition, the distribution of CWC reef habitat, which may rely on a differing conditions than reef-building CWC species, has not been projected into the future. Here, we extract a suite of surface and near-bottom oceanographic and biogeochemical variables from four-dimensional reconstructions of the global ocean interior to characterize the ecological niche of reef-forming CWCs and CWC reefs (i.e. areas with high live coral cover and skeletal accumulation) and build predictive models of their current global distributions. We also build models with the same biological data and methodology with an ensemble of climate models from scenarios of end-of-century climate change from the sixth phase of the Climate Model Intercomparison Project (CMIP6) and a single, higher resolution model from CMIP6. We show that distribution models trained with CMIP6 perform well, but slightly worse than those trained with higher-resolution oceanographic data, suggesting that resolution gains in future climate model iterations that resolve mesoscale oceanographic features will lead to better predictive performance. In addition, notable differences emerged between CMIP6 models of future conditions, highlighting the utility of ensemble approaches that reduce individual models biases and for clear communication of uncertainties. Our projections of framework-forming CWC distributions with CMIP6 ensemble data reveal regional and depth-driven differences in the rate and magnitude of climate change that framework-forming CWCs and CWC reefs will experience, and reduced habitat loss under rapid climate change mitigation. These findings highlight the need for exploration and conservation within these areas that may be critical in retaining ecosystem services provided by CWC reefs.

2. Investigating cold-water coral communities found on submarine vertical walls (cliffs) around the Azores

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Abstract

The Azores archipelago seascape is a diverse topographic environment which hosts submarine vertical walls, cliffs and overhangs. These vertical environments seldom received detailed analysis, despite

growing evidence of their importance as hotspots and refugia for structurally complex and vulnerable benthic communities. To address this, the crewed submersible Lula 1000 (Rebikoff-Niggeler Foundation) was used to collect images of vertical walls around the Islands of Pico and São Jorge to characterize invertebrate faunal assemblages. Using Structure from Motion, five 3D reconstructions of vertical walls were created (up to 400 m^2) in order to quantify the local heterogeneity of the walls and map the spatial distribution of important habitat-building species, such as black corals (*Leiopathes* cf. *expansa*) and scleractinians (*Desmophyllum pertusum*).The vertical walls explored supported dense aggregations of black corals, reef-forming scleractinians, cup corals and hexactinellid sponges, which we quantified to compare with proximal horizontal habitats. We calculated several terrain metrics of the vertical walls (e.g. slope, surface roughness and local exposure) from the 3D reconstructions to feed into a Random Forest classifier, resulting in a classified 3D model with the following geological and taxa classes; basalt rock, sediment, black coral, reef-forming scleractinians, structure-forming sponges, encrusting sponges and bivalve aggregations. The classified 3D map revealed an extremely heterogeneous environment. Fine-scale cold-water coral distribution indicated species-specific relationships with the terrain, representing niche partitions. Important habitat-building species like *Leiopathes cf. expansa*, *D. pertusum* and sponges introduced additional structural complexity into the physical environment, enhancing the associated biodiversity at local scales. The combination of 3D photogrammetric surveys and wider reaching image transects revealed multi-scale spatial patterns of cold-water corals found on submarine cliffs and their influence on local biodiversity. We discuss our results in the context of regional biodiversity patterns and explore the mechanisms behind why submarine walls are important for cold-water coral assemblages.

3. Quantifying Live and Dead Proportions of Solenosmilia variabilis Colonies in New Zealand Waters

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Abstract
Live and dead portions of cold-water coral reefs are threatened by different drivers under climate change. To predict reef futures, current reef composition must be explored first. Imagery from recorded videos allows us to observe and explore deep-sea reef composition in a non-invasive, low-impact way. In this study, live and dead proportions of reef-forming *Solenosmilia variabilis* colonies were quantified to explore differences between cold-water coral reef compositions across four sites in the South Pacific within the New Zealand Exclusive Economic Zone and the Louisville Seamount Chain. The study areas include the Gothic and Ghoul Seamounts in the Graveyard Seamount Complex on the Chatham Rise, and the Forde and Valerie Guyots in the Louisville Seamount Ridge. Still-images were extracted every 10 seconds from video footage from the National Institute of Water and Atmospheric Research's (NIWA) towed camera, the Deep-Towed Imaging System (DTIS). Adobe Photoshop was used to manually annotate scaling lasers and the entire portion of live and dead coral colonies in each image. Existing open source R code was used in RStudio to calculate total surface area and percentage of live and dead portions in each image. Thirteen stations across three cruises were analysed and will be combined with environmental data to understand how projected climate change (SSP5-8.5) will lead to habitat change.

The results of this study will allow us to quantify current reef health at the study sites as well as predict their futures under climate change.

4. Effect of environmental and anthropogenic factors on the distribution and co-occurrence of cold-water corals

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Abstract

Among the deep sea habit-forming species, Cold Water Corals (CWCs) are one of the most important bioengineering species, useful to improve habitat heterogeneity, biological diversity, and ecosystem functioning. Understanding their distribution provides a crucial baseline for evaluating the impact of both natural and human influences on these important deep-sea habitats.The aims of the present study are: i) provide new data on the spatial distribution of six CWCs species in the Strait of Sicily, ii) describe the principal environmental and anthropogenic variables that play a role in shaping their distribution, and iii) identify hotspots in which individuals belonging to the various species co-occur. Presence-only data of six CWCs species, ten environmental variables (depth, slope, rugosity, aspect, flowdir, temperature, salinity, current North, current East, chlorophyll-a), and one variable relating to fishing effort (Automatic Information System – AIS) were used to predict the suitable habitats using the Maximum Entropy modelling (MaxEnt) technique. MaxEnt identified slope, depth, and rugosity as the most important predictors, showing the highest percentage contribution for all six species considered. Throughout the entire study area, highly persistent density hotspots of CWC co-occurrence were discovered, with a total extension of 4.05 km^2 where all species co-occur. Although studies on the effect of environmental and anthropogenic factors that impact the distribution of these species of conservation interest remain scarce, the results obtained from this study offer useful guidance for decision-makers to develop necessary conservation measures.

5. Cold-water coral reefs in the Mauritania/Senegal region

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Abstract

In 2021 the NANSEN program conducted a survey on the coast at the border between Mauritanian and Senegal south of this formerly studied area. A main objective was to conduct visual habitat mapping of the seafloor with focus on cold-water coral reefs. In total 30 video lines were conducted using ROV and 14 of these were targeting structures suspected to be reefs at 450 to 650 meters depth. Bathymetry

mapping with multibeam was used to position video lines and terrain and backscatter analysis were conducted. Oceanographic variables were measured near the reefs using a CTD sonde. The occurrence and health state of the corals along video lines was annotated using the software 'CampodLogger'on the boat.Here we present the environment and health status of the 14 new *Lophelia* reef established in the study area all with occurrence of live *Lophelia*. Six of the encountered reefs (43%) were large and healthy with areas having 15% to 50% cover of live colonies. The reefs were in the OMZ and oxygen concentrations down to 1 ml/l were measured at reef sites and temperature was between 8,8 and 11,6° C. The reef health status was compared with their environmental setting including temp, salinity, oxygen, particle load, terrain, and backscatter. A reef habitat prediction model was developed based on a combination of bathymetry, oceanographic setting, and health status of the reefs. The occurrence of healthy *Lophelia* reefs in the study area is unexpected. The dormant state of reefs found further north on the Mauritanian coast have been explained by the OMZ and the geological and climatic history. There is a need for knowledge-based management of marine resources in these understudied areas and our study shows the importance of visual seafloor mapping to aid to the development of spatial management plans.

6. MARLEY: An autonomous platform to monitor deep-sea coral behavioural phenology as a high-frequency essential biodiversity variable

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Abstract
Deep-sea corals are vulnerable species, which good conservation status is a target for an increasing number of regional and international regulations. Beyond present-day anthropogenic disturbances, deep-sea corals, and particularly scleractinian corals, are under long-term threat from ocean warming and acidification. These ecosystem drifts call for the implementation of long-term and high frequency ocean monitoring systems. While there is a growing number of essential physico-chemical ocean variables that can be accurately monitored, there is still few biological variables that can be observed with high frequency to provide early warning signals of ecosystem changes. The phenology of engineering species observed through the prism of their behaviour could provide such an Essential Biodiversity Variable (EBV). In the framework of the Life Integrated Marha project, an autonomous platform has been developed for long-term monitoring of coral behaviour (five years). MARLEY (Monitoring deep-seA coRal EcosYstem) has been deployed for the first time in August 2021 on a coral garden dominated by *Madrepora oculata* in the Lampaul canyon (Bay of Biscay, NE Atlantic). The platform is equipped with a sediment trap, an ADCP, a CTD, an oxygen probe, turbidimeters, and a camera. Three-minutes video footage is acquired each 6 hours. Results of the first 5 months of data acquisition are presented. An image frame was extracted from each video footage and 50 images were manually annotated. The state of polyp extension was annotated for 300 visible polyps of a *Madrepora* colony. Manual annotations were used to train a machine learning model. The model allowed automatic annotation of the remaining 487 images. Temporal variations in *Madrepora* polyp behaviour are analysed in relation with environmental variables. In a second step, the associated fauna of the coral garden will be studied on the 136 frames extracted from video footage taken in a larger view.

7. Evaluation of spatial distribution models of mesophotic coral species in the Northeastern Gulf of Mexico

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Abstract

The Pinnacles Trend region is a 120 km extent of mesophotic (50-100 m) habitat, located off the Mississippi and Alabama coasts in the northeastern Gulf of Mexico. This area is of particular interest due to its proximity to the Deepwater Horizon oil spill (oil slick covered area for 2-5 weeks in 2011). To assist restoration efforts, this study aims to locate aggregations of three species of octocorals (*S. exserta*, *M. pendula*, *T. nivea*) and two species of black corals (*A. atlantica*, and *A. furcata*) throughout the Pinnacles Trend region through evaluation of spatial models. Models from three sources were analyzed: a biotope identification model (enhanced topographic position index; Nash & Randall, 2014), presence-only habitat suitability models (Silva & MacDonald, 2017), and presence-absence occurrence models (Goyert et al, 2021). An independent set of biological data was collected using a remotely operated vehicle (ROV) in summer 2022, gathering visual information on coral abundance and area swept to yield density values from 12 sites across Pinnacles Trend. The overall utility of all three model types was low, with minimal correlation between observed and predicted coral occurrences. The biotope identification model was the most reliable predictor of new coral aggregations of the three model types, identifying 466 reef-top features of varying size and relief throughout Pinnacles Trend, of which few have been surveyed. All reef-tops surveyed had corals present, but the coral species and abundance was unpredictable. Significant correlations were found between density of species and size of reef-tops. Based on these findings, when attempting to identify new aggregations of corals for sampling, more focus should be placed on learning the basic geology of areas and developing associated biotope identification models, as opposed to large-scale regional habitat suitability and occupancy models.

8. Analysis of high-resolution photogrammetry and terrain descriptors to understand cold-water coral spatial relationships

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Abstract

Cold-water corals (CWC) play an important role in the biodiversity of deep-sea habitats. Scleractinian CWC species such as *Lophelia pertusa* and *Madrepora oculata* develop three-dimensional complex frameworks that can baffle sediment and given favourable environmental conditions, they can form positive topographic features such as coral reefs and mounds. As technology and access to high-resolution data advance, it is now possible to map these environments at centimetric to millimetric scales. Techniques such as Structure-from-Motion (SfM) photogrammetry coupled with spatial pattern analyses allow for the quantification of fine-scale habitat descriptors that are important to assess key CWC reef ecological traits. In this study, we develop an approach to analyse CWC mound facies

distribution by integrating the 3D information of each facies object and their fine-scale terrain variables of CWC habitats in the Piddington Mound, Belgica Mound Province, southwest of Ireland. Four facies types were adopted: 1) live coral framework 2) dead coral framework 3) coral rubble, and 4) sediments and dropstones. Our results show that live and dead coral facies occupy and create areas of higher rugosity than compared to the coral rubble and sediments and dropstones facies. The live coral framework facies presents two high-density hotspots, one around the mid-slope area, and a second, less intense hotspot upslope, whilst the dead coral framework facies present one high-intensity hotspot upslope. Furthermore, in both live and dead coral facies, larger coral colonies (≤ 0.49m) tend to appear towards the mound summit whereas small coral colonies (≤ 0.17m) dominate the lower flank and flatter areas, which may suggest i) recent growth of coral colonies ii) suboptimal conditions at the mound base. The findings of this study contribute to the investigation of possible changes in this and surrounding habitats, providing fine-scale information towards the monitoring of vulnerable ecosystems.

Session 9. Deep-Sea Corals in Society

Type	N	Presenter	Title
Keynote	1	Hermione Cockburn	Discover the Deep: raising levels of ocean literacy via Scotland's deep-sea heritage
Full talk	1	Jason Cleland	A cross-sectoral research collaboration to study benthic fauna at the world's most famous deep-sea wreck, and a newly discovered ridge feature, during the OceanGate 2022 Titanic Expedition
Full talk	2	Ayla Besemer	Lophelia.org - a case study of the open-access educational platform on deep-sea corals
Full talk	3	Nina Ramos	Increasing accessibility to deep-sea science through 3D photogrammetry and museum collections
Full talk	4	Jaret Bilewitch	Using fisheries bycatch to document deep-sea octocoral diversity in Aotearoa New Zealand
Full talk	5	Jennifer Selgrath	Quantifying the Economic Value of Deep-Sea Corals and Sponges
Speed talk	6	Lisa Gilbane	Deep-sea coral science and applications in offshore energy and mineral management within the United States
Speed talk	1	Robert McGuinn	US National Oceanic and Atmospheric Administration's National Database for Deep-sea Corals and Sponges: A freely available resource for deep-sea researchers and resource managers

Keynote Abstracts

1. Discover the Deep: raising levels of ocean literacy via Scotland's deep-sea heritage

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Abstract

Public engagement with ocean science is an important element of creating the empathic, science literate society that we need to support a sustainable future for us and our planet. At Dynamic Earth in Edinburgh, the story of Scotland's deep-sea coral habitats and the pioneering work of Charles Wyville Thomson has provided a compelling foundation for a new permanent exhibition and an associated two-year ocean literacy outreach programme. The project, called Discover the Deep, has delivered over 275,000 science engagements to date with school pupils, teachers, community groups and public audiences. This talk will discuss the design and outcomes of the project and highlight the significant contribution from the Scottish marine science community.

Full Talks

1. A cross-sectoral research collaboration to study benthic fauna at the world's most famous deep-sea wreck, and a newly discovered ridge feature, during the OceanGate 2022 Titanic Expedition

Jason Cleland[1], Anna Gebruk[1], Murray Roberts[1], Lea-Anne Henry[1], Arne Biastoch[2], Tobias Schulzki[2], Maria Rakka[3], Beverly McClenaghan[4], Mehrdad Hajibabaei[4], Steve Ross[5]

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Abstract

In June and July 2022, OceanGate Expeditions and OceanGate Foundation organised five expeditions to the RMS *Titanic* wreck in waters around 3,800 m deep off Newfoundland, Canada. These complement similar OceanGate cruises in 2021 and provide a unique example of collaboration between academia (e.g., iAtlantic research programme), industry partners (e.g., eDNAtec, Nortek) and the private sector. These expeditions demonstrate how commercial deep-sea exploration can facilitate multidisciplinary scientific data collection at remote sites. The deep-sea submersible *Titan* supported by the vessel *Horizon Arctic* collected water samples, recorded 4K video, and took CTD measurements through the water column to describe oceanographic conditions and biological communities on and near the wreck, and around 40 km from the wreck at the Nargeolet-Fanning Ridge – an igneous rock feature in about 2,900 m, observed for the first time during the expedition. In addition, the expedition used cutting-edge research technologies such as environmental DNA analysis to complement UHD video. There are strong differences in species densities and compositions between the two sites. Coral communities of *Chrysogorgia* spp. and *Lepidisis* sp. were observed on the wreck, and sponges, black and gorgonian corals, and crinoids were observed on the ridge. These data will help answer key ecological questions, for example: How do biological communities differ between natural and artificial reef structures? How do oceanographic conditions drive deep-sea coral larvae dispersal? How important are rock patches in shaping abyssal biodiversity? The results demonstrate how environmental data collection can strengthen ecological studies, improving our understanding of biological changes in the deep-sea over space and time, and of deep-sea biological fouling of artificial substrates. This talk will explore the current biodiversity status of the *Titanic* wreck and Nargeolet-Fanning Ridge, as well as the potential for similar cross-sectoral research collaborations to support data collection in Atlantic deep-sea ecosystems in the future.

2. Lophelia.org- a case study of the open-access educational platform on deep-sea corals

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Abstract

Lophelia.org is the premier website for information about cold-water corals and the threats they face. The website was created in 2005 and is maintained today by a group of Edinburgh postgraduates who are passionate about increasing awareness of deep-sea corals. The website began as part of the Esmée Fairbairn Foundation Deep-Sea Conservation for the UK and European Union's HERMIONE projects and

was a contribution to the United Nations Decade on Biodiversity (2011-20). The website serves to educate everyone, not just those in the marine science world, about the incredible ecosystems of the deep seas, busting the myth that corals are restricted to shallow, tropical waters. As our ocean faces growing threats, enhancing public awareness of deep-sea corals and their vulnerability is essential to ensure support for policy that advances protection and resilience for these still little-understood ecosystems. Lophelia.org is now undergoing a significant modernisation and update. The site is being restructured to better explain the geographic spread of deep-sea corals alongside major milestones in discovery and policy development. The site will still explain the threats they face and showcase the marine science and technology needed to study deep-sea corals. The update also includes a Storymap tool that allows for deeper exploration of the areas in which these species are found, and will be regularly updated with new science and information, making it an online compendium of the most up-to-date discoveries and opportunities for engagement. New research on deep-sea corals is emerging daily. We consider this conference the launching point of the new Lophelia.org, and a chance for the website to be updated with new contributions, information, and science. Please connect with our team during this week's activities to learn more about how you can contribute!

3. Increasing accessibility to deep-sea science through 3D photogrammetry and museum collections

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Abstract

Natural history collections provide researchers with the unique opportunity to study deep-sea biology and evolution without ever having to leave shore. These collections include millions of specimens with associated metadata and serve as physical records that encapsulate patterns of biodiversity through time. Many specimens in these collections are invaluable, specifically the name-bearing type specimens which represent the defining features of a species. In addition, museum types can be extremely fragile and costly to collect, including those of deep-sea corals. Digitization of natural history collections can increase public access to, and use of these collections while simultaneously reducing risk to these valuable items. However, the most dominant form of digitization—2D imaging, is limited in its capacity to convey the morphological complexity of corals. An alternative form of digitization with the potential to address this short coming is photogrammetry, a cost-effective and noninvasive process for creating high resolution 3D models of real-world objects. Potential applications for 3D models of museum specimens created from this process include morphometric analysis, public engagement, and tools for hands-on teaching such as interactive learning experiences and 3D printed replicas. We present the first mass digitization effort using 3D photogrammetry for the Smithsonian National Museum of Natural History (NMNH) Department of Invertebrate Zoology, with a particular focus on coral type collections. The 3D models created from this effort will be publicly released under an open-access model and be freely available for viewing and download on Smithsonian websites. Through this project we aim to increase accessibility of NMNH collections and further encourage deep-sea coral exploration and taxonomic research.

4. Using fisheries bycatch to document deep-sea octocoral diversity in Aotearoa New Zealand

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Abstract

New Zealand has the fifth largest Exclusive Economic Zone (EEZ) in the world, with over four-million square km of deep-sea habitat. Although research voyages have been documenting marine biodiversity within the EEZ for decades, extensive regions remain under-sampled or unsampled due to the scale and limited accessibility of deep-sea environments. Consequently, wide-spread, diverse and cryptic benthic fauna such as the Octocorallia remain poorly documented in New Zealand. The current global financial downturn and resulting limitation of research funding indicate it is unlikely that conventional sampling approaches will be adequate to address research gaps in deep-sea biodiversity in the future. Conversely, fisheries bycatch represents an opportunity to supplement the breadth and depth of sampling coverage provided by targeted research voyages. Commercial fishing operators in New Zealand regularly target demersal fisheries species using mobile gear that interacts with benthic communities, potentially returning octocorals as incidental by-catch. Government observers are placed aboard some commercial vessels to document fishing impacts and submit specimens of protected coral bycatch for archiving and further identification. Due to the broad geographic range covered by commercial fishing vessels plus relatively high observer frequency for offshore bottom trawling operations, deep-sea bycatch can significantly contribute to regional estimates of octocoral diversity and species distribution records. We describe recent and ongoing efforts using phylogenetic and phylogenomic approaches to document undescribed and cryptic diversity of octocorals among fisheries bycatch specimens collected in New Zealand over the past 20 years. When coupled with taxonomically neutral methods of species delimitation such as genetic barcoding and phylogenomics, bycatch sampling can disentangle cryptic deep-sea taxa and provide a systematic framework for future taxonomic documentation of undescribed species. Although many octocoral species are undescribed in this region, the documentation of genetic diversity allows managers and conservation practitioners to assess the impacts of commercial fisheries on deep-sea coral diversity.

5. Quantifying the Economic Value of Deep-Sea Corals and Sponges

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Abstract

The biodiversity of deep-sea ecosystems emerges from unique habitats ranging from hydrothermal vents to deep-sea coral and sponge gardens. These slow growing and long-lived ecosystems are associated with a variety of species that are beneficial to humans. Yet their importance to human wellbeing often remains unrecognized. In an effort to understand the benefits that deep-sea coral and sponge gardens (hereafter DSC) provide to people, we are working to quantify the contribution of DSC-associated fisheries landings to the California state economy as a case study. From the list of 241 marine life species recorded in California's commercial landing data, we identified species that were likely associated with DSC and categorized them as 1) associated, 2) not associated, and 3) unknown (i.e. not enough life history data exist to assess). We found that 32% of commercially landed species are associated with DSC and that not enough information exists for 17% of species. Additionally 95% of fishing gears reported catching the associated species. Based on these findings we will discuss economic trends of DSC-associated catch trends.

6. **Deep-sea coral science and applications in offshore energy and mineral management within the United States**

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Abstract

The United States (US) Department of Interior's (DOI) Bureau of Ocean Energy Management (BOEM) manages offshore energy and seabed minerals throughout the several billion acres of the geologically varied Outer Continental Shelf. BOEM's mission is to balance responsible development of those resources with protection of the environment, and so funds research to inform DOI's environmental assessments and operational management associated with offshore oil and gas, marine minerals, and wind. Deep-sea coral habitat suitability is limited by the availability of hard substrates; however, corals can attach to many types of hard substrate and therefore are found throughout the Outer Continental Shelf. Understanding the distribution and sensitivity to disturbance of long-lived and fragile deep-sea corals remains a key focus for BOEM's 50-year-old Environmental Studies Program. Deep-sea coral habitats were studied indirectly via modeling and inferences based on geophysical parameters of the environment, as well as directly by exploration using deep-sea submersibles that collect imagery and samples. Results from these studies also informed multiple inter-agency projects such as the Natural Resource Damage Assessment's mesophotic and benthic restoration projects associate with the Deepwater Horizon oil spill in the Gulf of Mexico. Starting in the Gulf of Mexico and then moving into the Atlantic and Pacific Oceans, BOEM (and predecessor Marine Minerals Service) has funded such research for decades. This presentation describes BOEM's Environmental Studies Program long-term contribution to deep-sea coral protection throughout the US Outer Continental Shelf.

Speed Talks

1. **US National Oceanic and Atmospheric Administration's National Database for Deep-sea Corals and Sponges: A freely available resource for deep-sea researchers and resource managers.**

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Abstract

The Deep Sea Coral Research and Technology Program of the US National Oceanic and Atmospheric Administration creates and maintains the National Database for Deep-sea Corals and Sponges, which the Program makes freely available for use by resource managers, researchers, and the general public. The database contains over 910,000 highly-curated occurrence records, along with over 104,000 accompanying photographs. The database is updated quarterly and has been growing rapidly since its inception in 2010 and the launch of an online portal in 2015. The Program's focus is on the US Exclusive Economic Zone, but the database contains many non-US records as well. Occurrences can be searched, viewed, and downloaded from a dedicated data access portal. The Program also publishes the database via an ERDDAP data service, offering users the ability to query and download data programmatically. Visualizations of habitat suitability model outputs are also available within the portal. To enhance global

collaboration, the Program contributes records quarterly to the Ocean Biodiversity Information System (OBIS) and the Global Biodiversity Information Facility (GBIF). The current data holdings, data services, and real-world use-cases will be showcased. Future directions include the upcoming release of a modernized data access portal which will have an improved user interface and new functionality to summarize data over common spatial zones. The data access portal will also contain new spatial layers, such as a multibeam bathymetry mosaic and US fishery bottom-contact gear restriction zones. Upcoming improvements to the database include the integration of fish occurrence records from matching coral and sponge surveys. Instructions for downloading, analyzing, and using the occurrence records within desktop GIS programs and the R programming language are available online. We encourage you to contribute your data to help us grow and enhance this open data repository!

ISDSC8 - Research Highlights & Posters

Please find the abstracts and co-authors for the ISDSC8 Research Highlights & Posters below and use the hyperlinks to watch / download the pre-recorded 3-minute presentations where available.

1. Abigail Powell et al. Transformation at two rocky banks off the Oregon coast, USA
2. Alejandra Mejía-Saenz et al. Rock outcrops enhance abyssal benthic biodiversity and provide habitat for larger soft corals
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	Authors, Title, Recording	Abstract
1	**Abigail Powell**, Elizabeth Clarke Transformation at two rocky banks off the Oregon coast, USA https://media.ed.ac.uk/media/ISDSC8_Abigail+Powell_Research+Highlight/1_a4slq94v	In times of rapid environmental change, understanding the factors that affect the temporal dynamics of coral populations is vital for impact mitigation. However, difficulties in obtaining funding for repeated surveys can make monitoring deep-sea coral populations particularly challenging. In 2005, we carried out surveys with an autonomous underwater vehicle at two deep rocky banks off Oregon, and in 2018 had a rare opportunity to revisit those sites as part of a larger coast wide research cruise. We present how the abundance and diversity of corals, sponges and fish at the banks has changed since the initial surveys. Overall, we documented increases in many taxa at both Daisy and Coquille Banks. The most striking change was a transition from primarily small and dead sponges in 2005 to high densities of large glass sponges at Daisy Bank in 2018 (~3x increase in sponges). We also observed a ~1.5x increase in corals at Daisy Bank due to increases in a white coral, *Callistephanus* sp. At Coquille Bank we observed high densities of a small red coral, *Callistephanus* cf. *pacificus* in 2018 but it is unclear whether this represents an increase due to identification challenges. There was a ~5x increase in sponge abundance at Coquille Bank although overall densities were lower than at Daisy Bank. We also documented increases in commercially important fish groups at both banks. In particular, there was a ~10x increase in flatfish abundance in deep muddy habitats at both sites. We discuss possible explanations for the changes we observed including trawling regulations that came into effect from 2001 onwards limiting access to these areas. These results are a rare opportunity to study temporal dynamic of deep-sea benthic assemblages and indicate that large site-specific changes can happen over relatively short time periods.
2	**Alejandra Mejía-Saenz**, Erik Simon-Lledó, Louis S. Partridge, Joana R. Xavier, Daniel O. B. Jones Rock outcrops enhance abyssal benthic biodiversity and provide habitat for larger soft corals https://media.ed.ac.uk/media/ISDSC8_Alejandra+Mej%C3%ADa-Saenz_Research+Highlight/1_rpspj7yv	Abyssal corals are key contributors to benthic ecosystems by participating in nutrient cycling and providing shelter for other species. These and other sessile filter feeding taxa are typically associated with hard substratum, for example, nodules within abyssal polymetallic nodule fields. In addition, the hard substratum provided by nodules is thought to increase habitat complexity, promoting the occurrence of highly diverse abyssal assemblages. Hard substratum in these habitats is also available as outcropping rock fragments, but their contribution to habitat heterogeneity has been largely overlooked. Here, we assessed if the type and size of hard substratum can modulate benthic biodiversity at local scales within the Clarion Clipperton Zone (North Pacific abyss). We compared megafauna (animals > 10 mm) assemblages, including several scleralcyonaceans and antipatharians, in nodule-bearing habitats with those in areas containing rocks in addition to nodules. We found a lower faunal density but a clearly higher diversity and more heterogenous composition in the assemblages of rock-bearing areas compared to those with only nodules. This could be owing to an increased particle trapping in areas with rocks. In addition, hard substratum patch size appeared to positively influence the size of some taxa, like bamboo coral *Bathygorgia* sp. indet. These results suggest that rocks, in addition to nodules, constitute keystone structures enhancing habitat heterogeneity at local scales within nodule fields and may influence the distribution of deep-sea corals at a fine scale. Rock areas appear common in some abyssal plains and may make regionally-important contributions to abyssal biodiversity, suggesting that they may be relevant to include in conservation efforts.

	Authors, Title, Recording	Abstract
3	**Álvaro Romo**, Alfredo Veiga, Cristina Gutiérrez-Zárate, Rodrigo Pérez, Meri Bilan, Maria Rakka, ntonio Godinho, Timm Schoening, Marina Carreiro e Silva, Andrea Gori, Covadonga Orejas A Cost-Effective Setup for Photogrammetric Analyses of Cold-Water Corals under Aquaria Conditions https://media.ed.ac.uk/media/ISDSC8_%C3%81lvaro+Romo_Research+Highlight/1_jjpq8ujj	Over the last two decades, experimental work with Cold-Water Corals (CWC) under aquaria conditions has substantially increased. Advances in measurement procedures, aquaria setup designs or in the control of parameters (e.g., temperature, pH, dissolved oxygen concentration) have contributed to better understand the ecophysiology and vulnerability of CWC. However, monitoring the condition of CWC nubbins throughout an experiment (e.g., growth or tissue retraction) and normalising physiological data has been limited to standard techniques that often require the sacrifice of the nubbin at the end of the experiments. In order to overcome current limitations, a low-cost setup has been designed with the aim of obtaining calibrated 3D virtual reconstructions which allow detailed analysis of coral nubbins throughout the experiments. The setup is a low-cost (compared to other 3D scanning set-ups), easy-to-handle tool with a turning mechanism controlled by an external microprocessor, that automatically rotates the corals inside an aquarium and captures pictures over 360 degrees. The effectiveness and precision of this setup has been evaluated over a ten-month experiment performed with the CWC *Dendrophyllia cornigera*. More than 21,000 pictures have been taken to perform 720 virtual reconstructions. Here we present the characteristics of the system and discuss the obtained results. These highly-accurate 3D reconstructions are suitable for precise tissue growth analysis which can also be used to standardise physiological measurements such as respiration. More studies are needed to explore the full capacity of this approach.
4	**Ana Belen Yanez Suarez**, Katleen Robert Niche differentiation among sessile megabenthic fauna on vertical walls of The Charlie-Gibbs Fracture Zone https://media.ed.ac.uk/media/ISDSC8_Ana+Belen+Yanez+Suarez_Research+Highlight/1_2po8zep6	Deep-sea vertical walls are characterized by low sedimentation rates and hard substrates, making them suitable habitats for many sessile filter feeders, including cold-water corals (CWC). CWC and sponges contribute to the complexity of the abiotic background, increasing habitat availability for diverse organisms. While some areas of vertical walls can present a high density of sessile filter feeders, others are mostly bare rock. However, the habitat characteristics that favour the presence of CWC and sponges within vertical walls at a fine scale are poorly understood as owing to technological limitations, fine-scale (<1m) terrain variables (e.g., orientation, curvature, verticality, roughness, slope) have seldom been quantified in deep-sea habitats. These terrain variables can represent proxies of community structuring factors (e.g., nutrients, sedimentation rates) important to understand the habitat selection of megabenthic species. In this study, we investigate the fine-scale distribution and habitat selection of CWC and sponges on vertical cliffs of the Charlie-Gibbs Fracture Zone, a large geological feature offsetting the Mid-Atlantic Ridge. Structure from motion photogrammetry was employed to create high-resolution 3D models of vertical walls (~225 m^2) based on remotely operated vehicle (ROV) videos (at 1,000-1,400 m depth). The 3D models were used to derive terrain variables at five fine scales (0.3, 0.2, 0.1, 0.05, 0.02 m) and geotagged every coral colony. Using ecological niche factor analysis and Monte Carlo test (999 permutations), we found that the habitat used by *Solenosmilla* sp. differs significantly from the average available habitat conditions. *Solenosmilia* sp. distribution corresponded with areas of high verticality and slope (proxies for sedimentation rates), specific orientation (proxy of nutrients and local currents), and intermediate level of curvature (edges and overhanging) within vertical walls. Documenting the degree of habitat selection is important to understand species vulnerability and habitat functionality on vertical walls.

	Authors, Title, Recording	Abstract
5	**Antonio Godinho**, Inês Martins, Christopher Pham, Jonatas Castro, Meri Bilan, Marina Carreiro e Silva, Andreia Carvalho, Flávio Rodrigues, Manuela Ramos, Ana Colaço, Telmo Morato Effects of deep-sea mining sediments plumes on the physiology and branchial integrity of bluemouth/blackbelly rosefish *Helicolenus dactylopterus* https://media.ed.ac.uk/media/ISDSC8_Antonio+Godinho_Research+Highlight/1_g0uebyyg	The potential impacts of deep-sea mining operations remain poorly understood, despite increasing efforts over the past decade and growing evidences there will be great damage from this extracting industry on deep-sea organisms in the surrounding areas. Land-based experiments are important research solutions to test the response of deep-sea organisms to mining activities under controlled aquarium conditions, and therefore significantly improve the knowledge on these potential impacts of this industry. To this day only a few of such controlled experiments have been conducted, but close to none on deep (bentho-)pelagic fauna. The objective of this study is to evaluate the effects of seafloor massive sulfide mining-related sediment plumes on the physiology and branchial integrity of the blackbelly rosefish *Helicolenus dactylopterus*, a deep-sea fish known to live around seamounts cold-water coral gardens that provide nurseries and juvenile grounds in the northern Mid-Atlantic Ridge in the Azores region. In this study, juvenile *H. dactylopterus* (16-23 cm) were exposed to two different polymetallic sulfide (PMS) particles concentrations (5 and 25 mg L^{-1}) for a period of 13 and 26 days. Both treatments and the control (with no sediment) were composed by four replicate aquaria each (12 in total), with two individuals in each (n=8 / treatment). The PMS sediments were continuously pumped into the aquaria for a period of 20 h day^{-1}, to simulate mining discharges as reported by the industry. During the trial, a series of responses were measured, including respiration rate, daily behavior patterns and opercular movements. Fish were necropsied at T0, T13 and at T26 (days) and sampled to evaluate gill damages. This poster provides the experimental design description and the results obtained for respiration rates (RR) and branchial integrity in exposed individuals. Revealed gill changes at different levels of severity along with respective RR suggest possible impairing of tissue functions.
6	**Arvind Shantharam**, Pamela Goddard, Chris Rooper, Preliminary Identification of Environmental Drivers of Beta Diversity of Deep-sea Coral Assemblages of the Aleutians Islands https://media.ed.ac.uk/media/ISDSC8_Arvind+Shantharam_Research+Highlight/1_advojea1	Beta-diversity of deep-sea fauna is a relatively understudied aspect of the ecology of the marine biosphere and also represents a fundamental knowledge gap in the conservation of the deep sea. Using stereo camera survey data of the highly diverse Aleutian Island archipelago, multiple-site, abundance-based beta-diversity and its components (turnover and nestedness), following Baselga (2013, 2017) were computed for coral fauna densities, following hierarchical cluster analysis. Available explanatory factors including various spatial and environmental variables were related to dissimilarity indices. Cluster analysis identified nine unique coral assemblages. Spatially, most assemblages were localized to the western or eastern portions of the archipelago, often dominated by sea pens. Assemblage 7, dominated primarily by primnoid and stylasterid coral, connected all the assemblages in the study region. Overall beta-diversity was high, driven by the turnover component of beta-diversity. Three assemblages were identified by permutation tests to have generally higher beta-diversity. Ranked correlation analysis, computed via the BIO-ENV routine, with explanatory factors were generally low, suggesting factors not available account for the variation in assemblage composition heterogeneity. When the full set of explanatory factors are employed, temperature in combination with gravel and sand-dominated substrates are most associated with overall beta-diversity, whereas for the turnover component of beta-diversity, temperature is in combination with larger substrate classes like boulders and cobbles. The nestedness component was mostly driven by large substrate classes like boulder, cobble, and mixed-coarse, among high-relief areas. We preliminarily conclude rarer fauna such as sea pens occur in the less frequently occurring unconsolidated substrates

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		like sand and the more dominant large substrates promote dominance by a select group of coral taxa such as primnoids and stylasterids.
7	**Asako Matsumoto** & Leen P. van Ofwegen What is octocoral genus *Paracis* we saw at ROV dives?- with Re-description of all North Pacific type species and type of the genus.	Though families Plexauridae / Paramuriceidae (Octocorallia, Anthozoa) are quite hard to identify in situ ROV video observation, sometimes the genus *Paracis* has been rather easily identified only by images. For example, during the Campaign to Address Pacific monument Science, Technology, and Ocean NEeds (CAPSTONE) by NOAA Ship Okeanos Explorer, U.S. between 2015 and 2017, the tentative image identification counts ca. 190 *Paracis* in the database of Ocean Networks Canada SeaTube V3 (https://data.oceannetworks.ca/ExpeditionManagement). When the coral has large pavement-like sclerites on the coenenchyme surface in the video images, it has been recognized as the genus *Paracis*. In WoRMS, 21 *Paracis* species are regarded as valid. the Type species is *Paracis orientalis*. Seven species were reported from North Pacific: Japanese waters, *P. pustulata* (Wright & Studer, 1889), *P. squamata* (Nutting, 1910), *P. spinifera* (Nutting, 1912), *P. ijimai* (Kinoshita, 1909) and *P. miyajimai* (Kinoshita, 1909), Hawaiian waters, *P. horrida* (Thomson & Henderson, 1906) by Muzik, 1979 in the unpublished dissertation work, *P. orientalis* from Bikini Atoll, Marshall Islands by Bayer, 1949. We have re-examined the type of the genus *Paracis* and also all known *Paracis* type species from the North Pacific. The specimen identified as *P. horrida* (Hawaii) by Muzik, and *P. orientalis* (Bikini) by Bayer, 1949 were also re-examined and they are misidentifications. Among ca.190 *Paracis* during the CAPSTONE, a single specimen collected from Phoenix Islands, South East Pacific was NOT the genus *Paracis*.
8	**Bárbara de Moura Neves**, David Coté, Evan Edinger, Alexandre Normandeau, Vonda Hayes, Joey Angnatok, Owen Sherwood, Evert de Froe, Rodd Laing, Maxime Geoffroy Coral hanging gardens off Makkovik: a deep-water hotspot not so out of sight https://media.ed.ac.uk/media/ISDSC8_B%C3%A1rbara+de+Moura+Neves_Research+Highlight/1_bv0u391e	In Atlantic Canada, knowledge on the distribution and diversity of deep-water corals is mostly based on scientific bottom trawl survey data. Areas where the seafloor is too rough for trawling are often spared from disturbance and can act as refuges to relatively pristine benthic communities. In 2021, a Remotely Operated Vehicle (ROV) seafloor video survey in a high-relief area in coastal Labrador led to the discovery of a bedrock wall dominated by the coral *Primnoa resedaeformis*, a Vulnerable Marine Ecosystems (VME) indicator. The site is located at depths of 450-700 m within a cross-shelf trough 25 nm from the community of Makkovik, Nunatsiavut. It contrasts to other locations in the region where they are found growing isolated on boulders further offshore. The ROV surveys targeted two areas of similar depths, 2 km apart. In the first area, with a maximum slope of ~50°, corals were rare and observed as isolated colonies, often with the sponge *Plicatellopsis bowerbanki*. In the second area with steeper walls (>70°), corals were very conspicuous between 580-615 m, reaching densities of >2.5 colonies/m^2. Given the short distance between sites, the difference in the slope, and the presence of sediment covering the walls at the lower slope site, we hypothesize that slope is a crucial parameter influencing densities locally. Multibeam data indicate that similar depths and slopes are found in the area, but the overlap between specific depth and slope ranges where corals were found is small. Ongoing research aims to identify whether these corals extend beyond the identified depth and slope ranges and their current known distribution. Given the status of *P. resedaeformis* as VME indicators and their high densities at this location, this discovery will be an important consideration to ongoing marine spatial planning and protection initiatives of the Nunatsiavut and Canadian governments.

	Authors, Title, Recording	Abstract
9	**Brian Kennedy**, Steven Auscavitch, Timothy Shank, Constance Sartor, Alexis Weinnig, Anna Gauthier, Anameere Tennaba, Randi Rotjan Unmasking the mountain: Visualizing deep-water coral and sponge communities on four flanks of an equatorial central Pacific seamount https://media.ed.ac.uk/media/ISDSC8_Brian+Kennedy_Research+Highlight/1_kid6dpo6	Changes in benthic communities have been found across abiotic natural gradients of environmental variables for many deep-sea ecosystems, but these patterns remain undersampled on seamounts globally. Fine scale community changes have been hypothesized to vary on different flanks of seamounts depending on current flow and variations in water mass characteristics on different sides of a seamount, but this hypothesis has not yet been rigorously tested. Here, we assess the similarities of depth zones within a single central Pacific equatorial seamount. In 2021, we conducted four ROV transects aboard the RV *Falkor*. Transects were completed on each face of the seamount based on cardinal direction. Strong vertical zonation of corals and sponges were noted. Between ~500 meters and 250 m, *Aphrocallistes* cf. *beatrix* were the dominant sessile organism, with *Phyllochaetopterus limicolus* worms interspersed. Shallower than ~250 meters, the seafloor was composed of scoured carbonate pavement with sediment accumulation only found in rocky depressions. The majority of the organisms living in the sediments were scleractinians and small *Paracis* spp. octocorals. Differences in abundance were noted between flanks of the feature including Euplectellidae, Plexauridae and *Chrysogorgia*, which each showed a preference for one or two flanks. The zonation patterns found on this seamount indicate that the oxygen concentration has a strong effect on the positioning of scleractinian corals, such that almost no individuals were found within the oxygen minimum zone (OMZ). Statistically the communities between the different flanks of the seamount did not differ, however, the local contribution to beta diversity varied by depth. Given the emerging understanding of seamount importance to ocean biodiversity and productivity, this study is one of the first to attempt a holistic visualization of seamount biology that can advance new hypotheses about seamount ecology.
10	**Chieh-Jhen Chen**, Bo-Song Wang, Vianney Denis, Yu-Rong Cheng, Sylvie Dufour, Ching-Fong Chang Species diversity and phylogenetic relationship of Dendrophylliid corals in shallow water in Taiwan and deep water in South China Sea https://media.ed.ac.uk/media/ISDSC8_Chieh-Jhen+Chen_Research+Highlight/1_97x5johi	The Dendrophylliidae is a monophyletic family of scleractinian corals with members distributed worldwide from the shallow to the deep sea. In Taiwan, nine genera and 29 species of Dendrophylliidae are reported to date based on morphological characteristics. Therefore, their taxonomic status requires re-examination using molecular approaches. In this study, we examined morphological characteristics and sequenced a total 118 specimens collected in different depths in order to re-evaluate the species richness around Taiwan and South China Sea. We reconstructed the molecular phylogeny of Dendrophyllidae based on partitioned maximum likelihood and Bayesian methods using two mitochondrial markers (COI: cytochrome c oxidase subunit 1 gene; and IGR: intergenic spacer) and one nuclear marker (ITS: nuclear ribosomal internal transcribed spacer). Overall, 117 COI sequences, 107 IGR sequences, and 118 ITS sequences were obtained. The reconstructed molecular tree demonstrates that all the specimens we examined were Dendrophyllidae. From shallow waters, we identified five genera and 10 species, four of which are reported for the first time in Taiwan (*Cladopsammia gracilis*, *Eguchipsammia serpentina*, *Rhizopsammia verrilli*, and *Rhizopsammia wettsteini*). In addition, we discovered two novel species in two genera (*Heteropsammia formosa* sp. nov. and T*ubastraea formosa* sp. nov.) based on morphological and genetic evidence. For deep sea specimens, we found that *Dendrophyllia* sp. and *Balanophyllia crassiseptum* are closely related, while they are phylogenetic separated from the shallow waters *Dendrophyllia-Balanophyllia* group. Similarly, *Heterpsammmia cochlea* from the shallow and deep sea was also deeply phylogenetic divergence. We proposed that taxonomic nomenclature of deep-sea corals

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		is required. This study greatly improves the accuracy of biodiversity estimates and understanding of the evolution of Dendrophylliidae.
11	Christina Kellogg Expanding Microbiome Flexibility Concepts to Deep-Sea Corals	Microbial ecology studies of deep-sea corals (DSC) have followed the general research arc of the more easily accessed tropical corals. Molecular and culture-based techniques are being applied to extend our knowledge of DSC microbiomes from 'who is there' to include 'what are they doing.' Early studies evidenced that DSC appeared to maintain species- or genus-level bacterial community specificity, with the host being a stronger driver of microbial community composition than environmental conditions. A new concept has been proposed based on tropical zooxanthellate stony corals (Voolstra & Ziegler, 2020): that microbiome adaptability allows for rapid response to environmental changes, but that corals may take two very different approaches to managing their microbiomes: microbial conformers and microbial regulators. Microbial conformers are characterized as host species that show microbial adaptation to their surrounding environment, while microbial regulators are described as host species that maintain a constant or highly consistent microbiome, displaying microbial regulation despite environmental differences. For example, based on multiple researchers' publications of *Desmophyllum pertussum* (formerly *Lophelia pertusa*) microbiome data from different locations and as part of reciprocal transplants, this coral appears to be a poster child for DSC microbial conformers. This presentation will discuss expanding this conceptual framework to encompass both stony and soft DSC, enabling development of testable hypotheses about the adaptability of DSC to changing environmental conditions, which corals might have increased susceptibility to diseases, and their suitability for restoration projects.
12	Christina Conrath The influence of deep-sea coral and sponge habitats on the life history parameters or rockfish species in Alaska https://media.ed.ac.uk/media/ISDSC8_ChristinaConrath_Research+Highlight/1_uxu5x4p0	It is often assumed that deep-sea coral and sponge provide valuable habitats that result in higher productivity of commercially important fish species. The objective of this research is to test this assumption by examining fish condition and reproductive success over large spatial scales across habitats with and without coral and sponge. The first step in this study is to develop an accurate and logistically feasible method to assess the condition of Pacific ocean perch, *Sebastes alutus*, and northern rockfish, *Sebastes polyspinis*, during Alaska Fisheries Science Center Groundfish Assessment Program annual bottom trawl surveys in the Gulf of Alaska and Aleutians Islands. In this study, morphometric condition measures (Fulton's K, length-weight residuals, hepatosomatic indices), measurements from fatmeters (relating lipid content to either water content or biological impedance), and FT-NIRS measurements (based on molecular composition), will be compared to bomb calorimetry and proximate composition analyses that directly measure fish energy content and body composition. A pilot study will compare morphometric condition indices of fish sampled in 2014 with estimates of energy density from bomb calorimetry. In 2021 and 2022, Pacific Ocean perch and northern rockfish were sampled in the Gulf of Alaska and the Aleutian Islands using a broader range of tools and techniques. Preliminary results from these studies will be presented as well as a discussion of the use of these data to examine the value of deep-sea coral and sponge habitats. These data will ultimately provide us with a method to evaluate relationships between condition and habitat over broad spatial scales as part of on-going long-term surveys.

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13	**Claudio Lo Iacono**, Guillem Corbera, Paulo Vinicio Ferraz Correa, Marta Arjona Camas, Ruth Duran, Pere Puig, Fabio De Leo Black coral communities in Barkley Canyon at the core of NE Pacific Oxygen Minimum Zone https://media.ed.ac.uk/media/ISDSC8_Claudio+Lo+Iacono_Research+Highlight/1_c7w36n97	It is observed that low concentrations of dissolved oxygen (DO) act as natural stressors for cold-water coral communities, in particular scleractinian species. Nonetheless, recent findings are progressively challenging this notion. Here, we describe a surprisingly well-structured megabenthic community found at 900 m deep cliffs in the hypoxic waters of Barkley Canyon (NE Pacific). This area is bathed by the NE Pacific Oxygen Minimum Zone (OMZ), which is expanding across a wide depth range (530-1450 m) as a result of climate change. Yet, ROV surveys found an unexpected high abundance of black corals (*Chrysopathes speciosa*), sponges and several individuals of the thorny-head rockfish (mainly *Sebastolobus* sp.), including many juveniles possibly indicating a nursery area. Decade-long time-series from Ocean Networks Canada's NEPTUNE cabled seafloor observatory reveal extremely low average DO values (0.28 ml·L^{-1}), with corresponding low average temperatures (3.6 °C). Observatory Acoustic Doppler Current Profiler data revealed the occurrence of semidiurnal internal tide waves with amplitudes of up to 200 m. We hypothesize that the breaking of internal waves on the steep topography of Barkley Coral Cliffs triggers the resuspension of sediments, which based on previous studies are rich in organic matter. Bottom currents are directed down-canyon, and strongly conditioned by the local geomorphology of cliffs. Despite the permanent natural stressor of the OMZ's severe hypoxia, the well-developed black coral communities in coral cliffs may be thriving on an abundant and organic-rich suspended particle load. Studies focusing on the ecological responses, physiological and metabolic adaptations of black corals to severe hypoxia are currently lacking, in particular as OMZs rapidly expand in the E and NE Pacific due to climate change. The current study is a preliminary assessment of the main environmental drivers of black coral communities in Barkley Canyon and will provide insights onto deep-sea ecosystem responses to long-term climate change.
14	**Daniel Despujols**, Pedro Figueiredo, Ana Sofia Soares, Inês S. Gregório, Alejandra Mejía-Saenz, Celso Domingos, Jean-Baptiste Ledoux, Marina Carreiro e Silva, Joana R. Xavier New records of cold-water corals collected as bycatch from the northern continental shelf of Portugal: a DNA barcoding approach https://media.ed.ac.uk/media/ISDSC8_Daniel+Despujols_Research+Highlight/1_vi0901j4	Cold-water corals play a crucial role in the structuring of marine benthic communities, particularly in deep-sea areas where they can form vulnerable marine ecosystems (VMEs) such as coral reefs and gardens. These represent biodiversity hotspots, providing numerous ecological functions, e.g. serving as habitat and nursery for various species of fishes and invertebrates. Despite being relatively well documented in some areas of the Northeast Atlantic and the Mediterranean Sea, knowledge of their distribution on the Portuguese continental shelf is scarce. In this work, 224 samples of cold-water corals (Scleractinia, Antipatharia, Octocorallia) were obtained as bycatch from artisanal fisheries, operating bottom-contacting gears, from the northern continental shelf of Portugal. Of these, 36 specimens of various morphospecies were selected for taxonomic identification using a molecular barcoding approach. Phylogenetic reconstructions were performed using various mitochondrial (MutS, COI + Igr1) and ribosomal (ITS1, 5.8S, ITS2) markers, and main morphological features subsequently analyzed. We report the presence of several species of cold-water corals, including the scleractinians *Dendrophyllia ramea* (Linnaeus, 1758) and *Dendrophyllia cornigera* (Lamarck, 1816), and the malacalcyonaceans *Eunicella* spp. which are classified as VME indicators and listed by IUCN as vulnerable, endangered, or near threatened in the neighboring Mediterranean Sea. Our findings support the local ecological knowledge shared by fishing communities on these species and provide a first glimpse into the diversity and distribution of cold-water corals in the area. Generated

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		knowledge will be used to inform and support the management and conservation of coral species and habitats in Portugal.
15	**Daniela Pica**, Sarah Samadi, Magalie Castelin A phylogenetic analysis of Stylasteridae (Hydrozoa: Anthoathecata) with the description of new Adelopora species https://media.ed.ac.uk/media/ISDSC8_Daniela+Pica_Research+Highlight/1_8cs8rvz3	Stylasterid corals are calcified hydroids living mainly in the deep sea where they represent an important component of the coral community forming animal forests. To date, Stylasteridae includes 322 species belonging to 29 genera being the second group of calcified cnidarians regarding the number of species, after the scleractinians. Most of the studies on stylasterid corals are taxonomical based only on morphological analysis and this allowed the description of many new species and genera in the last 40 years. To date, the only molecular works regarding this family aimed to show some peculiarities of these corals (i.e., evolution in the deep sea and identification of the ancestor) highlighting the presence of many para/polyphyletic genera on the phylogeny. One of the few monophyletic genera is *Adelopora*, a genus that evolves a peculiar and unique morphological character, the operculum. The first *Adelopora* species was described in 1982 from the subantarctic region of the Atlantic Ocean while the other seven species described successively came from the New Caledonia-New Zealand region. Recently, a large amount of stylasterid specimens have been collected through the deep-sea cruises carried out by the Tropical Deep-Sea Benthos (TDSB) research program of the Muséum National d'Histoire Naturelle (MNHN) around New Caledonia and Papua New Guinea. Participation in two taxonomic workshops organized by the TDSB program allowed the morphological analysis of this huge collection (about 1700 lots) and the identification of many species and putative new ones. Several samples from different taxa were selected to significantly increase the number of species in the phylogenetic analysis, particularly for the *Adelopora* genus. The analysis confirms the well supported monophyletic clade of this genus and confirms the presence of new species.
16	**Daniela Pica** Stylasterid corals from the Tasmantid seamounts https://media.ed.ac.uk/media/ISDSC8_Daniela+Pica_Research+Highlight2/1_quxkcryt	Stylasterid corals are the second most diverse group of calcified cnidarians after scleractinian, with 29 genera and 322 valid recent species, but in some areas are still poorly known. These corals are mainly distributed in the deep sea where they originated and secondly colonized shallow water zones. Due to their rigid, branched skeleton, they are considered habitat-forming species as they can reach high density and establish a wide range of associations with other organisms, enhancing the biodiversity of the areas. While the stylasterid fauna has been revised and studied in many regions of the world, the Australian stylasterid deep sea fauna is still understudied. Natural history museums represent an incredible source of information about biodiversity and species distribution. However, in many cases, museum specimens lack contemporary expert identification. A case in point is the Stylasteridae stored in the Australian Museum (AMRI) collection, where many specimens remain unclassified or wrong classified with invalid names of species considered junior synonyms or having restricted distributions occurring elsewhere. Thanks to the AMRI Visiting Collection Fellowship in 2020 the entire collection (352 stylasterid lots) has been analyzed, corrected, and updated in the name. Among the identified species the study revealed the presence of 19 species and 7 genera as new records for the Australian fauna increasing the number of Australian stylasterids to 32 species and 13 genera. Interesting specimens were collected during two campaigns (RV *Franklin* 1982 and RV *Tangaroa* 1989) from the Tasmantid Seamounts, a north-south trending chain of submarine volcanoes, extending from the Coral Sea to the Tasman basin, that are quite biologically unexplored. The analysis of 74

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		lots, recorded from three seamounts, revealed the presence of several species in common with the surrounding regions, Northern Norfolk Ridge and Lord Howe Seamount Chain, but also the presence of new species.
17	**Derek Sowers**, Larry Mayer, Giuseppe Masetti, Erik Cordes, Ryan Gasbarro, Elizabeth Lobecker, Kasey Cantwell, Shannon Hoy, Michael White, Samuel Candio, Mashkoor Malik, Matt Dornback Mapping and Geomorphic Characterization of the Vast Cold-Water Coral Mounds of the Blake Plateau https://media.ed.ac.uk/media/ISDSC8_Derek+Sowers_Research+Highlight/1_v6ibizxv	The full extent of the largest cold-water coral (CWC) mound province thus far discovered has been recently revealed through multibeam sonar surveys completed during a multi-year exploration campaign on the Blake Plateau offshore of the southeastern U.S. CWC mounds in this region form distinct bumps or pinnacles (composed of slope, ridge, and peak features) readily observable in multibeam bathymetry data and were mapped in depth ranges spanning approximately 350-900 m. Bathymetric data from twenty-six multibeam sonar mapping surveys were synthesized and used to generate a standardized geomorphic classification of the region in order to delineate and quantify CWC mound habitats. Seafloor terrain features were classified using the Bathymetry- and Reflectivity-based Estimator for Seafloor Segmentation (BRESS) method developed by Masetti et al. (2018) into five geomorphic landform classes (peaks, valleys, ridges, slopes, and flats) to support the enumeration of coral mound features and to quantify the area of each landform class. The 'peak' landform class was utilized to identify and count the number of individual apparent CWC mounds. The complex geomorphology of eight subregions representing distinct spatial patterns of CWC mound formation was described qualitatively with geomorphic 'fingerprints' and quantitatively by measurements of mound density and vertical relief. Ground-truth for the bathymetric analysis was provided by direct substrate observations from 23 submersible dive videos that revealed coral rubble to be the dominant substrate component within the peak, ridge, and slope landforms explored, thereby validating the interpretation of these bathymetric features as CWC mounds. The methods used in this study provide a pragmatic standardized approach for identifying, characterizing, and quantifying CWC mound-forming habitats and could be applied to other CWC provinces to enable more direct comparisons among geographically diverse settings.
18	**Diego Moreno Moran**, Lara M. Beckmann, Ignacia Acevedo-Romo, Jonathan Havenhand, Ann I. Larsson, Rhian Waller Fertilisation experiments on the widespread cold-water coral *Lophelia pertusa* https://media.ed.ac.uk/media/ISDSC8_Diego+Moreno+Moran_Research+Highlight/1_gepk3i74	The azooxanthellate coral *Lophelia pertusa* (recently synonymised to *Desmophyllum pertusum*) is one of the most common and accessible framework building cold-water corals, which has meant a wealth of research and data is available for this species. It is found from 39m in some Norwegian fjords, but also below 3,000 m in the open seas. Compared to other cold-water coral species, *L. pertusa* has received more attention in terms of reproductive studies, from seasonality and gametogenesis to larval development. However, there are still knowledge gaps, particularly regarding fertilisation kinetics, including variability in the proportion of fertilised eggs over time, and ultrastructural observations on gametes and embryogenesis. This poster presents some preliminary results from experiments focusing on several aspects of fertilisation kinetics including a) sperm concentration on direct ejection from polyps, particularly changes over the course of a full spawning season; b) the fertilisation rate of *L. pertusa* eggs at different sperm concentrations, and c) sperm motility. Additionally, we examined the ultrastructural morphology of gametes and various early developmental stages using Scanning Electron Microscopy (SEM). Sperm motility was measured by analysing videos using a Computer Assisted Sperm Analysis (CASA) software. The fertilisation experiments were conducted during spawning seasons from 2019 and 2023 between January and March using corals collected from Tisler Reef in Norway. Insights into fertilisation kinetics

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		help us to understand the spawning mechanisms in deep-sea and cold-water corals and how these may affect colonies' overall health and distribution. In general, understanding reproduction is vital to appreciating how these important ecosystem engineers maintain populations and colonize new regions, as well as understanding their resilience to anthropogenic impacts.
19	**Gary Williams** The pennatuloidean deep-sea faunal assemblage – two decades of progress in the status of biodiversity knowledge https://media.ed.ac.uk/media/ISDSC8_Gary+Williams_Research+Highlight/1_4anrnrae	The pennatuloidean cnidarians (sea pens) are a monotypic clade of the octocorals, and represent a diverse and important component of the deep-sea benthos, ranging in depth from sea level to at least 6260 m. Although a published account that mentioned sea pens first appeared as early as 1469, significant progress over the past twenty years has resulted in research findings regarding biodiversity, systematics, and biogeography. Since 2003, 40 genera and at least 229 of the 250 estimated species are currently recognized as valid. In the last decade, considerable sophistication in molecular analysis techniques has allowed for rapid advances in molecular phylogenetics with the production of phylogenetic trees involving a greater range of diversity for the entire group, as well as greater resolution of affinities between taxa. In addition, morphological and molecular evidence has resulted in a consensus regarding the evolutionary affinities of the sea pens within the Octocorallia as a whole. The ellisellid gorgonians and the pennatuloideans have been shown to form a strong monophyletic clade, based on both morphological and molecular evidence. Fifty-two percent of pennatulacean species are known to inhabit depths greater than 500 m, while the deepest known taxon is in the genus *Umbellula* from a recorded depth of over 6200 m. Although the vast majority of sea pens are adapted to anchor in soft sediments, several species in the genus *Anthoptilum* possess an adaptation of the proximal-most portion of the peduncle that allows them to adhere to hard substrata such as horizontal rocky outcrops, and are circumglobal in distribution between 368 and 1969 m in depth. These species are known colloquially as rockpens, and have also been found unattached and free in the water column, and observed to travel along in bottom currents.
20	**Gerald Hoff** A Synopsis of the Deep Sea Coral Research and Technology Program's Alaska Initiative 2020-2023	The U.S National Oceanic and Atmospheric Administration (NOAA) established the Deep Sea Coral Research and Technology Program to lead a national effort to improve our understanding of deep-sea coral communities and inform management of options to protect deep-sea coral and sponge ecosystems. The Program works with partners to support multi-year regional field research initiatives and targeted projects to locate and map deep-sea coral and sponge communities, conduct research on these species, and provide additional information to support conservation efforts. The Program has funded research in the U.S. Southeast (2009-2011), West Coast (2010-2012, 2018-2021), Alaska (2012-2014, 2020-2023), Northeast (2013-2015), Pacific Islands (2015-2017), and greater Southeast (U.S. Southeast, Gulf of Mexico and Caribbean; 2016-2019). Beginning in 2020, a four-year Initiative began focusing on deep-sea research in the Gulf of Alaska and Aleutian Islands. The Science Plan outlines research priorities and objectives addressing management needs for deep-sea coral communities in Alaskan waters. The plan focuses on field research and collection of new information on deep-sea coral and sponge taxonomy, distribution, diversity, and life history, as well as natural and induced habitat changes. There are six priorities for the Science Plan: (1) Validate Gulf of Alaska coral and sponge distribution models using visual surveys, (2) Examine the susceptibility to damage from anthropogenic activities and recovery rates of corals and

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		sponges, (3) Collect life history information on corals and sponges to support population modeling, (4) Use environmental DNA for species distribution modeling and biodiversity studies, (5) Develop risk assessment models for corals and sponges in Alaska that take into account anthropogenic and climate effects, (6) Map untrawlable habitats in the Gulf of Alaska and Aleutian Islands. Results will be reported to the North Pacific Fishery Management Council and made public to inform resource management decisions.
21	**Guarani Cavalcanti**, Teresinha Silva, Halésio Barros Neto, Celio Roberto Jonck, Emerson Morosko, Priscila Silva SENSIMAR PROJECT outcomes – deeps-sea coral environments of SE Brazil	To enhance the knowledge and to improve environmental management tools on deep-sea coral ecosystems along the Brazilian southeastern continental margin, the RD&I Center (CENPES) of Petrobras (Brazilian O&G Company) started in 2016 the 'SENSIMAR – Sensitive Marine Environment Project'. The studies, have just finished (2022/december), was carried out in a collaborative way with Brazilian and Norwegian Institutions (universities and companies). The project encompassed the following research themes: habitat mapping, ecological assessment; reproductive effort, population, connectivity, genomics and evaluation of the effects of offshore O&G activities. using the main framework coral species found in SE Brazil (*Desmophyllum. pertusum*, *Solenosmilia variabilis*, *Madrepora oculata* and *Enallopsammia rostrata*). Besides that, SENSIMAR promoted human resources formation and knowledge dissemination of deep-sea coral science in Brazil. Potential coral-habitats features, furtherly identified as coral carbonate mounds and *D. pertusum* reefs were mapped from the compilation of several high-resolution geophysical data, previously obtained for the study area. 12 cruises with ROV-equipped vessels were used for seafloor imaging (ground-truthing/ecological characterization) and for sampling coral and sediment. One lander and two sediment traps were used for temporal dynamics evaluation of these ecosystems. The reproductive biology study showed that there was no significant annual variation in fertility rates between species and no significant geographic variation between the reproductive effort of each species among the different studied areas. High levels of connectivity and low levels of clonality were observed in all studied species. The reference transcriptome was performed and the mitochondrial genome was assembled for all species. Laboratory experiments. to evaluate the tolerance levels of deep-sea corals and associated fauna (polychaete Ophryotrocha) to drilling discharges and sedimentation, in short and long-term exposures were performed. Online platform (DECODE) for storing and sharing deep-sea coral data obtaining by ROV was developed and the Brazilian Network of Deep-Sea Coral Specialists (CoralProf Network) is now consolidated.
22	**Iga-Maria Nestorowicz**, Ann I. Larsson, Susanna M Strömberg, Laurence De Clippele Guiding artificial reef deployment for cold-water coral reef restoration in the Skagerrak by using habitat suitability modelling and local environmental variables	Damage caused by trawling and other anthropogenic activities have caused Sweden's cold-water coral reefs to almost completely disappear. In a large-scale effort to restore these *Lophelia pertusa* (*Desmophyllum pertusum*) corals, artificial reefs will be deployed under the EU LIFE *Lophelia* project. To ensure the success of this active restoration method it is important that the artificial reefs are deployed in areas that have larval availability and suitable environmental conditions. Habitat Suitability Modelling (HSM) can be a useful tool to identify such areas. This is because variables derived from bathymetry can serve as useful proxies for temperature, food, current and sedimentation regimes, all of which are important factors driving cold-water coral distribution and growth. In this study, coral presence/absence data from Autonomous Underwater Vehicle (AUV) and Remotely Operated Vehicle (ROV) videos, and high

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	https://media.ed.ac.uk/media/ISDSC8_Iga-Maria+Nestorowicz_Research+Highlight/1_aqfa9j4m	resolution (0.5 x 0.5 m) bathymetry, current speed, sedimentation rate, temperature and salinity data were collected from the six target restoration areas in the Kosterfjord-Väderöfjord. A Random Forest modelling approach was used to create a habitat suitability map using the terrain variables slope, rugosity, bathymetric positioning index, eastness and northness, derived from bathymetry in ArcPro. The areas were furthermore broadly described based on the data from acoustic doppler current profilers and sediment traps. The HSM indicated sites suitable for restoration, with depth, BPI (i:36 x o:72) and eastness being found to be the three most important variables in driving *L. pertusa*'s distribution. Our results indicate that *L. pertusa* can tolerate a wide range of sedimentation rates (4 – 45 g/m^2/day) and extreme temperature events (up to 13°C) but that they prefer sites with high current intensities (mean 17, max. 79 cm/s). Areas which, at present, only have coral rubble present, are characterized by lower current intensities (mean 8, max. 40 cm/s) and sedimentation rates (8.3 ± 5 g/m^2/day).
23	**Nancy Prouty**, Jane Rudebusch, Tom Laidig, Elizabeth Clarke, Diana Watters, Abigail Powell, Guy Cochrane, Jenna Hill, Charles Paull, Lisa Gilbane, Susan Zaleski Expanding partnerships, expanding possibilities: 5-year synthesis of deep-sea coral and sponge observations along the U.S. West Coast by EXPRESS	Since 2017, a cross-disciplinary team of scientists and resource managers from federal agencies and private sector organization known as EXPRESS (Expanding Pacific Research and Exploration of Submerged Systems) has led advancements in deepwater research and exploration of the western United States exclusive economic zone. The team encompasses an increasingly large and diverse group of participants from the National Oceanic and Atmospheric Administration, U.S. Geological Survey, Bureau of Ocean Energy Management, and Monterey Bay Aquarium Research Institute. The group has dedicated more than 570 days at sea to provide foundational environmental data along the West Coast and in priority planning areas for offshore conventional and renewable energy. EXPRESS has supported the collection and analysis of bathymetry and backscatter data from multibeam sonar systems, visual survey data of seafloor habitats from unmanned systems, and geological and biological samples. EXPRESS team members have conducted 216 dives with remotely operated and autonomous underwater vehicles dedicated to surveying and sampling biological communities across the continental shelf, slope and abyssal plain from 50 m to over 3,000 m depth. Results from this study include more than 25,000 in-situ observations of deep-sea corals and sponges (DSCS) comprising more than 100 taxa and associated physical data. These observations make a significant contribution to the growing global database of DSCS observations and exemplify the value of science partnerships for leveraging resources in the advancement and innovation of deep-sea research and exploration. EXPRESS has significantly broadened the scope and impact of its data collection and analysis efforts to support resource managers and decision-makers. Together this information will help identify and characterize marine geohazards; evaluate management strategies to protect access, habitat, infrastructure and managed species; minimize conflict with existing uses and marine life; and ensure that renewable energy resources are efficiently developed in an environmentally responsible manner.
24	**Julia Johnstone**, Will Jenkins, Mackenzy Jankiewicz, Jonathan Quigley, Janessy	During expeditions in 2021 and 2022, live colonies of the octocorals *Swiftia exserta* and *Thesea nivea* were collected from depths of 65–100 m in the northern Gulf of Mexico. After collection, these corals were maintained in aquaria at federal facilities at NOAA Hollings Marine Laboratory in South Carolina, the USGS Wetland and Aquatic Research Center in Florida, and the NOAA Southeastern Fisheries Science Center in

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	Frometa, Amanda Demopoulos, Peter Etnoyer Reproductive success in captivity by two mesophotic octocorals: observations of synchronized spawning, reproductive potential, and larval ecology https://media.ed.ac.uk/media/ISDSC8_Julia+Johnstone_Research+Highlight/1_2nlf8vko	Texas. In the fall of both 2021 and 2022, a subset of collected colonies spawned in captivity, providing an opportunity to learn about their reproduction and inform future restoration activities. In 2021, *S. exserta* spawning occurred simultaneously in two facilities on October 19th and 20th. In 2022, spawning was observed on 19 days from September 29th to November 7th with participation by both *S. exserta* and *T. nivea*. These spawning events permitted detailed observations of gender ratios, spawning behavior and timing in reproductively mature colonies and yielded approximately 2,000 fertilized oocytes for use in trials describing aspects of larval ecology. Individual spawns were preceded by polyps assuming a distinctive 'spawning posture' and lasted from five minutes to nearly two hours, and presumably cued by lighting. Larvae of both species developed at similar rates to other broadcast spawning octocorals, becoming swimming planulae by three days post spawn (dps) and starting to settle by 14 dps. The distribution of samples across facilities enabled comparisons between individuals, sites, seasons, and facilities, as well as between years of spawning observations. These observations represent the first such records in either *S. exserta* or *T. nivea* and provide important insights for the direct restoration of these species. Future work will include providing size estimates for reproductive maturity, investigating the relationship between nutrition and reproductive condition, and identifying influences of key environmental variables on spawning in these species.
25	**Kasey Cantwell**, Martha Nizinski, Rachel Medley, Caitlin Adams, Erik Cordes, Amanda Demopoulos A Window into the Deep: highlights and discoveries from 6 years of deepwater exploration during the Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE) Campaign	The Atlantic Seafloor Partnership for Integrated Research and Exploration (ASPIRE) was a collaborative ocean exploration field program focused on providing a foundation of publicly available data throughout the region and raising our collective knowledge of the North Atlantic Ocean. This multi-platform and interdisciplinary campaign was coordinated through NOAA Ocean Exploration to meet the science and management needs of multiple U.S. agencies and academia, as well as international and industry partners. These data provide critical information relevant to emerging blue economy sectors, including, but not limited to, sustainable fisheries, offshore energy, coastal and offshore hazards, marine tourism and recreation. From 2016-2022, ASPIRE supported over 600 days at sea executed on 9 different ships and collected more than 629,000 square kilometers of new seafloor bathymetry. In addition to acoustic data, imagery and video data were collected on over 215 ROV, HOV, or AUV dives throughout the region, including along the east coast of the US and Canada, US Caribbean, New England and Corner Rise Seamounts, and the Mid Atlantic Ridge and Azores Plateau. As a Galway Statement Implementation Committee endorsed project, ASPIRE expanded bathymetric coverage within U.S. waters and the high seas, improved knowledge of unexplored areas, and expanded understanding of the distributions of coral and sponge communities throughout the North Atlantic. Most notably, through the extensive mapping operations, the largest bathymetry gap in deepwater (>200 m) along the US East Coast was closed, revealing the world's largest deep-sea coral province ('Million Mounds') to date. Other scientific contributions during the ASPIRE campaign included rarely observed predator-prey interactions, extensive documentation of previously unknown deep-sea coral and sponge habitats, observations of coral community development on artificial reef structures, and collections of specimens that will contribute to transatlantic connectivity studies.

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26	**Kathrin Busch**, F. Javier Murillo, Ellen Kenchington Deep-sea coral and sponge microbiome landscapes of the deep North Atlantic Ocean – spatio-temporal predictions, risk assessments, and knowledge dissemination https://media.ed.ac.uk/media/ISDSC8_Kathrin+Busch_Research+Highlight/1_pdd8kmjh	Symbioses between microbes and invertebrates are emerging as key drivers of ecosystem health and services. Deep-sea corals and sponges can harbour dense and diverse microbial communities inside their tissue, which play fundamental roles in key physiological processes. We are however, currently lacking an understanding of continuous spatio-temporal distribution patterns of animal-associated microbial communities. We here present an innovative approach how microbial communities living inside of corals and sponges may be predicted on basin-wide scales using Hierarchical Modelling of Species Communities (HMSC). Our study focuses on multiple deep-sea animal species, covering among others the corals *Lophelia pertusa* and *Desmophyllum dianthus*, as well as the sponge species *Vazella pourtalesii*. Region-wise our study is based in the deep ocean along the North American east coast, spanning a wide geographic range from 31°N to 75°N. We present different scenarios of spatial microbiome distribution patterns, including patterns simulated under worst-case CO_2 emission scenarios. We integrate our resulting biodiversity atlas with an 'atlas of threats', covering human activities such as fisheries, and consider the ocean management dimension of our research results. In particular we evaluate on effectiveness and needs of marine protected areas along the deep-sea Canadian east coast. The synthesized knowledge generated in the frame of this project represents an important step forward in including microbiomes in spatial predictive frameworks, and in providing critical knowledge for conservation of deep-sea coral reef and sponge ground ecosystems.
27	**Kristina Beck**, Sebastian Hennige, Blair Easton, Uwe Wolfram, Murray Roberts Physiological response and skeletal dissolution of the cold-water coral *Lophelia pertusa* to multiple environmental stressors https://media.ed.ac.uk/media/ISDSC8_Kristina+Beck_Research+Highlight/1_odga3xsj	The cold-water coral (CWC) *Lophelia pertusa* is an important ecosystem engineer, forming complex three-dimensional reefs in the deep sea. These reefs consist of both live corals and dead skeletal parts and are associated with high biodiversity. However, CWCs are threatened by various environmental changes due to climate change. Previous laboratory studies mostly examined the effects of individual environmental factors, especially elevated temperatures and reduced pH. So far, little is known about the effects of reduced oxygen concentration and food availability on CWCs and the combined effect of all these parameters on their physiology. Therefore, we conduct a long-term aquarium experiment with *L. pertusa* under end-of-century conditions. We investigate the combined effect of increasing p CO_2 (400 and 1,000 ppm), elevated temperature (9 and 12 °C), reduced oxygen concentration (80 % and 100 %), and reduced food supply (25 and 50 mg C m^2 d^{-1}) on coral calcification, respiration, and energy reserves over one year. In a parallel experiment, we also examine the dissolution rates of live and dead skeletons at different pCO_2 levels (750, 1,000 and 1,250 ppm) using computed tomography (CT) scans to better predict how ocean acidification will affect the structural integrity of CWC reefs in the future. Here we will present the first physiological data collected after three months of this experiment. We hypothesise that live corals are able to cope with the environmental changes due to a combination of factors over short periods of a few months, but not over one year. In the long-term, we expect that the combination of all four factors will have a negative impact on the physiology of *L. pertusa*, which is most likely driven by warming and reduced food availability.
28	**Laura Anthony**, Sandra Brooke	The reef-forming cold-water coral *Desmophyllum pertusum* is a gonochoristic annual broadcast spawner with genetically distinct regional populations across the North Atlantic. It has been observed that populations from the Northeast Atlantic (NEA), the

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	Exogenous Drivers of *Desmophyllum pertusum* Regional Reproduction Differences https://media.ed.ac.uk/media/ISDSC8_Laura+Anthony_Research+Highlight/1_241tktfh	Southeast U.S. (SEUS), and Gulf of Mexico (GOM) have offset gametogenic cycles, spawning at different times of the year. The NEA population has a protracted spawning period between late January and early March, with oogonia forming before the end of the spawning period. Meanwhile, the GOM population's spawn is complete by the end of October. To understand the differences between these populations, *D. pertusum* samples collected from 2002-2019 were histologically analyzed from several reefs across each region to compare regional gametogenic timing and reproductive output with several environmental variables. Specimens from the Northern GOM had mature gametes from mid-September to the end of October and the SEUS specimens had mature gametes from mid-September to the end of November. Oogonia were not seen forming prior to the end of the spawning period in individuals from the GOM or SEUS. During their respective spawning periods, the SEUS had the smallest mature oocytes while the NEA had the largest oocytes. When compared to environmental variables including temperature fluctuations, lunar cycles, and particle flux, the gametogenic cycles from each region typically began and ended around biannual peak particle fluxes. The correlation of the *D. pertusum* gametogenic cycle with particle flux patterns could have implications for reproductive synchrony in the face of changing primary productivity blooms and stratification.
29	**Laura Martín García**, Marcos González-Porto, Jesús M. Falcón, Sebastián Jiménez-Navarro, Noemí Dionis Insense, Bertín García Mañé, Clara Estil-Las García, Pablo Martín-Sosa Diversity and distribution of deep scleractinian corals from the northeastern Atlantic https://media.ed.ac.uk/media/ISDSC8_Laura+Mart%C3%ADn+Garc%C3%ADa_Research+Highlight/1_5d4w88r7	The order Scleractinia (Anthozoa, Hexacorallia) is one of the cnidarian groups with greater biodiversity and abundance within benthic communities. At present, there are around 40 species of scleractinian in the Canary Region, northeastern Atlantic Ocean. Most of these species are from shallow waters but several species find their suitable habitat in the circalittoral and bathyal environment. Some of them are framework-building corals and create carbonate mounds in deep bottoms where are used as microhabitats by marine vertebrates and invertebrates. During the last decade, an intensive sampling has been carried out aboard different scientific vessels in the seamounts and the Special Areas of Conservation (SAC) of the Canary region. Video recording transects were performed in the study area using the ROTV TASIFE and the ROV Liropus, besides direct samplers (dredges and trawls). This sampling has provided a representative and broad image database of the biodiversity of this region and samples of different species and depths. This paper presents the abundance and distribution of deep scleractinian corals around the Canary Islands archipelago from 80 to 1500 m depth. Among the results, we highlight the data related to the habitat-forming species *Madrepora oculata*, *Desmophyllum pertusum*, *Dendrophyllia cornigera* and *Anomocora fecunda*. New images and data about the presence, distribution of *Solenosmilia variabilis* and *Dendrophyllia alternata* are provided.
30	**Lénaïck Menot**, Julie Tourolle, Louis Amand, Touria Bajjouk, Christophe Brandily, Mathilde Chemel, Evan Edinger, Axel Ehrhold, Marie-Claire Fabri, Sandra Fuchs, Pierre E. Galand, Ana Hilario, Franck Lartaud, Jean-Romain Lagadec, Loïc N.	In the North East Atlantic, the Bay of Biscay has been a refuge for reef-building deep-sea corals during the past 45,000 years and over three glacial-interglacial cycles. Today, these cold-water corals thrive in the many submarine canyons incising the continental margin, where they may have found shelter from deep-sea trawling. However, submarine canyons are conduits for sediments and pollutants from shallow waters to the deep sea. They may funnel down sediments resuspended by trawling as well as marine litter. In addition to trawling and terrigenous pollution, CWC also face the cumulative threats of ocean warming, deoxygenation and acidification. With the main support from Life Integrated Marha (2018-2025) and ANR ARDECO (2021-2025)

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	Michel, Bertrand Moreau, Karine Olu, Florence Pradillon, Ricardo Siva Jacinto, Bruce Shillito, Magali Zbinden ChEReef: A multi-disciplinary and multi-scale project to assess and predict the health of deep-sea corals in the Bay of Biscay (NE Atlantic) https://media.ed.ac.uk/media/ISDSC8_L%C3%A9na%C3%AFck+Menot_Research+Highlight/1_7t12ndwh	projects, ChEReef (Characterisation and Ecology of coral Reefs) aims at monitoring the health of three reef-building scleractinians (*Desmophylum pertusum*, *Madrepora oculata* and *Solenosmilla variabilis*) and at defining their resilience to cumulative impacts. The project is structured around four main objectives: 1) assessing and modelling past, present, and future pressures including fishing and climate change; 2) mapping and deciphering both natural and anthropogenic drivers of CWC habitat distribution; 3) monitoring the health of a coral garden; and 4) predicting coral responses to climate changes. The strategy involves the quantification of fishing pressure and trends; nested scales of morphosedimentary and biota mapping; annual assessments of the trophic and reproductive status of corals, as well as the composition and functions of coral microbiomes; high-frequency monitoring of currents, temperature, oxygen, turbidity, particle fluxes as well as the behaviour of corals; in-situ experiments on coral growth, larval supply and recruitment; and finally ex-situ experiments, at both atmospheric and hydrostatic pressures, on coral holobiont responses to warming and acidification. An overview of the project and preliminary results will be presented.
31	**Lindsay Clark**, Cherisse Du Preez, Amanda E. Bates, S. Kim Juniper Monitoring cold-water corals and sponges in changing ocean conditions: A case study in the Northeast Pacific Ocean Oxygen Minimum Zone https://media.ed.ac.uk/media/ISDSC8_Lindsay+Clark_Research+Highlight/1_uj2lnog1	Understanding the mechanisms which constrain the distribution patterns of vulnerable marine species underpin ocean change predictions and guide informed Marine Protected Area (MPA) management and monitoring strategies. The Canadian Northeast Pacific contains some of the lowest oxygen levels in the global ocean where a mid-water oxygen minimum zone (OMZ) is losing oxygen rapidly (15% in the last 60 years) and is transected by a dense collection of seamounts which support abundant long-lived habitat-forming cold-water corals and sponges (CWCS). The MPAs within this region aim to maintain and restore habitat-forming CWCS (i.e., SGaan Kinghlas-Bowie Seamount and Tang.ɢwan-ḥačxʷiqak-Tsigis MPAs) given a backdrop of rapid ocean change. Seven long-term monitoring sites (LTMS) were established on Dellwood Seamount in 2018 at depths identified as vulnerable to further oxygen depletion. 3D reconstructions of these LTMS were created to characterize abiotic and biotic factors and establish abundance and condition baselines for future monitoring. Three years later five of these LTMS were revisited, enabling the first CWCS time-series in the MPAs. Contrary to our expectations, we found evidence of changes in the abundance and condition of CWCS within the relatively short interval. Based on 3-D mosaic image analysis, we observed decreases in the number of coral branches, increases in the amount of visible dead tissue on sponges, and an overall decline in the total number of individuals per LTMS. Our findings highlight the importance of (1) ecological studies to identify drivers of biodiversity change, and (2) annual monitoring to monitor MPA effectiveness and facilitate strategic management in Canadian Northeast Pacific MPAs to support CWCS
32	**Marcos González-Porto**, Deiene Rodríguez Barreto, Laura Martín García, Ana De la Torriente Diez, Jesús M. Falcón, Álvaro Herrera, Alberto Serrano, Sebastián Jiménez-Navarro, Noemí Dionis Insense, García Mañé,	Antipatharians, also known as black corals, form three-dimensional habitats with high biodiversity from the infralittoral to the bathyal rocky bottoms of The Canary Islands. About thirty species belonging to this group have been found in this archipelago and surrounding areas. However, the taxonomic identification of some species still seems confusing, mainly due to their phenotypic plasticity. Therefore, the combination of morphological and genetic studies to support their identification is required. During a survey aboard the RV *Ángeles Alvariño* conducted in 2022 in Special Areas of Conservation (SAC) at La Palma and El Hierro, the western islands of the Canary

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	Clara Estil-Las García, Pablo Martín-Sosa Contrasting morphology identification of several black corals (Hexacorallia: Antipatharia) from the Canary Islands with molecular data https://media.ed.ac.uk/media/ISDSC8_Marcos+Gonz%C3%A1lez-Porto_Research+Highlight/1_ftiou6lj	Archipelago, 23 specimens of black corals were collected with a remote operated vehicle. These samples, collected at depths between 120 and 531 m, were identified using morphological characters and molecular techniques (amplification and sequencing of 28S rRNA gene fragment). Although the results confirm the coincident morphological and molecular identifications for species of the genera *Leiopathes* or *Antipathes*, they show certain discrepancies in some taxa between the two approaches. Specifically, morphological features such as size, arrangement of the polyps and the shape of the spines, assign three samples to two different genera *Antipathella* and *Tanacetipathes*, while sequence homology to Genbank available sequences for Antipatharia and the phylogenetic analysis identified them as the same taxa. On the other hand, five collected specimens morphologically identified as *Stichopathes* spp. appear in two separate clades in the phylogenetic tree, being assigned to different genera by the molecular method, which confirms that the genus *Stichopathes* is a polyphyletic taxon, as previously reported (Bo et al., 2012). Further confirmation of the results presented here will be performed using mitochondrial markers. This study greatly contributes to clarify black corals taxonomy in The Canary Islands.
33	**Maria Rakka**, Martha Nizinski, David Packer, Marlene Wall, Anna Metaxas Assessing the impact of climate change on deep-sea corals: combining biological traits with a community approach https://media.ed.ac.uk/media/ISDSC8_Maria+Rakka_Research+Highlight/1_dvjjjczk	Corals are conspicuous ecosystem engineers in the deep sea, where they support rich communities and provide a variety of ecosystem services. Although climate change is expected to pose multiple stressors to deep-sea coral communities, attempts to evaluate the effect of climate stressors on corals have focused primarily on a few common species, thus substantially limiting our understanding. Trait-based approaches provide a useful alternative to species-centered approaches as they allow a link between organism performance and higher ecological levels. However, their use in deep-sea coral studies has been limited, mainly due to the lack of knowledge on coral traits. In this study, we assess the impact of climate change on deep-sea coral assemblages in the Gulf of Maine, an area with high climatic variability which is already experiencing extreme conditions including warming and acidification. By combining joined species distribution modelling and trait-based approaches, we first explore the current assemblages of deep-sea corals in the study area and evaluate the effects of environmental variables on community trait structure. The constructed models are then used to project changes in coral assemblages under future climate change scenarios. By combining and comparing the results of the two approaches, the study can provide useful insights into the processes that shape coral assemblages. Moreover, the results can have wider application to other regions, leading to a more complete understanding of potential future impacts on deep-sea coral communities.
34	**Mauricio Silva**, Virginia Biede, Amy Baco-Taylor Assessing recent trawling footprint overlap with deep-sea scleractinian reef suitable habitat on North Pacific Seamounts	The recent discovery of extensive fields of deep-sea scleractinian reefs between 500 and 850 m depth in the Northwestern Hawaiian Islands (NWHI) and the Emperor Seamount Chain (ESC) significantly extended the geographic range of reef occurrence. However, despite the opportunities this discovery brings, it also highlights the vulnerability of these communities to anthropogenic activities such as deep-sea mining and bottom-contact fishing. Known reef locations were used to estimate the regional extent of scleractinian reef occurrence using habitat suitability modeling. To estimate how much of the predicted and confirmed habitat of North Pacific deep-sea scleractinian reefs is under threat of trawl fishing, publicly available satellite automatic identification system

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	https://media.ed.ac.uk/media/ISDSC8_Mauricio+Silva_Research+Highlight/1_1r977dsl	(AIS) positioning of fishing vessels from 2012-2021, complemented with satellite images, were evaluated using spatial statistic techniques. From the 9 seamounts studied, confirmed and predicted reef area from Yuryaku, Kammu, and Koko showed the most overlap with active bottom trawling. Data suggests that most trawling efforts are being made in the same areas that have been identified as potential reef habitat, especially areas where medium slope and high rugosity overlap. High presence of fishing vessels correlates with visual observations of lost gear and extensive areas of reef rubble in many areas on these seamounts. This puts the deep-sea scleractinian reef habitat at high risk of being damaged, with limited potential for recovery due to the low resilience of the community and repetitive fishing effort in the same areas.
35	**Meredith Everett**, Steven Auscavitch, Randi Rotjan Exploring the deep-sea coral communities of the central Pacific with eDNA	Deep seamount environments in the Pacific remain both underexplored and undercharacterized with respect to marine benthic resources, despite recent exploration efforts. The 2015-2017 CAPSTONE (Campaign to Address Pacific Monument Science, Technology and Ocean Needs) expeditions, and ongoing exploration by the Ocean Exploration Trust and Schmidt Ocean Institute have yielded important insights to the diversity and abundance of deep-water coral communities and their variability in the seamount environments, however due to the geographic scale of the region, these efforts provide just a glimpse of this potential diversity. Though exploration in the region has only just begun, there is growing interest in the potential for mineral resource development in the deep central Pacific, driving a growing need to better characterize the deep-sea communities and their biodiversity throughout the region. To preserve biodiversity and biological resources, more effort, including the application of novel techniques that can further enhance traditional surveys, such as environmental DNA (eDNA) sequencing are needed. We have applied eDNA sequencing and a newly developed octocoral DNA voucher library for the central Pacific to better characterize deep-sea octocoral community biodiversity for the region. MutS amplicon libraries have been sequenced on an Illumina MiSeq for eDNA samples collected in Papahanaumokuakea Marine National Monument, from multiple units within the Pacific Remote Islands Marine National Monument, and within the National Marine Sanctuary of American Samoa. The resulting data are being applied to better characterize patterns of octocoral community biodiversity within each region, and examine patterns of biodiversity in relationship to habitat variables. Additionally, we are comparing community structure among regions to better understand patterns of connectivity or dispersal barriers to species distribution within the region. These data will help to contextualize the general biodiversity of the region, and provide valuable insight into the hidden communities likely associated with the species observed with deepwater ROVs.
36	**Pål Buhl-Mortensen**, Mamadou Lamba Ba, Amelia Bridges, Kouamé Kanga Désiré, Marta Gil, Jose A A Perez, Francisco Jose Ramil, Roberto Sarralde	As part of the EAF-Nansen Programme, two surveys were undertaken in the Southeast Atlantic, focused on the exploration and mapping of benthic seamount habitats comprising vulnerable marine ecosystems (VME). Ten features were targeted from the Discovery Seamounts and the Guinea Seamount Chain in the sub-Antarctic and tropics, respectively. The lack of knowledge of benthic ecosystems in this region represents a challenge for management, and thus the South East Atlantic Fisheries Organisation had set priorities for work in these areas beyond national jurisdiction. Fishing effort across the seamounts varied, with some being currently closed to fishing and others having been fished in the past. All seamounts had summits with a central flat plateau located

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	Cold-water coral ecosystems in the southeast Atlantic – are they threatened?	at depths between 382 and 825 m. ROV dives were conducted at 47 locations including summit centres and edges, mid-slope and deep slope areas down to 1800 m depth. VME-indicator taxa (e.g. gorgonians, black corals, stone corals and sponges) were observed at 37 locations, with varying taxonomic compositions and dominance; at 32 locations, these occurred at relatively high densities. Various types of coral gardens were the dominant VME habitat type. The scleractinian *Enallopsammia rostrata* was abundant in the Guinea Seamount Chain and occurred as solitary fan-shaped colonies. Extensive areas of dead *Solenosmilia variabilis* reef framework indicate that the Guinea Seamount Chain previously harboured coral reefs. Coral rubble areas were observed at 20 locations at the edges of seamounts down to mid-slope locations at 1380 m depth. Colonial scleractinians were not observed on the Discovery Seamounts where Isididae and Primnoidae octocorals were most common. No evidence of human footprint was observed on any of the ten features, but at one location on the Discovery Seamounts, extensive grazing on bamboo corals (*Keratoisis* sp.) by a sea urchin was observed at depths between 850 and 960 m.
37	**Pål Buhl-Mortensen**, Heidi Meyer, Rebecca Ross, Jonatan Marquez, Genoveva Gonzalez-mirelis Observations of Arctic cold-water coral ecosystems	Cold-water coral distribution in Arctic waters is still largely unknown yet may be at high risk from climate change impacts and increasing human activities. During two cruises in 2022, new cold-water coral habitats were documented with ROV and towed video along the continental margin north of Svalbard. In total 225 locations were surveyed between 75 and 3,000 m depth. Coral habitats were documented above 1250 m depth at 47 (21%) locations, in water with temperatures between -0.8 and 4.3 °C. Nephtheidae-dominated coral gardens on mixed bottoms where most common. These occurred within a broad depth range (74-1,000 m depth), and often in densities higher than 5/m^2. Two types of seapen habitats were observed; a shallow (117-838 m depth) type, mainly consisting of *Virgularia* sp. and *Funiculina quadrangularis*, and a deep type (890-1289 m depth) with *Umbellula encrinus*. Shallow seapen habitats were observed at 16 (7%) locations, whereas *Umbellula* habitats were only observed at 6 (3%) locations. Two gorgonian species were characteristic for soft-bottom coral gardens; *Radicipes gracilis* and *Isidella* cf. *lofotensis*. They had a slightly overlapping depth range, with *Radicipes* occurring between 447 m and 794 m depth, and *Isidella* from 695 to 986 m depth. The area north of Svalbard has been fished (mainly shrimp trawling) at depths down to 800 m since the 1970s, and is becoming more and more accessible due to longer ice-free periods. This activity was clearly observable on the seabed as trawl marks and dead and/or broken coral skeletons. Between 200 and 800 m depth 52 % of all locations had clear trawlmarks. For the coral habitats the most dramatic impact was observed for *Isidella*-habitats where broken skeletons were found at 62 % of the locations.
38	**Rebecca Ross**, Amelia Bridges, Pål Buhl-Mortensen, Margaret Dolan, Anna-Leena Downie, Genoveva Gonzalez-mirelis, Kerry Howell, Jonatan Marquez, Heidi Meyer, Nils Piechaud	Spatial species distribution predictions are probably the primary reason people use habitat modelling, but there are many other applications beyond just figuring out where taxa might occur. Within the context of deep sea corals, this talk is intended as a mini-review to promote habitat modelling as a useful tool for many purposes. Ecological examples touch upon: characterising the ecological niche of a taxon or biotope, separating species from the habitats they form, providing a basis for connectivity modelling, planning survey targets, exploring climate change implications for taxa or habitats, and highlighting and resolving taxonomic issues. Meanwhile conservation applications include: exploring conservation-worthy density thresholds, assessing

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	The flexibility of deep sea coral habitat models: ecological and conservation applications https://media.ed.ac.uk/media/ISDSC8_Rebecca+Ross_Research+Highlight/1_4he292en	percentage protecting targets, evaluating human impacts, and assessing newly discovered biotopes for their conservation relevance.
39	**Sandra Brooke**, Amy Baco-Taylor, Jeroen Ingels, Steven Morey, Matthew Poti, Arliss Winship HydroSMAC: Hydrodynamics and habitat Suitability for Meiofauna And Corals	The eastern Gulf of Mexico (GOM) is dominated by a massive carbonate platform that slopes gently for over 200km offshore before dipping sharply down to abyssal depths to form the west Florida escarpment (WFE). The escarpment is one of the least accessible places in the GOM, but the few ROV surveys of this feature revealed dense coral communities at depths >1500 m. The HydroSMAC project used habitat suitability models (HSM) and high-resolution oceanographic models to select target exploration sites for the research cruise in October 2019. The dominant habitats were steep rocky ridges with intermittent sedimented terraces. Octocorals were the most abundant and diverse coral taxa and included several species of Coralliidae, Isididae, Primnoidae, Chrysogorgiidae, Plexauridae and Paragorgiidae. Scleractinians were uncommon but large *Enallopsammia rostrata* colonies were observed >2,000 m. The WFE supports a completely different suite of sessile benthic species than shallower coral habitats and may have species unique to the eastern GOM. An analysis of meiofaunal communities was used to validate the hydrodynamic model using sediment samples collected using push cores during ROV dives and a multi-corer to augment the limited ROV cores. Meiofauna species diversity was assessed using morphological techniques and genetic metabarcoding. The infaunal work has shown great potential as a tool for assessing current regime and other environmental conditions that are important drivers of deep coral distribution, and which could be incorporated into HSM for corals and other fauna. The WFE extends over 600km and comprises hundreds of ridges that potentially support coral communities, but the biology and ecology of this massive deep coral province is virtually unknown. The Deepwater Horizon oil spill highlighted the need for better understanding of deep-sea ecosystems that are vulnerable to anthropogenic impact, including underexplored regions such as the WFE.
40	**Santiago Herrera** & Erik Cordes Genome assembly of the deep-sea coral *Lophelia pertusa*	We present the genome assembly of *Lophelia pertusa* from the southeastern coast of the United States, the first one for a deep-sea scleractinian coral species. We generated PacBio Continuous Long Reads data for an initial assembly and chromosome conformation data for scaffolding. The scaffolded assembly was annotated using evidence from transcripts, proteins, and ab initio gene model predictions. This assembly is comparable to high-quality reference genomes from shallow-water scleractinian corals. The assembly comprises 2,858 scaffolds (N50 1.6 million base pairs) and has a haploid size of 556.9 million base pairs. Approximately 57% of the genome comprises repetitive elements and 34% of coding DNA. We predicted 41,089 genes, including 91.1% of complete metazoan orthologs. This assembly will facilitate investigations into the ecology of this species and the evolution of deep-sea corals.

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41	**Seonock Woo** & Yejin Jo Genetic resources and coral biodiversity of seamount in West Pacific	Seamounts are relatively small sub-marine volcanoes that develop adjacent to mid-oceanic ridges, on the oceanic crust and also in extensional forearc basins along the island arcs. Since seamounts are volcanic and host active hydrothermal convective systems, seamounts have a significant effect on element cycles involving sea water and its dynamic interaction with the ocean crust. They may also have a significant influence on global ocean circulation patterns because their presence induces much greater mixing than is measured in areas with smooth bottom topography. Seamounts have a great effect on circulation patterns and currents, which in turn have very important effects on seamount biota. In general, seamounts host very diverse and abundant faunas, with important effects on oceanic biology. In this study, we explored seamounts in West Pacific, approximately 400 km northeast from Guam, using ROV (remotely operated vehicle) and RV *Onnuri* to investigate the deep-sea fauna and biodiversity around the seamounts and aimed construction of the ecological map and discovery of biological resources, particularly from cnidarian. First of all, we purposed sampling of deep-sea coral species among the cnidarian and extracted its RNA and DNA. We constructed transcriptomic assemblage of 3 deep sea corals (*Rohdanirdogorgia* sp., *Chrysogorgia stellata*, *Calyptrophora lyla*) after de novo RNA sequencing to investigate further gene expressions in abiotic extreme environment and also to discover differentially expressed genes comparing between deep-sea environment and shallow water species or cold water and tropic coral species. This research was supported by Korea Institute of Marine Science & Technology Promotion (KIMST) funded by the Ministry of Oceans and Fisheries(20210646) and KIOST (PEA0123).
42	**Sophia Kleemeier**, Jürgen Laudien, Covadonga Orejas, Marlene Wall, Kristina Beck, Thomas Heran, Claudio Richter, Verena Häussermann Physiological plasticity of the cold-water coral *Desmophyllum dianthus* to increased salinity and water temperature https://media.ed.ac.uk/media/ISDSC8_Sophia+Kleemeier_Research+Highlight/1_muusfud0	The cosmopolitan cold-water coral *Desmophyllum dianthus* is an important ecosystem engineer, providing habitat for many benthic organisms. Although most CWC populations are located in the bathyal zones of the oceans, some *D. dianthus* populations thrive from 250 m to 1,200 m in the Mediterranean Sea, a marine habitat with high salinity (38.1–39.9) and temperature (11 °C –14 °C). Other populations at higher latitudes, such as in the Chilean fjord region, can be found in waters as shallow as 8 m depth and are therefore exposed to natural fluctuations in abiotic and biotic environmental parameters (temperature: 8–14 °C; salinity: 28.5–34.0). The aim of this study was to explore the potential capability of *D. dianthus* to thrive in environments with different physical and chemical water parameters. The latter were chosen so that the species occurs naturally there, such as the Mediterranean, to reveal the potential plasticity of *D. dianthus* to acclimate to changing environmental conditions. The response of Chilean *D. dianthus* to increased Mediterranean temperature and salinity was investigated over a three-month period. A uni- and bifactorial approach was used to identify the individual and interactive effect of increased temperature and salinity on polyp behavior, respiration and growth. While both warming alone and in combination with increased salinity, did not affect behavior nor respiration, the combination of increased temperature and salinity stimulated their growth rate by 140%. In conclusion, Chilean *D. dianthus* specimens are capable to survive for three months at higher temperatures and salinity and grow significantly more than has been documented in the Mediterranean. This indicates that Chilean *D. dianthus* specimens display high plasticity and resilience to changes in salinity and temperature. Therefore, their widespread

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		distribution might likely be due to this great phenotypic plasticity in relation to various physical and chemical factors.
43	**Susanna M Strömberg** What do we know about settling in deep-sea corals? – Settling behaviour in larvae of *Desmophyllum pertusum* https://media.ed.ac.uk/media/ISDSC8_Susanna+M+Str%C3%B6mberg_Research+Highlight/1_f94x0uu1	v In contrast to their shallow tropical counterparts, hardly anything is known about settling and recruitment in deep-sea corals. While tropical coral larvae are known to be attracted to crustose coralline algae and bacterial films and some of the specific compounds that trigger settling and metamorphosis have been isolated, nothing is known about the triggers for deep-sea coral larvae. We know that the larvae of *Desmophyllum pertusum* (syn. *Lophelia pertusa*) settle on dead coral skeleton, but also on oil and gas platforms and other man-made objects. Adult *D. pertusum* colonies thrives in high-current velocities at seafloor features like constrictions and sills. The larvae therefore need to overcome the difficulties of settling in high-current environments. Our hypothesis is that they use cnidocysts for anchoring to protruding objects and they have been observed to discharge cnidocysts in response to sudden turbulence. This could be an adaptation to attach to protruding objects, as a protruding object would create micro-eddies that could facilitate larval attachment. Larvae have also been observed to enter microscopic crevices, probably a way of protecting themselves from predators until they have built their skeleton. A combination of protruding objects and microscopic crevices should thus be an optimal substrate for these larvae. Substrates rich in calcium carbonate and other mineral components (e.g., strontium, magnesium) have been used to elicit coral settling. Water movement has been shown to stimulate settling in some larvae. Here, I will present our latest results in settling in *D. pertusum* larvae, combining materials, topography, and turbulence.
44	**Sydney Lewis**, Heather Coleman, Thomas Hourigan Deep dive into deep-sea coral and sponge research project outcomes	Deep-sea corals and sponges provide biogenic habitat that supports communities of high biodiversity in the deep sea. Furthermore, habitat complexity supports spawning, recruitment, and nursery grounds for commercially important fish and invertebrate groups. In 2009, NOAA established the Deep Sea Coral Research and Technology Program (DSCRTP) to provide scientific information necessary for managing deep-sea coral ecosystems. Major DSCRTP research goals include identifying deep-sea coral and sponge (1) spatial distribution, (2) sensitivity to stressors and ability to recover, (3) spatial extent and intensity of relevant anthropogenic activities, and (4) effectiveness of management measures. DSCRTP has funded a variety of efforts to meet these goals, including expeditions, predictive habitat modeling, survey tool development, lab analysis, data management, and educational opportunities. The following internship was designed to create an inventory of projects funded between 2009-2021. Documented project attributes include proposed objectives such as number of samples taken, species discovered, new technology developed, papers published, outreach efforts, models created, and funds provided. This high-level inventory now allows DSCRTP to assess the effectiveness of past funding efforts and inform delegation of future program funding. An RShiny dashboard was developed to complement the inventory and to increase its communicability. With this tool, DSCRTP has a mechanism to review past work, design future priorities, and easily track current and subsequent projects.
45	**Tina Molodtsova**, Ulyana Simakova	We tested the possibility of using X-ray imaging to study skeletons, identify characteristic morphological features, and detect endosymbionts in deep-sea Scleractinians. As the model objects we used the widely distributed framework-building species:

	Authors, Title, Recording	Abstract
	Comparative X-ray analysis of deep-sea framework-building Scleractinia https://media.ed.ac.uk/media/ISDSC8_Tina+Molodtsova_Research+Highlight/1_ci7adhgc	*Desmophyllum pertusum*, *Solenosmilia variabilis*, and *Madrepora* spp. In *Desmophyllum pertusum* worm runs of *Eunice* cf. *norvegicum* (Eunicidae: Annelidae) were easily detected using the X-ray. Comparative X-ray studies of Solenosmillia variabilis and *Desmophyllum pertusum* (Caryophyllidae Scleractinia) revealed that the two species can be easily identified by their X-ray structure. X-rays can be used for reliable identification of debris of these two species. Our finding seems to be useful because both of these species are indicators of Vulnerable Marine Ecosystems and misidentifications of these two species are not uncommon in the literature. The work supported by RSF project 22-24-00873.
46	**Tyler Fountain,** Bárbara de Moura Neves, Philippe Archambault, David Coté, Alexandre Forest, Evan Edinger How do oceanographic and geological drivers structure cold-water coral and other megabenthic epifauna diversity in the Labrador sea and Baffin Bay? https://media.ed.ac.uk/media/ISDSC8_Tyler+Fountain_Research+Highlight/1_qz77p83g	This research aims to investigate how environmental variables affect the distribution of cold-water corals and other megabenthic invertebrates in the NW Atlantic and Eastern Canadian Arctic. To better understand how megabenthic epifauna diversity is structured by biogeographical features and environmental conditions (e.g., temperature, salinity, calcium carbonate saturation depths), we are using seafloor imagery data collected during 7 research cruises conducted aboard CCGS *Amundsen*. ROV video and oceanographic data have been collected annually since 2013, from 14 locations spanning the Eastern Canadian Arctic to mid Labrador shelf, at varying depths and latitudes. Here we present a pilot study investigating the relationship between biodiversity, depth, and substrate composition across four different locations in NW Labrador Sea and SE Baffin Bay in July 2016, at depths of 408-940 m. Consecutive non-overlapping images were extracted from the videos and analyzed to gather species count data, categorize primary and secondary substrate composition and derive Simpson's diversity indices along each dive. Of the 78 recorded taxa, 18 coral and 29 sponge taxa were identified, and the relationship between biodiversity, substrate, and depth was modeled using combined data from each location. Preliminary pooled data indicates a positive relationship between biodiversity and increasingly coarse substrate composition (e.g. cobble, boulder), and a negative relationship with depth. Although depth and substrate were found to be negatively correlated, inclusion of this interaction term within the model did not provide additional explanatory power. Analyzing biodiversity data by site, as opposed to by transect segments within sites risk overestimation while also missing finer scale heterogeneity in biodiversity. Future research aims to build upon this preliminary assessment by integrating more oceanographic data and seafloor characterization into our analysis, thus further evaluating how environmental variables influence the distribution of cold-water corals and structure the biodiversity of megabenthic invertebrate epifauna in this region.
47	**Virginia Biede,** Nicole Morgan, Amy Baco-Taylor Deep-sea benthic community patch sizes on seamounts in the Hawaiian-Emperor Seamount Chain https://media.ed.ac.uk/media/ISDSC8_Virginia+Biede_Re	Deep-sea benthic community patch size is a fundamental parameter for understanding communities at multiple scales but is rarely quantified. Patch size is not only important for understanding local ecological processes but can be an important interdisciplinary tool. Knowledge of patch size is important for designing ecological surveys as well as informative for management decisions, including designating areas as vulnerable marine ecosystems or marine protected areas, and the efficacy of move on rules. To gain a better understanding of patch sizes on North Pacific seamounts, an existing dataset derived from surveys with the AUV Sentry conducted in 2014 and 2015, was reanalyzed using QGIS and R. The Sentry data included annotations from surveys of seafloor communities between 200 m – 800 m depth on multiple seamounts of the

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	search+Highlight/1_kyxxd8ug	Northwestern Hawaiian Ridge and Emperor Seamount Chain. Sentry images were annotated for 5 taxonomic groups, corals, sponges, crinoids, anemones, and brisingids, in all dive images, and categorized for density as sparse, medium, or abundant for each taxon. This existing dataset was re-analyzed for patch size of each group among these seamounts. Overall, the mean patch size found for all taxa and all densities was 22 m in length. However, this varied per feature from 5 m to 27 m. The largest patch size was greater than 2 km on Koko Guyot, which is currently exposed to active bottom trawling. Investigating only the coral group, the mean varied from 5 to 31 m. The largest coral patch was 1243 m in length and found on Northwest Hancock. Utilizing Moran's I, patches were determined to be non-randomly distributed. Local Moran's I resulted in varied autocorrelation of patch size and site. Further analyses will investigate patch size comparisons between trawled and never trawled seamounts, different taxonomic groups, and the potential correlation of patch locations and environmental parameters.
48	**Yuthika Jalim**, Evan Edinger, Bárbara de Moura Neves, Philippe Archambault, David Coté, Boris Dorschel, Bodil W Lauridsen, Owen Sherwood, Vonda Hayes Colony metrics and biodiversity of Southwest Greenland colonial scleractinian communities on rock walls https://media.ed.ac.uk/media/ISDSC8_Yuthika+Jalim_Research+Highlight/1_69eerofz	Near-vertical rock walls off Southwest Greenland likely represent the NW limit of the cold-temperate colonial scleractinian coral habitats within the North Atlantic. The size structure and depth distribution of the dominant coral species, *Lophelia pertusa* (*Desmophyllum pertusum*), and other sessile invertebrate fauna of one of these communities, were described using ROV video collected on the rock walls between 700 and 1,000 m depth, and drop video camera from the slope above the walls, in August 2018, overlaid on multibeam bathymetry recorded in 2017. Rock walls appeared to be composed of igneous or high-grade metamorphic rocks with two orthogonal, near-vertical structural planes. *Lophelia* colonies occurred only on rock walls oriented to the SW, facing into the prevailing current. Other sessile megafauna were dominated by a diverse assemblage of sponges, nephtheid soft corals, and the large gorgonians *Primnoa resedaeformis* and *Paragorgia arborea*, with rare *Acesta* bivalves. These species occurred on all wall orientations examined. A veneer of fine sediment appeared to cover the bedrock where the slope of bedrock walls was not near-vertical. Shallower than the rock walls, around 725 m, the sloping bottom was composed of weakly consolidated diamicton, including rare apparent authigenic carbonate crusts. No scleractinian corals were observed on the diamicton, where the megafauna was dominated by sponges and alcyonacean soft corals. Colonial scleractinian corals occurred between 725 and 925 m depth, and were dominated by the orange tissue form of *L. pertusa*, in both globular and shelf-like morphologies. Rare colonies of *Madrepora oculata* were observed. Density of *Lophelia* corals was usually less than 3 colonies m^{-2}, maximum 6.25 m^{-2}. Average colony diameter was generally 40-50 cm, decreasing slightly with depth, and maximum colony diameter of 1.75 m. Shelf-like colonies were more common shallower than 825 m, while globular colonies were more prominent in deeper water.

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