

59TH



PENICHE, JULY 07-10, 2026

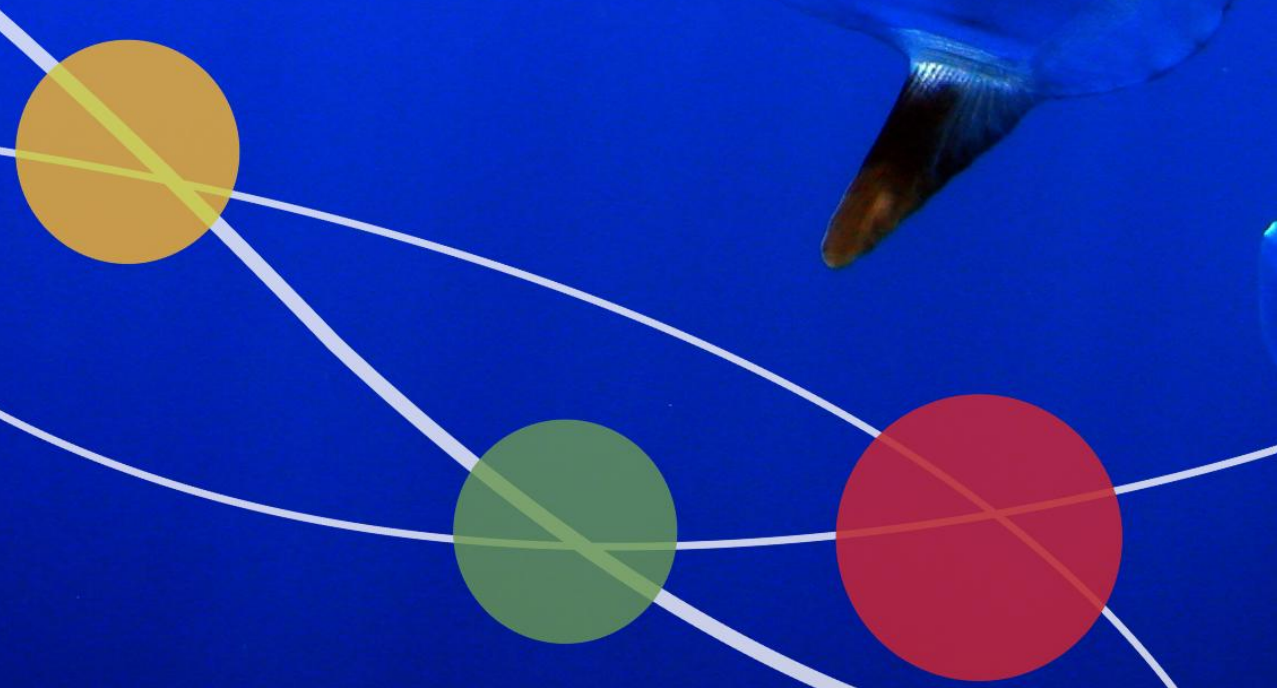
EMBS

E U R O P E A N

M A R I N E B I O L O G Y

S Y M P O S I U M

Bringing marine biologists
together since 1966



59th European Marine Biology Symposium

Bringing marine biologists together since 1966

7th to 10th July 2026, Peniche, Portugal

Organized by

School of Tourism and Maritime Technology – Polytechnic

University of Leiria

MARE – Marine and Environmental Sciences Centre

ARNET – Aquatic Research Network

EuroMarine – European Marine Research Network Association

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Welcome to the 59th EMBS and to Peniche!

It is our great pleasure to welcome you to the 59th European Marine Biology Symposium (EMBS), hosted by the School of Tourism and Maritime Technology of the Polytechnic of Leiria (ESTM-IPLeiria), in partnership with Marine and Environmental Sciences Centre (MARE) and the EuroMarine Network.

For six decades, EMBS has brought together marine scientists from across the world, providing a forum to exchange knowledge, discuss emerging challenges, and build collaborations across disciplines. We are delighted that this tradition continues in Peniche, a city deeply connected to the ocean through its history, culture, fisheries, surfing, and marine research.

This year, we are delighted to welcome approximately 230 participants from 25 countries, reflecting the international and interdisciplinary nature of the EMBS community. The diversity of backgrounds and expertise represented at EMBS reflects the strength of our scientific community and creates an inspiring environment for discussion, collaboration, and innovation.

The scientific programme covers the range of marine biology, from molecular and microbial studies to ecosystems and marine megafauna, encompassing ecology, conservation, oceanography, biotechnology, ecotoxicology, fisheries, and marine management. Alongside outstanding keynote lectures, oral and poster presentations, workshops, and networking opportunities, we hope the symposium will encourage new ideas, new partnerships, and lasting collaborations.

Beyond the scientific programme, we invite you to discover Peniche and its remarkable coastal environment. We hope you will have the opportunity to experience its rich maritime heritage, exceptional biodiversity, renowned seafood, and the unique landscapes of the Berlengas UNESCO Biosphere Reserve.

We sincerely thank all participants, keynote speakers, session conveners, reviewers, sponsors, institutional partners, volunteers, and members of the organising committee whose commitment has made this symposium possible.

We wish you an enjoyable, inspiring, and memorable 59th EMBS 2026.

Warm regards,

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Practical Info



1.1 Arrival to the venue

Lisbon is served by Humberto Delgado International Airport (LIS), located approximately 90 km from Peniche (around 1 hour by car).

If travelling by car, you may rent a vehicle at Lisbon Airport and drive to Peniche via the A8 motorway. The route is straightforward, with well-maintained roads and clear signage.

Alternatively, you can travel by bus. From Lisbon Airport, take the Metro to either Jardim Zoológico (Sete Rios) or Campo Grande, where you can catch a direct bus to Peniche. Bus services are operated by Rede Expressos and Rodoviária do Oeste.

The 59th European Marine Biology Symposium (EMBS 2026) will take place at the School of Tourism and Maritime Technology (ESTM–IPLeiria), located on the northern waterfront (Marginal Norte) of Peniche, as illustrated in Figure 1.

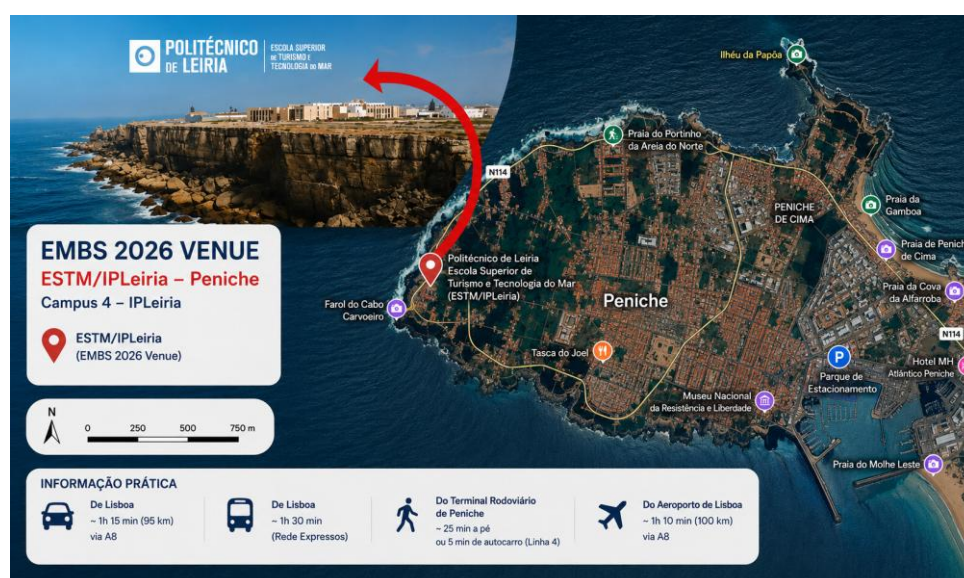


Figure 1. Location of ESTM–IPLeiria within Peniche.

Arrival at ESTM–IPLeiria: Figure 2 provides an aerial view of the ESTM campus. The main entrance, which also serves as the EMBS 2026 entrance, is located on the south side of the building. Upon arrival, participants will find conference signage and members of the Organising Committee, who will be available to guide attendees throughout the venue.

Lunches will be served in the campus canteen, located in the building immediately east of ESTM, adjacent to the conference venue.

Participants arriving by car may use the parking spaces available along Rua do Conhecimento, directly in front of the campus.

Those arriving by bus will be dropped off at the rear of the university campus. From there, it is approximately a 5-minute walk to the EMBS main entrance.



Figure 2. Map of ESTM–IPLeia showing the EMBS 2026 main entrance, canteen and parking areas.

1.2 Hotels

Star Inn is the official hotel of the event. Guests will benefit from a 10% discount by using the promotional code EMBS26. Here is a list with a few other recommendations for hotels near the venue

Sea Garden Residence: Located in the center of Peniche and surrounded by the sea, near the public garden (Jardim Público) and the tourist office (Posto de Turismo).

PINHALmar: Located in a unique environment, the hotel is a modern resort designed for the comfort and relaxation of its guests.

Mh Hotel Peniche: Located across from the Cova da Alfarroba beach, the hotel offers a fusion of modernity, comfort, and elegance, set within a seaside and beach environment, offering a unique experience of excellence and a high degree of personalization in a pleasant setting in close contact with nature.

1.3 Passport & Visa

Some people do not need a visa to visit Portugal because they hold a passport from a country that Portugal has a visa exemption agreement with. This also applies if you have a residence permit in an EU/EEA country or if you have a special passport.

1.4 Participant badges

Participant badges can be collected from the registration desk at the venue. Participants need to wear their badge during the different sessions of the conference since only registered participants can access the conference.

1.5 Meals & Breaks

During the coffee breaks, several refreshments will be served.

The lunch will be provided at the venue, where several options, including vegan and vegetarian alternatives, will be offered at the buffet. The conference dinner will be included in the registration fee.

1.6 Certificates

Certificates of Attendance and Presentation will be sent to each participant after the conference.

1.7 Partners

The 59th EMBS Symposium gladly presents its organising Committee: Município de Peniche and EuroMarine network.



1.8 Sponsors

The 59th EMBS Symposium gladly presents its sponsor: **SOQUÍMICA, LDA**. A leading Portuguese supplier of high-quality laboratory equipment and specialised technical services, with over 90 years of experience. Representing internationally recognised brands, the company provides innovative solutions for research, education, industry, and environmental applications, supporting laboratories across a wide range of scientific and analytical fields.



1.9 Abstract codes

Abstracts are identified using the following format:

Sx-OC-## = Scientific Session (S1–S6) – Oral Communication – Presentation Number

Sx-PC-## = Scientific Session (S1–S6) – Poster Communication – Presentation Number

Example: S3-OC-15 refers to Oral Communication 15 in Scientific Session 3.

Keynotes

Biography



Antonio Di Franco

Dr. Antonio Di Franco is a Senior Researcher at the Stazione Zoologica Anton Dohrn and a marine ecologist specializing in marine conservation, fisheries ecology, and coastal socio-ecological systems. His research focuses on ecological effectiveness, governance, and management of marine protected areas (MPAs), as well as connectivity and dispersal processes in marine populations. He also integrates human dimensions into marine conservation, including stakeholder perceptions, resource use, and socio-ecological interactions, with a particular focus on the Mediterranean Sea.

Over his career, he has coordinated and contributed to numerous international projects examining the impacts of human activities on marine ecosystems and the role of MPAs in biodiversity conservation and fisheries management. His work integrates field-based research, quantitative ecology, and applied conservation science to inform evidence-based marine policy and ecosystem-based management.

He has played leading roles in Mediterranean initiatives on MPA networks, spillover effects, and small-scale fisheries sustainability. His research has advanced understanding of fish population dynamics, larval connectivity, and the links between ecological and social components of coastal systems, contributing to the integration of marine science, conservation practice, and environmental governance.



Stazione Zoologica Anton Dohrn, Naples, Department of Integrative Marine Ecology, Sicily Marine Centre, Palermo, Italy

Francesco Regoli

Former Director of the Department of Life and Environmental Sciences, current Vice-Rector for Research, Francesco Regoli is a marine ecotoxicologist and full professor at the Università Politecnica delle Marche, in Ancona, Italy. Over the past decades, he has established himself as one of the leading international researchers in the fields of marine pollution, oxidative stress, and biomarker-based environmental assessment. His scientific work has focused on understanding the effects



of contaminants such as trace metals, hydrocarbons, pharmaceuticals, microplastics, and other emerging pollutants on marine organisms and coastal ecosystems. Through a multidisciplinary approach combining molecular and cellular biology, physiology, and ecotoxicology, he has significantly contributed to the development of effect-based methodologies used worldwide in environmental monitoring and ecological risk assessment.

Francesco has authored hundreds of scientific publications, and since 2022 he has been included in the Highly Cited Researchers, representing the top 1% of the most influential scientists in their field worldwide. He has coordinated numerous European research projects focused on marine conservation, climate change, and contaminant impacts on aquatic ecosystems, in addition to serving as Editor-in-Chief of Marine Environmental Research, thereby playing a major role in advancing modern ecotoxicological research and scientific communication in marine sciences.



UNIVERSITÀ
POLITECNICA
DELLE MARCHE

Marche Polytechnic University, Ancona, Italy

Thomas Wernberg

Dr. Thomas Wernberg is a Danish-born marine ecologist internationally recognized for his research on kelp forests, marine climate change, and coastal ecosystem resilience. He is an Australian Research Council Laureate Fellow and Professor of Marine Botany at The University of Western Australia, where he studies the impacts of ocean warming and marine heatwaves on temperate reef ecosystems and macroalgal habitats worldwide. His work has greatly advanced the understanding of biodiversity loss and climate-driven changes in coastal marine systems.



Throughout his career, Prof. Wernberg has contributed extensively to marine conservation and climate science through international collaborations and high-impact scientific publications. He is particularly known for documenting the ecological impacts of the 2010–2011 marine heatwave in Western Australia, which caused widespread kelp forest decline, while also developing research on ecosystem restoration, kelp forest recovery, blue carbon conservation and ecosystem services from kelp forests.



University of Western Australia and Norwegian Institute of Marine Research

Vitor Vasconcelos

PhD in Biology at FCUP, Porto. Full Professor - Faculty of Sciences of Porto University and director of CIIMAR - Interdisciplinary Center of Marine and Environmental Research. Member of the Scientific Council of the Portuguese Science and Technology Foundation (FCT) – Natural and Environmental Sciences. Member of Scientific Council of the National Natural History Museum of France. Director of the Group of Blue Biotechnology and Health of CIIMAR. Main research focus on cyanobacteria secondary metabolites and their uses: toxins and molecules with biotechnological applications. Responsible for the LEGE culture collection with more than 2000 strains of cyanobacteria and microalgae. Director of the Doctoral Program in Marine Biotechnology and Aquaculture (U Porto and U Minho). Project evaluator of the Innovation Agency and various international research funding institutions.



CIIMAR and University of Porto



Programme



Session 1 - Marine Biodiversity & Ecosystem Functioning

Marine biodiversity underpins the structure, functioning, and resilience of ocean ecosystems. This session focuses on patterns and drivers of biodiversity across spatial and temporal scales, and on how biological diversity influences ecosystem processes, stability, and services. We welcome contributions addressing biodiversity from genes to ecosystems, including studies on community structure, species interactions, functional traits, trophic dynamics, habitat complexity, and shifts in species distributions and community composition in coastal, pelagic, and deep-sea systems. Empirical, experimental, and modelling approaches are encouraged, as well as long-term observations and comparative studies that improve our understanding of how biodiversity responds to and shapes ecosystem functioning under natural and human-driven change.

Session 2 - Global Change and Multiple Stressors in Ocean Health

Ocean ecosystems are increasingly exposed to complex mixtures of chemical contaminants and climate-driven stressors, posing significant risks to marine environmental health. This session focuses on marine ecotoxicology under global change, inviting contributions that examine the effects of anthropogenic stressors pollutants including emerging contaminants, and in interaction with ocean warming, acidification, deoxygenation, and other global change drivers.

We welcome studies addressing toxicological responses from molecular and cellular mechanisms to population-level consequences, including mixture effects, cumulative impacts, and non-linear stressor interactions. Contributions employing experimental, field-based, and modelling approaches are encouraged, particularly those using advanced biomonitoring tools (e.g., OMICS, biomarkers), adverse outcome pathways (AOPs), predictive modelling, machine learning, and other New Approach Methods (NAMs). Research with clear implications for environmental risk assessment, ecosystem evaluation, and evidence-based marine management is especially welcome.

Session 3 - Marine Conservation, Management & Policy

Effective conservation and sustainable management rely on strong scientific evidence and close links between science and policy. This session focuses on research supporting marine conservation planning, marine protected areas (MPAs), ecosystem-based management, restoration, and policy development in a rapidly changing ocean.

We welcome contributions addressing the design, implementation, and evaluation of conservation and management measures, including MPA effectiveness, ecosystem-based and adaptive management, cumulative impact assessment, and marine spatial planning.

Session descriptions

Studies exploring how scientific knowledge is translated into governance and decision-making at local, regional, and European scales are particularly encouraged.

Special emphasis will be given to work aligned with current European priorities, such as the Biodiversity Strategy 2030, restoration targets, and the integration of climate change into conservation and management. Contributions highlighting science–policy interfaces, stakeholder participation, and the use of advanced monitoring, modelling, and data platforms to support evidence-based governance are especially welcome.

Session 4 - Sustainable Food Production and Fisheries

Marine living resources are essential for global food security and socio-economic wellbeing. This session focuses on research supporting the sustainable production of seafood through fisheries and aquaculture, within an ecosystem-based and climate-aware management framework.

We welcome contributions addressing stock assessment, ecosystem-based fisheries management, selective and low-impact fishing technologies, bycatch and discard reduction, and the integration of environmental drivers into management models. Studies on sustainable aquaculture, including alternative feeds, integrated multi-trophic aquaculture, spatial planning for aquaculture, and mitigation of environmental impacts are particularly encouraged.

Special emphasis will be given to work aligned with current European advances, including the implementation of the Common Fisheries Policy, the use of advanced monitoring and data platforms, incorporation of socio-economic dimensions into management, and the development of low-carbon and resource-efficient seafood production systems. Contributions demonstrating how science informs adaptive, evidence-based, and participatory management are especially welcome.

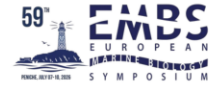
Session 5 - Blue Biotech Innovations: From Marine Biodiversity to Bioactive Solutions

Marine organisms represent an extraordinary source of novel compounds, materials, and biotechnological solutions for a wide range of applications. This session focuses particularly on marine-derived bioactive compounds for health, pharmaceuticals, and sustainable materials, as well as on innovative bioprocesses that translate marine biodiversity into high-value products. We welcome contributions to bioprospecting, natural product discovery, genome mining, metabolomics, and synthetic biology, together with studies on marine enzymes, biomaterials, biopolymers, and industrial biotechnology. Interdisciplinary approaches bridging marine biology, chemistry, biotechnology, and engineering are especially encouraged, as are contributions addressing sustainable and responsible exploitation of marine bioresources.

Session 6 - Citizen Science and Participatory Monitoring

Public participation is increasingly recognised as a central component of marine research, monitoring, and management. This session invites contributions to citizen science initiatives and participatory monitoring programmes that generate robust and policy-relevant data and foster strong links between scientists, stakeholders, and society. We welcome studies addressing co-created monitoring schemes, integration of citizen science into official monitoring frameworks, and the use of local and traditional ecological knowledge. Emphasis will be given to advances in digital tools, mobile applications, and online platforms, as well as the application of artificial intelligence for species identification and data validation, approaches to ensure data quality and uncertainty assessment, and long-term community-based monitoring. Contributions demonstrating how citizen science supports marine conservation, resource management, restoration, and policymaking are especially encouraged.

TUESDAY • 7 JULY



15:00

REGISTRATION OPENING

Registration Desk
 Reception Hall

17:00

OPENING CEREMONY

AUDITORIUM 1

WELCOME ADDRESSES

- Vice-President of the Polytechnic University of Leiria, **Pedro Assunção**
- Director of the School of Tourism and Maritime Technology (ESTM), **Sérgio Leandro**
- Directors Board of the Marine and Environmental Sciences Centre (MARE), **Maria Jorge Campos**
- President of the Portuguese Committee for the Intergovernmental Oceanographic Commission and Coordinator of the Committee for the UN Decade of Ocean Science for Sustainable Development (2021–2030), **Luís Menezes**
- Mayor of Peniche, **Filipe Sales**
- Secretary of State for Fisheries and Maritime Affairs, **Salvador Malheiro**

★ PLENARY INTERVENTION

- Prof. Dr. Mark John Costello, Director of EuroMarine and President of EMBS
Building a Stronger Marine Biology Community in Europe: The Role of EMBS and EuroMarine

18:30

ICE-BREAKER EVENT

BERLENGA ROOM

- Finger food
- Drinks
- Music
- Networking

WEDNESDAY • 8 JULY



09:00 **Thomas Wernberg** - University of Western Australia and Norwegian Institute of Marine Research
AUDITORIUM 1 Impacts of Marine Heatwaves from Species to Ecosystem Services

	AUDITORIUM 1 S1 - Marine Biodiversity & Ecosystem Functioning Chair – Bianca Reis & Paulo Maranhão	AUDITORIUM 2 S2 - Global Change and Multiple Stressors in Ocean Health Chair – Inês Morão & Juan Muñoz-Arnanz	CONFERENCE ROOM S6 - Citizen Science and Participatory Monitoring Chair – Vera Sequeira & Eirini Apazoglou
09:45	Ahmed Ali S1-OC-03 Integrating Biodiversity Occurrence Records and Sentinel-2 to Produce Macroalgae Maps Along Portugal's Coastline	Ana Rodrigo S2-OC-19 Are marine annelids adapted to pollution? Initial indications by molecular and biochemical biomarkers	
10:00	Francesca Panizzuti S1-OC-03 Integrative taxonomy of living encrusting coralline algae on columnar coralligenous bioconstructions offshore Marzamemi, Sicily	João Vitorino S1-OC-03 CYP1-like expression in an integrated biomarker approach with <i>Mytilus galloprovincialis</i> from a contaminated estuary	Jasmine Ferrario S6-OC-01 Citizen science actions in marinas to detect non-native species: "What's growing under your boat?"
10:15	Kjell Norderhaug S1-OC-19 Legacy and contemporary drivers shaping kelp forest distribution in Norway	Patrícia Cardoso S2-OC-06 Combined effects of increased temperature and PFOA exposure on two different populations (Atlantic versus Mediterranean) of <i>Mytilus galloprovincialis</i> on the fitness, bioaccumulation, and biochemical responses	Rita da Silva S6-OC-02 BioMARatona: Leveraging Citizen Science for Intertidal Biodiversity Monitoring
10:30	Marta Martins S1-OC-17 When Thermal Shifts Reshape Function in Intertidal Seaweeds	Ana Gomes S2-OC-11 Dietary strategies for enhancing the resistance of <i>Paracentrotus lividus</i> (Lamarck, 1816) to thermal stress	Chiara Bacchiani S6-PC-01 Changing seas through the eyes of recreational fishers: a participatory monitoring of marine biodiversity and ecological trends in southern Italian waters
10:35			Ana Hilário S6-PC-06 From Fishing Vessels to Data: collaborative Mapping and Monitoring of Deep-Sea Habitats in the NW Portugal
10:40			Ana Soares S6-PC-07 Seeing through fishers' eyes: revealing the presence of VME indicator species in Portugal
10:45	Luís Morais S1-PC-54 Kelp forests as blue carbon contributors along the central Portuguese coast	Gary Kett S2-PC-10 Monitoring Aquatic Ecosystem Health and Mitigating Plastic Pollution in European Rivers and Estuaries	Zeeshan Arshad S6-PC-04 Citizen Science in Maritime Supply Chain Management: A Participatory Monitoring Framework
10:50	Mar Humet S1-PC-55 Tracking the spread of the invasive kelp <i>Undaria pinnatifida</i> across Atlantic Iberia	Neus Campanyà-Llovet S2-PC-05 Habitat degradation risk in European deep seas	Inês Gregório S6-PC-05 Upskilling ECRs in deep-sea science: Boosting careers through training activities and networking
10:55	Martina Orlando-Bonaca S1-PC-11 Widespread decline of canopy-forming macroalgae along the Slovenian coastline (northern Adriatic): evidence from an expanded long-term monitoring network	João Vitorino S2-PC-11 Metabolic and oxidative stress biomarkers reflect site-specific responses of intertidal gobies to a warming gradient	

11:00 - 11:30



Coffee Break & Poster Session

	AUDITORIUM 1 S1 - Marine Conservation, Management & Policy Chair – Sílvia Lourenço & Paulo Maranhão	AUDITORIUM 2 S2 - Global Change and Multiple Stressors in Ocean Health Chair – Inês Morão & Juan Muñoz-Arnanz	CONFERENCE ROOM S3 - Marine Conservation, Management & Policy Chair – Bianca Reis & João Franco
11:30	Marta Castilla-Gavilan S1-OC-31 Linking diet, physiology and reproduction to assess the biocontrol potential of sea urchins on an invasive macroalga	Mariana Molinari S2-OC-29 Physiological and Ecological Responses to Thermal Stress in <i>Mytilus</i> along the Iberian Peninsula	Virginia Menicagli S3-OC-05 <i>Posidonia oceanica</i> beach wrack management: Benefits and drawbacks for dune plant seedlings
11:45	Valle Rodríguez S1-OC-25 Spatio-temporal variability of <i>Rugulopterix okamurai</i> beach wrack and its contribution to CO2 emissions	Paula Masiá S2-OC-27 Trophic transfer as an important pathway for microplastic contamination in corals and its potential molecular impacts	Henna Raitanen S3-OC-10 The effects of light intensity on <i>Chara tomentosa</i> thallus and rhizoid growth
12:00	André Ferreira S1-OC-11 Environmental gradients determining the distribution of intertidal organisms at small scales	Marlene Pinheiro S2-OC-15 Effects of polymetallic and sediment plumes in <i>Adreus fascicularis</i> (Porifera: Tethyida) under hyperbaric conditions: a case study for deep-sea mining	Antoine Van Oost S3-OC-16 Priming winter-dormant fragments improves attachment performance in <i>Gelidium corneum</i> restoration
12:15	João Nunes S1-OC-41 How well can large-scale atmospheric and oceanic products predict rocky intertidal temperatures?	José Seco S2-OC-22 Ice Fish's Shield: How Hemoglobin's Absence Battles Mercury in Antarctica	Alexandre Marques S3-OC-24 Evaluating green gravel as a restoration strategy for <i>Laminaria ochroleuca</i> kelp forests along the Portuguese coastline

WEDNESDAY • 8 JULY

	AUDITORIUM 1 <i>S1 - Marine Conservation, Management & Policy</i> <i>Chair – Sílvia Lourenço & Paulo Maranhão</i>	AUDITORIUM 2 <i>S2 - Global Change and Multiple Stressors in Ocean Health</i> <i>Chair – Inês Morão & Juan Arnanz</i>	CONFERENCE ROOM <i>S3 - Marine Conservation, Management & Policy</i> <i>Chair – Bianca Reis & João Franco</i>
12:30	Mar Humet S1-OC-37 Shelter from the heat: how canopy cover and microhabitats shape intertidal species richness across a Northeast Atlantic latitudinal gradient	Patrizia Stipčich S2-OC-24 Seagrass bleaching: the Mediterranean Sea as a case study	Roberto De Michele S3-OC-25 Sustaining seagrass restoration: long-term preservation of <i>Posidonia oceanica</i> seeds and seedlings
12:45	Ovidiu Popa S1-OC-43 Viral Alchemy in the Arctic: Marine Viral Functional Diversity and Host Metabolic Reprogramming in Fram Strait Waters	Vânia Amorim S2-OC-30 Spatial and seasonal distribution of PFAS in water, suspended particulate matter, and biota from the Douro and Tagus estuaries (Portugal)	Ana Lokovšek S3-PC-15 Restoring Mediterranean Macroalgal Forests: Improvement of In Situ Cultivation Methods for <i>Cystoseira</i> s.l. species
12:50			João Neto S3-PC-08 Nursery Function and Storm Resilience of a Restored Saltmarsh: a Before-After Control-Impact Study in the Mondego Estuary (Portugal)
12:55			Fergal McGrath S3-PC-02 EMODnet Seabed Habitats: EUSeaMap(2025) and Habitat Mapping Products For Policy

13:00 - 14:30

 **Lunch Break**

	AUDITORIUM 1 <i>S1 - Marine Biodiversity & Ecosystem Functioning</i> <i>Chair – Maria Jorge Campos & Filipe Costa</i>	AUDITORIUM 2 <i>S2 - Global Change and Multiple Stressors in Ocean Health</i> <i>Chair – Sara Novais & Tiago Simões</i>	CONFERENCE ROOM <i>S3 - Marine Conservation, Management & Policy</i> <i>Chair – Teresa Mouga & João Franco</i>
14:30	🔗 <u>Francesco Regoli</u> - Marche Polytechnic University, Ancona, Italy Emerging contaminants and new challenges for marine organisms		
15:15	Ana Sofia Lavrador S1-OC-38 Molecular reference data gaps for deep-sea VME indicator taxa in the Northeast Atlantic: implications for DNA-based biodiversity assessments	Alberto Ruiz S2-OC-21 Global warming and an invasive kelp species jointly accelerate carbon turnover in Northeast Atlantic	Andreu Dalmau S3-OC-07 Assessing diving pressure to support MPA management
15:30	Bastien Macé S1-OC-16 Coastal Urbanization: A Silent Architect of Marine Biotic Homogenization Revealed by Environmental DNA	Alejandro Bernal-Ibáñez S2-OC-03 A nutritional trap at the invasion front: how <i>Rugulopterix okamurae</i> dismantles herbivore resistance in Mediterranean reefs	Erika Fabbriizzi S3-OC-08 Informing Marine Protected Area networks design: the importance of ecological connectivity
15:45	Filipe Costa S1-OC-34 Cross-taxa DNA barcoding-driven insights into marine biodiversity, cryptic lineages and biogeography	Grasso Gaia S2-OC-10 Shifts in macroalgal traits and metabolic processes along a pH gradient	Inês Ribeiro S3-OC-17 Bridging gaps between Designations and Protections in MPAs in Portugal - Madeira Archipelago as a Case Study
16:00	Luís Afonso S1-OC-01 Assessing eDNA Metabarcoding Approaches for Marine Vertebrates: From Extraction to Bioinformatics	Joana Pereira S2-OC-28 Climatic and ecological drivers of the decline of a canopy-forming macroalgae	Tomás Pinheiro S3-OC-23 From Policy Objectives to Operational Indicators: A Participatory Workflow for Monitoring Marine Protected Area Networks
16:15	Rafaela Roque S1-OC-44 Hidden microbial life in marine temperate mesophotic ecosystems: structure, dynamics and functional potential	Sara D'Ambros Burchio S2-OC-05 Sunscreens in the sea: nano-TiO ₂ threatens the Mediterranean canopy-forming alga <i>Ericaria amentacea</i>	Jesús Padrón-García S3-OC-22 Towards a Marine Biological Corridor in the European Macaronesia: Status, Gaps and Conservation Synergies
16:30	Miguel Guerreiro S1-PC-56 Current and Future Distribution of Portuguese Deep Sea VMEs	Luca Rindi S2-OC-17 Beyond the Host: Host-Associated Microbiomes and Regime Shifts in Marine Macroalgal Forests	Dafni Nikisanli S3-PC-09 PAM for MPA monitoring: listening for noise pollution and illegal boat incursions
16:35	Philipp-Konrad Schätzle S1-PC-57 Development and changes in the microbial composition during seagrass decay at the southern German Baltic Sea coast		Francesca Acampa S3-PC-18 Operationalizing OECMs in Marine Spatial Planning: Evidence from Italy

WEDNESDAY • 8 JULY

	AUDITORIUM 1 S1 - Marine Biodiversity & Ecosystem Functioning <i>Chair – Maria Jorge Campos & Filipe Costa</i>	AUDITORIUM 2 S2 - Global Change and Multiple Stressors in Ocean Health <i>Chair – Sara Novais & Tiago Simões</i>	CONFERENCE ROOM S3 - Marine Conservation, Management & Policy <i>Chair – Teresa Mouga & João Franco</i>
16:40	Inês Castro S1-PC-42 Transmissible Cancer Lineages in Iberian Cockles: Assessing Regional Distribution, Coexistence and Organ Tropism		Rui Cereja S3-PC-23 CoastNet infrastructure: an environmental quality data repository to support the management of the Portuguese coastal area
16:45		Carolina Mourato S2-PC-15 Can kelp bounce back from a heatwave under ocean acidification?	
16:50		Bianca Reis S2-PC-18 Reduced thermal performance of kelp recruits under an upwelling-limited climate change scenario	
16:55		Tamara Smith S2-PC-19 Ocean warming drives dramatic shifts in the fluxes of key greenhouse gases from the mat of <i>Posidonia oceanica</i>	

17:00 - 18:30



Coffee Break & Poster Session

17:00 - 18:30

CONFERENCE ROOM

ECR Special Session

“Science with others: when,
why, should I?”

OYSTER, SII ECS & JIs INMAR

19:30 Bus from Star Inn Hotel to Dinner Venue

20:00



Conference Dinner

Notes

During Dinner

- Yellow submarine Quizz
- Open Bar and DJ until 00:30

00:30 Bus from Dinner Venue to Star Inn Hotel



QUINTA DO JUNCAL

Estrada Nacional 114, 2525-812 Serra d'El-Rei

THURSDAY • 9 JULY



AUDITORIUM 1

09:00 **Antonio Di Franco** - Stazione Zoologica Anton Dohrn, Department of Integrative Marine Ecology, Sicily Marine Centre, Italy
Marine Protected Areas as Social-Ecological Systems: Understanding When and How They Work

AUDITORIUM 1

S1 - Marine Biodiversity & Ecosystem Functioning

Chair – Sónia Cotrim & Jorge Gonçalves

09:45 **Chiara Silvestrini S1-OC-27**
 The functional footprint of small-scale fisheries on Mediterranean coralligenous reefs: selective removal of seascape ecosystem engineers

10:00 **Luca Licciardi S1-OC-15**
 Marine Animal Forests as functional engines: Biotic filtering overrides biogeographic variability in the Mediterranean

10:15 **Matteo Bolzonella S1-OC-32**
 Integrating functional and ecological traits perspective with taxonomic diversity to define marine hotspots at global scale

10:30 **Margherita Burini S1-OC-06**
 River plume-driven structuring of coastal ecosystems: pelagic and benthic responses to cumulative stressors

10:35

10:40

10:45 **José Queirós S1-PC-34**
 Sharks of the Gorging Bank: new records from deep-sea video observations

10:50 **Maria Pla Prahl S1-PC-13**
 Can rubble support reef recovery? Interactive Effects of Rubble Substrate Ecology and Submarine Groundwater Discharge on Coral Recruitment Dynamics

10:55 **Inês Ferreira S1-PC-07**
 Intertidal Biodiversity Mosaics and Thermal Heterogeneity Along the North-Western Iberian Coast

AUDITORIUM 2

S2 - Global Change and Multiple Stressors in Ocean Health

Chair – Inês Morão & Tiago Simões

Bernardo Duarte S2-OC-09
 Toxicophenomics: A New Frontier in Marine Contaminants of Emerging Concern (CECs) Mixture Toxicity Screening

Arianna Pansini S2-OC-14
 Influence of field CO₂ enrichment reveals *Zostera noltii* response to ocean acidification

Alessia Riccardi S2-OC-18
 Out of Sync? How ALAN impacts circadian regulation in *Posidonia oceanica*

Ana Silva S2-OC-23
 Standing at water edges: Ecohydrological interactions between coastal groundwater discharge and intertidal community dynamics under global change

Luísa Ramalho S2-PC-12
 Mussels as Sentinels of Coastal Pollution: Linking Microbial Load, Biochemistry, and Anthropogenic Pressure

Maria Carolina Martone S2-PC-14
 Industrial thermal effluents drive compositional shifts in epibiont assemblages associated with the invasive pearl oyster *Pinctada radiata* in the Mediterranean Sea

Maria Bordalo S2-PC-04
 CHILL project - Coastal environments in the spotlight: integrating impacts of psychoactive drugs in coastal urban ecosystems under light pollution

CONFERENCE ROOM

S4 - Sustainable Food Production and Fisheries

Chair – Sílvia Lourenço & Nuno Sales Henriques

Larissa Modica S4-OC-02
 Evolution of maturity parameters of Black-bellied anglerfish (*Lophius budegassa*) in Atlantic Iberian waters

Marco Simões S4-OC-03
 New evidence of the population structure of *Sardina pilchardus* from the Portuguese coast, obtained through microsatellites

Filipa Pinto S4-OC-01
 Copper-induced oxidative dynamics reveal the potential of *Ulva* sp. for targeted mineral biofortification

Weibo Rao S4-PC-20
 SEALNet: Shape-Enhanced Adaptive Learning for Lightweight Underwater Fish Detection and Contour Reconstruction

Carolina Mourato S4-PC-05
 Carbon fluxes in suspended shellfish aquaculture: developing an integrated metabolic assessment for bivalves and associated fouling communities

Guilherme Bueno S4-PC-11
 Sustainable Feed for Circular Aquaculture: Microencapsulated Phytase for Reducing Phosphorus Discharge

Jorge Moutinho S4-PC-06
 Metabarcoding-based assessment of marine macrozoobenthos in an offshore Integrated Multi-Trophic Aquaculture (IMTA) system in Southern Portugal

Sílvia Lourenço S4-PC-01
 Impact of marine heatwave on the condition and quality of *Magallana gigas* (Thunberg, 1793) oysters

Lara Weber S4-PC-16
 Influence of cold stress on pigment composition and physiological parameters in *Cassiopea xamachana*

11:00 - 11:30



Coffee Break & Poster Session

AUDITORIUM 1

S1 - Marine Biodiversity & Ecosystem Functioning

Chair – Sónia Cotrim & Jorge Gonçalves

11:30 **Soraia Vieira S1-OC-29**
 Integrating benthic nematode and bacterial communities to assess spatial-temporal dynamics and ecosystem functioning in estuarine sediments

11:45 **Teresa Ferreira S1-OC-12**
 Unravelling megabenthic communities in cold-water coral mounds of the Angola Margin (SE Atlantic)

12:00 **Sofia Ramalho S1-OC-35**
 Thriving benthic communities sustained by complex seafloor and ocean circulation beneath an Antarctic ice shelf

12:15 **João Silva S1-PC-58**
 Light matters: evaluating trap design and illumination for sampling larval assemblages in kelp forests

AUDITORIUM 2

S2 - Global Change and Multiple Stressors in Ocean Health

Chair – Inês Morão & Tiago Simões

Marcos Rubal S2-OC-20
Nucella lapillus in the Atlantic shores of the Iberian Peninsula. Range shifts, changes in reproductive pattern and maybe a refuge

Inês Pires S2-OC-16
 Benthic communities and their environmental drivers in the Tagus estuary: 20 years of change

Fernando Lima S2-OC-12
 CCTBON: Temperature and biodiversity monitoring on rocky shores across the entire Atlantic Ocean

Gabriela Oliveira S2-OC-13
 Integrating ecological modelling approaches in the digital twin of the Ocean

CONFERENCE ROOM

S5 - Blue Biotech Innovations: From Marine Biodiversity to Bioactive Solutions

Chair – Susana Silva & Vítor Vasconcelos

Mariana Almeida S5-OC-01
 Marine biopolymers: linking biodiversity and innovation

Francisco Ewerton Lima S5-OC-10
 Biological and biochemical activity of the R-Phycocyanin and iota-carrageenan extracted in sequence from *Solieria filiformis* biomass cultivated in Ceará, Brazil

Isabel Abreu S5-OC-07
 Marine Macroalgae as a Source of Neuroprotective Agents: The Role of Sphaerococcon A Analogues

Inês Novo S5-OC-12
 Extraction of Functional and Colouring Compounds from Brown Macroalgae for Textile Applications

THURSDAY • 9 JULY



AUDITORIUM 1	AUDITORIUM 2	CONFERENCE ROOM
	S2 - Global Change and Multiple Stressors in Ocean Health <i>Chair – Inês Morão & Tiago Simões</i>	S5 - Blue Biotech Innovations: From Marine Biodiversity to Bioactive Solutions <i>Chair – Susana Silva & Vítor Vasconcelos</i>
12:30	Julio Donfack S2-PC-24 Impact of aerosols on chlorophyll-a distribution in the Arabian Sea using multi-satellite observations	Francisca Soledade S5-OC-16 Marine-derived compounds: a promising source of novel neuroprotective agents for Parkinson's Disease
12:45		João Andrade S5-PC-18 Temporal bioactivity shifts in a brown alga: the case of <i>Bifurcaria bifurcata</i>
12:50		David Leitão-Silva S5-PC-17 An investigation on the pigments in the sea star (Asteroidea) <i>Astropecten aranciacus</i>
12:55		Filipa Sampaio S5-PC-19 Cellulose extraction from the brown algae <i>Rugulopteryx okamurae</i> for textile applications

13:00 - 14:30

Lunch Break

AUDITORIUM 1	AUDITORIUM 2	CONFERENCE ROOM
S1 - Marine Biodiversity & Ecosystem Functioning <i>Chair – Sílvia Lourenço & Paulo Maranhão</i>	S3 - Marine Conservation, Management & Policy <i>Chair – Sónia Cotrim & Filipe Costa</i>	S5 - Blue Biotech Innovations: From Marine Biodiversity to Bioactive Solutions <i>Chair – Ana Augusto & Celso Alves</i>
14:30	Anna Piwoni-Piórewicz S1-OC-23 Towards better understanding and predicting of <i>Calanus</i> patchiness using both marine and atmospheric drivers	Luísa Pacheco S5-OC-14 Process Optimisation in Algae-Derived Textile Dyeing: Improving Colour Fixation and Functional Performan
14:45	Blondine Agus S1-OC-02 Age estimation of the European flying squid <i>Todarodes sagittatus</i> in the Central Mediterranean Sea	Miguel Oliveira S5-OC-13 Blue biotechnology meets nanomaterials: green synthesis of silver nanoparticles for biomedical applications
15:00	Camila Soto S1-OC-04 Alginate utilization drives variations in bacterial community dynamics in coastal ecosystems	Inês Cabral S5-OC-05 Bridging marine annelid regeneration and biomedical applications by integrating transcriptomics and histopathology
15:15	Emily Peterson S1-OC-22 Comparative physiological response of native and nonnative Northern European bivalve species to temperature and seston composition	
15:30	Héliaz Le Bayon S1-OC-39 When reproduction meets infection: <i>Perkinsus olseni</i> in Manila clams	
15:45	Małgorzata Dembek S1-OC-08 Linking trophic ecology and larval condition in Baltic herring using CSIA-AA and RNA:DNA ratios	
16:00	Paulina Filz S1-OC-13 Bright and dark spots after the heatwave: shifting fish contributions to Nature and People on temperate reefs	
16:15	Neil Cook S1-OC-07 Dolphin Diet Detectives: Unveiling Dolphin Diets and Engaging Communities in Cardigan Bay, West Wales, UK	

Special Session

"Algae as Nature-Based Solutions for the EU Green and Blue Transitions"

Celso Alves, APAA

Mariana Almeida, CESAM

Alberto Reis, LNEG

Vítor Vasconcelos, CIIMAR

Teresa Mouga, MARE/IPLeiria

Jan Verbeek, Seaforester

THURSDAY • 9 JULY



AUDITORIUM 1

16:30

16:35

AUDITORIUM 2

S3 - Marine Conservation,
Management & Policy

Chair – Sónia Cotrim & Filipe Costa

Morane Clavel-Henry S3-PC-01

Joint disciplinary and cross-sectoral efforts to enhance Norway lobster protection, promote stock recovery, and ensure sustainable fisheries within an ecosystem-based management framework

Sara Araújo S3-PC-21

AURORA Shiny App – Converting Raw Biodiversity Data into Darwin Core Archives

CONFERENCE ROOM

Special Session

**“Algae as Nature-Based
Solutions for the EU Green
and Blue Transitions”**

Celso Alves, APAA

Mariana Almeida, CESAM

Alberto Reis, LNEG

Vitor Vasconcelos, CIIMAR

Teresa Mouga, MARE/IPLeiria

Jan Verbeek, Seaforester

17:00 - 18:15



Coffee Break & Poster Session

18:15 Bus from ESTM to the Sunset Party Venue

18:30 - 20:30



Sunset Party

Notes

18:30 Sunset Party

Danau Beach Bar

Finger Food and Drinks until 20:30

21:00 Bus from Sunset Venue to Star Inn Hotel



DANAU Beach Bar

Baleal, Largo da Praia, 2520-001 Ferrel

Friday • 10 JULY

AUDITORIUM 1

- 09:00  **Vítor Vasconcelos** - CIIMAR and University of Porto
Cyanobacteria bioactive molecules: from culture collections to metagenomics

AUDITORIUM 1

09:45

10:00

10:15

10:30

10:45

AUDITORIUM 2

S3 - Marine Conservation, Management & Policy
 Chair – Susana Mendes & Sérgio Leandro

Daniel Sequeira S3-OC-06
 Floating offshore wind farms: A SWOT analysis of its implementation on the Portuguese coast

Miguel Pinto S3-OC-09
 Incorporating seasonality influences climate change vulnerability estimation of marine species

Miguel Fernandes S3-OC-20
 Integrating Climate Risk and Vulnerability into Marine Spatial Planning: Insights from the Portuguese Case Study

Ana Luísa Machado S3-OC-14
 Open occurrence data to reveal monitoring gaps and distribution signals for Habitats Directive marine mammals in Europe

Laura Trovão S3-OC-18
 From willingness to pay to willingness to act: bridging governance gaps in deep-sea restoration

CONFERENCE ROOM

S3 – Blue Biotech Innovations: From Marine Biodiversity to Bioactive Solutions
 Chair – Carina Félix & Rui Pedrosa

Bruno Fonseca S5-OC-09
 Neuroprotective Potential of Sphaerococcenol A and Its Derivatives against Parkinson's Disease: Integrated in silico and in vitro evaluation

Roberto De Michele S5-OC-02
 Microbial Life Inside Posidonia Seeds: Beneficial Endophytes and Implications for Marine Plant Health

Andrea Lopez-Mobilia S5-OC-11
 Exploring Coral-Associated Bacteria as a Source of Novel Bioactive Compounds for Blue Biotechnology

Catarina Faustino S5-OC-03
 The anatomy and biochemistry of squid's camouflage and its biotechnological value

Cátia Gonçalves S5-OC-17
 The venomous saliva of cephalopods: A deep dive into its biotechnological potential

11:00 - 11:30



Coffee Break & Poster Session

11:30



Closing Session & Award Ceremony

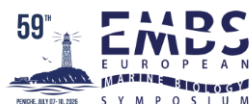
AUDITORIUM 1

- Closing remarks
- Best Oral Presentation Award
- Best Poster Presentation Award
- Farewell

13:00



Lunch Box



SCIENCE WITH OTHERS: WHEN, WHY AND HOW?

59th EMBS Special Session Organised by OYSTER, SII ECS, JIS INMAR

Hosted by ECR Networks: SII ECS, OYSTER, JIS INMAR

Description: Scientific collaboration is key to strengthening research and supporting career development, but it also comes with its own challenges. This interactive session will explore the networking challenges researchers face at different stages of their careers, provide guidance on career pathways and opportunities, and highlight the importance of mentorship in professional growth. Moderated by three ECR Networks, the discussion will bring together insights, shared experiences, and practical advice to help participants build meaningful collaborations and expand their professional networks. **Come and join us!**

Registration: Limited on-site spots available.

Date: 8th July 2026

Start time: 17:00 to 18:30 CET

Location: Escola Superior de Turismo e Tecnologia do Mar | School of Tourism and Maritime Technology
Politécnico de Leiria | Polytechnic of Leiria
Campus 4 - Rua do Conhecimento, n.º 4
2520-614 Peniche – PORTUGAL

Programme:

Time	Description
16:45 – 17:00	Arrival & Welcome
17:00 - 17:05	Live Slido: Participant Backgrounds and Views
17:05 – 17:20	Meet the Networks: OYSTER, ICES SII ECS and JIS INMAR
17:20 – 17:50	Thematic Roundtables: Challenges, Opportunities and Collaboration Needs
17:50 – 18:05	Interactive Gallery Walk
18:05 – 18:25	Plenary Exchange: Shared Insights and Open Discussion
18:25 – 18:30	Key Takeaways, Next Steps and Collaboration Pathways
20:00 – 24:30	(19:30 Bus from Star Inn Hotel to Dinner Venue) 59 th EMBS Social Dinner QUINTA DO JUNCAL Address: Estrada Nacional 114, 2525-812 Serra d'El-Rei



SPECIAL SESSION

15:30 - 17:00 | 9 julho

Algae as Nature-Based Solutions for the EU Green and Blue Transitions

Associação Portuguesa de Algologia Aplicada



#AgaePT #APAA



PROGRAMME

15:30

Associação Portuguesa de Algologia Aplicada

Celso Alves, APAA

15:40

**European Blue Bioeconomy and the Algae Sector:
Research, Innovation, and Opportunities**

Mariana Almeida, UA

16:00 - 17:00

PANEL DISCUSSION

Moderator: Alberto Reis, LNEG

Vitor Vasconcelos, CIIMAR

Teresa Mouga, MARE/IPLeiria

Mariana Almeida, UA

Jan Verbeek, Seaforester



Oral Communications



Wednesday, 8th July

Session 1 - Marine Biodiversity & Ecosystem Functioning

Integrating Biodiversity Occurrence Records and Sentinel-2 to Produce Macroalgae Maps Along Portugal's Coastline (S1-OC-03)

Ahmed Ali^{1,2,*}, Isabel Sousa Pinto^{1,2}, Patrizio Mariani³, Cesar Capinha⁴

¹ CIIMAR/CIMAR LA, Interdisciplinary Centre of Marine and Environmental Research, University of Porto, Portugal

² Faculty of Sciences, University of Porto, Portugal

³ National Institute of Aquatic Resources, Denmark.

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Climate-driven changes in coastal ecosystems increase the need for scalable and repeatable approaches to monitor benthic macroalgae distributions. Traditional monitoring based on field surveys or UAV mapping provides valuable local information but is often resource-intensive and difficult to extend to regional scales. This study presents an end-to-end, reproducible pipeline that fuses professional and citizen-contributed occurrence records (GBIF, OBIS, iNaturalist), seabed substrate priors and high-resolution Sentinel-2 surface reflectance to map macroalgae along the Portuguese coastline. We curated and filtered ~1,900 occurrence records to build the training dataset and generated non-vegetation samples using indicator-species locations, NDVI thresholds and substrate masks. Sentinel-2 surface reflectance was extracted around each observation date under cloud-aware constraints, and a set of aquatic vegetation indices and fixed environmental predictors was computed. VIF filtering reduced multicollinearity, and PCA retained the first six components, which together with the fixed predictors were used in a Random Forest classifier (200 trees). Model robustness was quantified via Monte-Carlo cross-validation (10 repeats of randomized train/test splits) and further validated against independent in-house CIIMAR field observations. Results showed strong discrimination between macroalgae and non-macroalgae, with MCCV median Overall Accuracy of 0.91 and median Kappa of 0.83. The proposed workflow provides a scalable and reproducible framework for integrating biodiversity occurrence databases with satellite remote sensing to support large-scale coastal vegetation monitoring.

Integrative taxonomy of living encrusting coralline algae on columnar coralligenous bioconstructions offshore Marzamemi, Sicily (S1-OC-21)

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Mediterranean coralligenous bioconstructions represent hotspots of biodiversity and play key ecological roles in rocky reef systems, yet many of their components, particularly calcareous algae, remain poorly characterized at the species level. In this study, we focus on the living encrusting coralline algae covering three columnar coralligenous constructions collected by scuba divers offshore Marzamemi, Sicily, along a depth gradient from approximately 35 to 95 meters. The coralligenous bioconstructions are part of a broader field of discrete columnar structures distributed along the Hyblean Plateau, a geologically complex sector of the African foreland, which was mapped during the “CresciBluReef: New technologies for knowledge and conservation of Mediterranean reefs” project. This project produced a 17 km² high-resolution bathymetric map using a R2Sonic 2022 multibeam echosounder, ground-truthed by ROV observations, allowing precise selection of coralligenous samples. The sampled columns were covered by dense canopies of fleshy algae and colonies of erect bryozoans, which were manually removed before processing. For taxonomic identification, we combined molecular analyses targeting the *rbcL* and *psbA* genes with detailed morphological characterization using scanning electron microscopy, aiming to apply an integrative taxonomy approach to describe the living encrusting coralline algae communities. While the phylogenetic analyses are ongoing, preliminary observations indicate high diversity and variable dominance of coralline taxa along the depth gradient. These findings contribute to a better understanding of the biodiversity of Mediterranean coralligenous bioconstructions and provide baseline information that can inform conservation strategies. By integrating molecular and morphological data, this work highlights the importance of detailed species-level studies in revealing cryptic diversity and

understanding ecological processes shaping coralligenous communities. Ultimately, this study underscores the role of coralligenous bioconstructions as biodiversity reservoirs in Mediterranean reefs and demonstrates how targeted sampling combined with integrative taxonomy can support both fundamental research and applied conservation efforts.

Legacy and contemporary drivers shaping kelp forest distribution in Norway (S1-OC-19)

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Kelp forests along the Norwegian coast have undergone shifts in distribution during the last 6 decades with large impacts on coastal diversity and production. Fishery driven predator release of the main grazer, the sea urchin *Strongylocentrotus droebachiensis*, resulted in overgrazing of 5 000 km² kelp forests in the 1970s. Dense urchin populations persists in the northern part of this barren ground area, but in the southern part sea urchins are retreating and kelp recovering. It has been suggested that this shift is related to gradual warming or expansion of predatory crabs. Here we present data showing a spatial shift in the dominant constraints on urchin persistence, demonstrating that life-stage- and latitude-specific mechanisms can decouple recruitment from adult population persistence, with consequences for species range dynamics and kelp forest resilience. In a system where the legacy of overfishing is still evident, climate suitability alone does not predict population persistence when dominant constraints shift across life stages and space.

When Thermal Shifts Reshape Function in Intertidal Seaweeds (S1-OC-17)

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Climate-driven changes are reshaping marine communities worldwide, yet its functional consequences for intertidal macroalgae remain poorly resolved. We investigated temporal trends in community thermal affinity and functional trait composition of low intertidal macroalgae assemblages along the northern Portuguese coast over seven years spanning more than one decade (2006–2008, 2021–2024). Although mean Community Thermal Index (CTI) remained relatively stable, substantial community turnover occurred. This was driven primarily by abundance changes in cold-affinity species, with deborealization and borealization emerging as the dominant processes structuring thermal composition. Furthermore, we demonstrate pronounced temporal shifts in functional traits, including pigmentation, morphology, reproductive mode and structural complexity. Analyses of functional redundancy and originality showed that foundation species disproportionately shape community functional structure. More specifically, *Laminaria ochroleuca* exhibited high functional originality but low redundancy, indicating potential vulnerability to abundance declines. Community turnover, including the emergence of invasive species like *Asparagopsis armata*, further illustrates dynamic restructuring of functional space. Together, these results indicate that, despite apparent thermal stability, intertidal macroalgae communities are undergoing functional reorganization, with potential consequences for productivity, habitat complexity, and blue carbon capacity. Conserving functionally original and habitat-forming species is therefore critical for maintaining ecosystem resilience in the face of climate change.

Linking diet, physiology and reproduction to assess the biocontrol potential of sea urchins on an invasive macroalga (S1-OC-31)

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Marine macroalgal invasions are major drivers of ecological change in coastal ecosystems. In the Mediterranean Sea, the invasive brown alga *Rugulopteryx okamurae* has rapidly expanded, yet its interactions with native herbivores remain poorly understood. The sea urchin *Paracentrotus lividus* is a key grazer and potential biocontrol agent, but it is unclear whether this alga can sustain its populations over time. We evaluated the effects of diets with increasing proportions of *R. okamurae* and/or *Ulva* sp. (0%, 25%, 50%, 75% and 100% *R. okamurae*) on ingestion, metabolism, behaviour, and reproductive condition of *P. lividus* over three months. Sea urchins consistently consumed more *Ulva* sp. than *R. okamurae*, although ingestion of both algae increased over time, indicating progressive acceptance of the invasive alga. Physiological condition declined when diets contained more than 50% *R. okamurae*, as shown by reduced metabolic rates and alterations in coelomic fluid parameters. However, oxygen consumption was strongly correlated with ingestion, suggesting that this effect was primarily driven by reduced food intake rather than direct toxicity. At $\leq 50\%$ inclusion, these effects were mitigated and no adverse responses were observed. Similarly, gonadal development increased over time only in diets containing $\leq 50\%$ *R. okamurae*, while higher inclusion levels impaired this response and maintained individuals in immature stages. In contrast, no diet effects were detected on righting or sheltering behaviour, indicating maintained functional performance. Overall, although *P. lividus* shows some capacity to incorporate *R. okamurae* into its diet, high proportions of the alga impair physiological and reproductive performance. These results confirm that its efficiency as a biological control agent is likely limited under high algal dominance, while the presence of alternative resources such as *Ulva* sp. may buffer these effects.

Spatio-temporal variability of *Rugulopteryx okamurae* beach wrack and its contribution to CO₂ emissions (S1-OC-25)

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The proliferation of *Rugulopteryx okamurae* along the SW Iberian coast has led to recurrent accumulations of beach-cast wrack, creating highly active zones of carbon release. This study examines the spatio-temporal variability of wrack biomass and

associated CO₂ emissions across sandy beaches in Cádiz over a three-year period (2023–2026), combining seasonal surveys with high-resolution monthly monitoring. Wrack biomass showed strong spatial and temporal variability, ranging from ~1 to >30 kg m⁻² and reaching maxima up to 11.97 t m⁻¹, with significant differences among beaches and years. Intertidal biomass remained relatively consistent among sites, whereas total biomass differed markedly, reflecting variability in beach width and accumulation patterns. CO₂ emissions varied significantly across beach zones ($p < 0.001$), with highest mean values in the lower shore (~40 $\mu\text{mol m}^{-2} \text{s}^{-1}$) and extreme peaks exceeding 290 $\mu\text{mol m}^{-2} \text{s}^{-1}$. Emissions displayed pronounced temporal variability, peaking in 2024 (~45 $\mu\text{mol m}^{-2} \text{s}^{-1}$), and showed substantial within-beach heterogeneity linked to wrack position and condition. CO₂ fluxes were positively correlated with biomass ($p = 0.48$) and wrack thickness ($p = 0.39$; $p < 0.001$), although maxima did not always coincide with highest biomass values. Linear models explained up to ~49% of the variance and identified wrack thickness, time, pressure and beach zone as key predictors, with thickness emerging as the strongest driver. These results indicate that metabolic activity in wrack deposits is largely controlled by decomposition stage and microenvironmental conditions rather than biomass alone. Consequently, invasive wrack accumulations act as dynamic and significant CO₂ sources, highlighting their importance in coastal carbon budgets and the need for management strategies aimed at minimizing greenhouse gas emissions from beach-cast biomass.

Environmental gradients determining the distribution of intertidal organisms at small scales (S1-OC-11)

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Rocky intertidal ecosystems are exposed to strong thermal and hydrodynamic variability driven by tidal cycles. Small-scale differences in surface orientation and inclination create pronounced microclimatic heterogeneity, potentially shaping the distribution of sessile invertebrates. During emersion, organisms experience rapid fluctuations in temperature and wave action, frequently operating near their physiological limits. This study aims to determine how centimetre-scale environmental gradients influence the spatial distribution of sessile species, and whether surface

orientation (north- vs south-facing) and inclination drive differences in presence and abundance. Sixty 25×25 cm permanent quadrats were established on three rocky shores along the northwestern Portuguese coast, equally distributed between south- and north-facing surfaces with a $45 \pm 10^\circ$ inclination. Quadrat vertices were permanently marked with screws and a numbered washer. Each quadrat was also equipped with temperature or temperate and pressure loggers that recorded hourly data. High-resolution images of each quadrat were collected monthly and processed using organism detection tools, enabling the identification of organisms and the quantification of their abundances. Downloaded thermal profiles were analysed in R to determine the precise thermal conditions experienced by organisms inhabiting each quadrat. Temporal analyses revealed clear variability in biological cover at the quadrat scale across all shores and over time. Monthly changes were heterogeneous, with some quadrats exhibiting marked shifts while others remaining relatively stable. Barnacles displayed the greatest variability in class-level analyses. Analysis of thermal profiles revealed pronounced thermal heterogeneity between orientations, with south-facing surfaces displaying higher potential for thermal stress. Our preliminary results show that topographic complexity drives biodiversity patterns even at the centimetre scale. Furthermore, we show that biological cover also changes over small temporal scales, with significant removal and colonization events identified across many quadrats and shores. These findings highlight the importance of considering small-scale dynamics when studying the effects of thermal stress in intertidal communities.

How well can large-scale atmospheric and oceanic products predict rocky intertidal temperatures? (S1-OC-41)

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With temperature records being routinely broken, monitoring temperature variability is essential for understanding its effects on biodiversity. Despite significant progress in remote sensing technologies and the emergence of satellite platforms and atmospheric reanalysis products, there is a clear mismatch between the scale at which climate data are usually collected and modelled and the fine-scale conditions that organisms experience across their habitats. This mismatch is perhaps nowhere more evident than in intertidal systems, which represent some of the most thermally heterogeneous environments on Earth. Here, we evaluate how effectively large-scale environmental

datasets capture the temperature profiles in the Iberian intertidal zone. High-frequency *in situ* temperature data from autonomous loggers deployed across 70 sites were compared against traditional gridded sea surface temperatures (OISST) and atmospheric reanalysis models (ERA5). Regional upwelling dynamics and extreme thermal events were also quantified for two locations with contrasting environments (Moledo and Testada) to evaluate the detection ability of gridded products. Results reveal discrepancies between gridded datasets and *in situ* observations, especially throughout summer. During atmospheric exposure periods, reanalysis datasets compressed the daily thermal amplitude. When evaluated against defined thresholds (90th percentile, >33.8°C), ERA5 failed to capture the range of thermal variation, with high rates of missing events and overestimation of the number and duration of thermal stress periods. During submerged intervals, coastal OISST exhibited a weak response to wind forcing and Ekman transport, and a limited detection of nearshore cooling events. In contrast, water temperatures from logger data revealed well-defined cooling patterns following wind-driven upwelling, larger temperature fluctuations, and stronger wind-temperature coupling. Although gridded products are important for characterizing broad-scale environmental patterns, their spatio-temporal resolution limits the capacity to capture the full magnitude and timing of thermal exposure in intertidal habitats, particularly in regions of intense upwelling. Evaluating coastal climate impacts solely based on these datasets, without *in situ* references, may lead to a significant underestimation of thermal stress for coastal species.

Shelter from the heat: how canopy cover and microhabitats shape intertidal species richness across a Northeast Atlantic latitudinal gradient (S1-OC-37)

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Rocky intertidal ecosystems are characterised by strong microhabitat variability and temperature fluctuations, where canopy-forming macroalgae and modulate environmental conditions through the amelioration of thermal stress. While these species are often recognized as ecosystem engineers or foundation species, the magnitude of their ecological functions, such as thermal buffering and habitat provisioning have been rarely compared across broad latitudinal scales. Moreover, their effects are rarely assessed relative to other local environmental drivers, such as tidal height and microhabitats created by different sun exposures on the shore. Hence, here we investigated the role of the canopy-forming furoid, *Ascophyllum nodosum* in modulating microhabitat temperature and species richness along a 28° latitudinal gradient in the Northeast Atlantic, from the southern to near the northern limits of its distribution. We established a field experiment across three regions (six sites) comparing intact canopies with removal plots regularly cleared of regrowth every 2–3 months between 2024 and 2025. These plots were established at two shore heights and at two microhabitats (sun-exposed - hot and shaded -cold). Temperature was recorded every 30 minutes while biodiversity surveys were performed in each visit. This allowed us to evaluate how canopy presence, microhabitat, and tidal level shape community structure across this range. Our results show clear differences in community composition and species richness across regions along the latitudinal gradient. Crucially, canopy presence increased local species richness by 22–46% across regions and reduced maximum microhabitat temperatures by up to 3.4 °C compared to removal plots, emerging as the dominant driver of thermal buffering. These effects were strongest under high solar exposure and at higher shore levels, and decreased in magnitude from southern to northern regions along the latitudinal gradient. Overall, these results demonstrate that local-scale factors shape biodiversity, with the canopy-forming furoid *Ascophyllum nodosum* emerging as the dominant driver of both microhabitat temperature and species richness. This highlights its critical role in mitigating thermal stress, particularly in warmer regions. These findings underscore the importance of *Fucales* in buffering climate change impacts and their key role in the conservation of intertidal biodiversity.

Viral Alchemy in the Arctic: Marine Viral Functional Diversity and Host Metabolic Reprogramming in Fram Strait Waters (S1-OC-43)

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Arctic marine viruses are important regulators of microbial mortality, food-web connectivity, and biogeochemical cycling, yet their functional diversity and ecological roles remain insufficiently resolved. In this study, we investigated viral community composition and auxiliary metabolic potential in Fram Strait waters using a combined metagenomic and virome-based approach. Seawater samples from the Hausgarten long-term ecological research region were processed using complementary size-fractionation and FeCl₃ flocculation workflows to improve recovery of free viral particles and host-associated viral signatures. Across all recovery strategies, 31,761 raw viral contigs were detected, with the FeCl₃-enriched virome yielding the highest number of viral discoveries. Notably, only the FeCl₃-derived virome recovered viral contigs below the deep chlorophyll maximum, indicating that targeted viral concentration substantially improves access to deeper-water free-virus diversity. In parallel, multi-fraction sampling revealed viral assemblages that would have remained poorly represented in conventional cellular metagenomes alone, highlighting the value of combining ecological compartments in Arctic virome studies. Taxonomically, the dataset was dominated by Caudoviricetes, while functionally it contained diverse auxiliary metabolic genes, including 2OG-Fe(II) oxygenases, glycosyltransferases, and ribosomal proteins. These genes suggest that Arctic viruses may reprogram host metabolism during infection, supporting energy optimization, stress responses, and viral replication. Together, the results support a model in which Arctic marine viromes are both taxonomically complex and functionally consequential, contributing to top-down host control, metabolic reprogramming, and ecosystem-level modulation of carbon and nutrient flow under ongoing environmental change.

Molecular reference data gaps for deep-sea VME indicator taxa in the Northeast Atlantic: implications for DNA-based biodiversity assessments (S1-OC-38)

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Environmental DNA (eDNA) metabarcoding is increasingly used to assess and monitor marine biodiversity due to its time- and cost-effectiveness, but its performance depends strongly on the completeness of reference data available for the target taxa. Here, we evaluated the public data of the most commonly used barcode markers for coral and sponge Vulnerable Marine Ecosystems (VME) indicators from the Northeast Atlantic. Target taxa were derived from the most recent VME indicator list published by the International Council for the Exploration of the Sea (ICES), which exhibits variable taxonomic resolution. Taxa were expanded to accepted species known to occur in the Northeast Atlantic based on OBIS and GBIF records. For the final list of 191 species, reference data coverage was assessed in GenBank and BOLD for six target markers (COI, 16S, 18S, 28S, ITS and MutS) using synonym-aware queries. Of these, 115 species (60.2%) had sequence data in at least one database, while 76 (39.8%) lacked any reference coverage. COI was the best represented marker (102 species; 53.4%), followed by 28S (58; 30.4%) and MutS (57; 29.8%- only present in corals), whereas 18S (43; 22.5%), 16S (39; 20.4%) and ITS (29; 15.2%) were less represented. Overall sequence coverage was similar in Cnidaria (59.6%) and Porifera (61.8%), but marker representation differed strongly between phyla: in Cnidaria, the best represented markers were COI, MutS and 16S, whereas in Porifera they were COI, 28S and 18S. GenBank dominated reference availability, covering 112 species (58.6%) versus 42 (22.0%) in BOLD, with only three species uniquely represented in BOLD. These results reveal substantial and uneven reference gaps that currently limit the robustness of eDNA-based assessments of deep-sea VMEs in the Northeast Atlantic. Our findings also provide a clear, evidence-based framework for prioritising future sequencing efforts across both taxa and genetic markers.

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Coastal Urbanization: A Silent Architect of Marine Biotic Homogenization Revealed by Environmental DNA (S1-OC-16)

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Urbanization is rapidly expanding along the world's coasts, transforming natural ecosystems into increasingly uniform artificial environments. Yet, the patterns and processes shaping marine biodiversity under urban pressure remain poorly understood. We investigated whether coastal urbanization drives marine communities toward greater similarity – a process well documented in terrestrial and freshwater systems as urban biotic homogenization but rarely examined in the sea. We analyzed fish communities from seawater environmental DNA samples collected across Mediterranean seaports and less urbanized coastal sites, covering a continuous gradient of urban pressure. Seaports exhibited higher local but lower regional species richness, revealing an apparent paradox where local biodiversity hotspots become coldspots at the regional scale. This pattern reflected a shift toward more homogeneous communities in urbanized seascapes and emerged in the absence of non-indigenous species, which are commonly invoked as the main drivers of biotic homogenization. Instead, homogenization was primarily driven by increased occupancy of disturbance-tolerant native taxa inside seaports. Homogenization was evident at both taxonomic and phylogenetic levels, indicating that disturbance-tolerant taxa are phylogenetically clustered. Outside seaports, community resemblance to seaport communities was driven by urban pressure rather than distance to the nearest seaport, indicating that urbanization structures communities beyond seaport boundaries. Overall, urban pressure emerged as the dominant driver of community similarity, exceeding spatial and environmental predictors. Together, these results show that biotic homogenization in marine ecosystems can emerge from urban filtering of native species, independently of biological invasions. Coastal urbanization is thus revealed as a fundamental and underappreciated architect of marine biodiversity reorganization, extending the Homogenocene concept to the sea.

Cross-taxa DNA barcoding-driven insights into marine biodiversity, cryptic lineages and biogeography (S1-OC-34)

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More than two decades after DNA barcoding was first proposed, cytochrome oxidase I (COI) data now provide an unprecedented resource for assessing marine biodiversity at broad taxonomic scales. Here, we examine the potential of COI barcodes to reveal cryptic diversity, genetic structure, and biogeographic patterns across three major marine groups: two invertebrate assemblages, one with direct development (Peracarida) and one with planktonic larval stages (Polychaeta), and a vertebrate dataset from eastern Atlantic fishes. Public COI barcode records were retrieved from BOLD, curated using BAGS, and clustered into molecular operational taxonomic units (MOTUs) using Barcode Index Numbers (BINs). Across the three groups, the number of MOTUs exceeded the number of morphospecies by 22–28%: Peracarida included 571 species from 109 families and 797 MOTUs, Polychaeta 972 species from 61 families and 1,370 MOTUs, and fishes 1,225 species from 269 families and 1,716 MOTUs. Between 13% and 15% of morphospecies in each group were split into two MOTUs, and a relatively small number of morphospecies accounted for a substantial share of the excess MOTUs. A notable portion of conspecific MOTUs were also geographically structured. Together, these patterns indicate that COI barcode-delimited MOTUs generally capture biologically meaningful species and intraspecies-level diversity in marine taxa. Our results reveal substantial cryptic diversity across marine organisms with distinct dispersal strategies and suggest that species with broad geographic distributions may be less common in the marine environments than often assumed. They show that taxa can remain spatially segregated even in the absence of obvious dispersal barriers. Large COI datasets can expose biogeographic hotspots of endemism, as demonstrated by the oceanic islands of Macaronesia. Overall, DNA barcoding is proving to be a powerful framework for detecting hidden diversity and refining our understanding of marine biogeography, with important implications for biodiversity assessment, conservation, and management.

Assessing eDNA Metabarcoding Approaches for Marine Vertebrates: From Extraction to Bioinformatics (S1-OC-01)

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Environmental DNA (eDNA) metabarcoding is being increasingly used for marine biodiversity monitoring, yet methodological variation can influence detection outcomes and limit comparability among studies. Developing robust, standardized, and accessible protocols is therefore essential. Here we evaluated key stages of the marine vertebrate eDNA metabarcoding workflow, including extraction strategies, PCR polymerase choice, and bioinformatic processing of high-throughput sequencing data. Two extraction approaches were compared: the standard DNeasy PowerWater Sterivex protocol and a modified protocol including bead-beating homogenization of filter material out of the Sterivex cartridge. Recovery of free extracellular DNA (f-exDNA) was also assessed using controlled seawater samples spiked with common dolphin DNA. In addition, we evaluated two DNA polymerases differing in their proofreading capacity using both mock communities and environmental samples. Direct extraction from intact Sterivex filters produced higher DNA concentrations and greater amplicon sequence variant richness, although both extraction approaches recovered comparable marine vertebrate diversity. Recovery of f-exDNA remained low under the tested conditions. Polymerase choice influenced taxonomic detection patterns in mock communities: the proofreading enzyme enhanced amplification of fish taxa, whereas the non-proofreading polymerase generated a higher number of cetacean reads relative to fish, suggesting a cost-effective alternative for marine mammal monitoring programmes. Moreover, re-sequencing of identical eDNA extracts produced partially distinct species profiles despite identical amplification protocols, reflecting stochasticity inherent to metabarcoding workflows. To support reproducible analysis, we developed the Marine Vertebrate eDNA Metabarcoding pipeline (MVeM), an open-source workflow integrating stringent Illumina sequence filtering, bit score-based BLAST taxonomic assignment with a Lowest Common Ancestor approach to resolve matching conflicts, geographic exclusion lists to minimize erroneous assignments and improve species-level resolution, and contamination control tracking based on unsupervised machine learning. Together, these laboratory and computational steps outline a reproducible framework for marine vertebrate eDNA metabarcoding, helping to support biodiversity monitoring and the integration of molecular approaches into marine ecosystem assessment.

Hidden microbial life in marine temperate mesophotic ecosystems: structure, dynamics and functional potential (S1-OC-44)

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Marine microbial communities are fundamental drivers of global biogeochemical cycles, ocean ecology, and planetary health. Temperate mesophotic ecosystems (TMEs), located at intermediate depths (30–150 m), represent unique transitional zones between shallow and deep waters. These environments support key ecological services such as nutrient cycling and waste bioremediation, while serving as biodiversity hotspots. Despite their importance, TMEs remain largely understudied, especially concerning the diversity, dynamics, and adaptive potential of their associated microbiota. To address this gap, sediment samples were collected from 25 mesophotic sites (30–70 m depth) along the NW Portuguese coast (Viana do Castelo) over a three-year study period. DNA was extracted and analysed using 16S rRNA metabarcoding (Illumina and PacBio), revealing a high number of shared ASVs across sites and depths. TME benthic microbiomes showed modest temporal variation (species level, $R^2 = 14.8\%$), while maintaining a stable core microbiome composed of 37 bacterial species across all sampling campaigns, suggesting a high degree of ecological resilience in these open and dynamic marine environments. Cross-platform validation (44% genus overlap and consistent diversity patterns) confirmed the robustness of the pipeline and results accuracy. Community structure was significantly shaped by both depth and site-specific factors, with local environmental conditions explaining greater variance, highlighting the multifactorial nature of microbiome assembly in these heterogeneous marine systems. Species-level analyses indicated functional redundancy within the core microbiome and potential connectivity between benthic and pelagic compartments. A functional model of TME benthic microbiomes was created, integrating taxonomic composition with ecological context to illustrate their involvement in global biogeochemical cycles (C, N, S) and highlight their cruciality in maintaining ecosystem health and functioning. In parallel, the ongoing development of a mesophotic-derived microbial biobank (>100 bacterial strains), integrating genomics and phenomics characterization approaches, is uncovering the biotechnological potential of these microorganisms for sustainable blue economy solutions, while contributing to the long-term conservation and management of TME bioresources for future generations.

Session 2 - Global Change and Multiple Stressors in Ocean Health

Are marine annelids adapted to pollution? Initial indications by molecular and biochemical biomarkers (S2-OC-19)

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Marine annelids, such as *Hediste diversicolor*, are ubiquitous and abundant organisms, that are paramount for sediment bioturbation, nutrient cycling and the structuring of sedimentary habitats. The Tagus Estuary, Portugal's biggest, is biogeographical and ecotoxicological heterogeneous, having sites ranging from heavily contaminated by metals and organic contaminants to a natural reserve site. The present study aimed at comparing *H. diversicolor* dwelling in two areas with very distinct contamination profiles Alcochete considered a clean area and Seixal, polluted, as a contribution to understand the specie's resilience to pollution. Worms collected from both sites were analysed for histopathology (4% m/v paraformaldehyde, embedded in epoxy resin), metal bioaccumulation quantification via ICP-OES, biochemical biomarkers (LPO, CAT, TAC) and molecular biomarkers (GST, SOD, CYP450, and MTLP) using qPCR. The results showed higher oxidative stress levels (LPO and TAC) in organisms from the reference site (Alcochete) compared to the polluted site (Seixal). Although bioaccumulation for some of the metals tested (Cu, Fe, Ti, and TL) was significantly higher in Seixal, this was not reflected in the overexpression of the studied molecular biomarkers. Only the worms' size was significant different between sites. These data suggest that long-term chronic exposure (several generations) to contaminants may induce adaptation processes or deplete antioxidant reserves, potentially reducing the inducibility of gene responses. The absence of inflammatory foci in histological analyses supports the hypothesis that these populations have developed resilience to contaminated environments, possibly through epigenetic inheritance. Overall, this work shows that in *H. diversicolor*, long time exposure to contaminants was not reflected in increased biomarker responses, as could be expected. The use of these marine annelids as bioindicators of contamination should then be carefully applied due to the possible adaptation and resilience. In fact, this species is able to cope with pollution, however, by unknown mechanisms that go beyond the classical biomarkers.

CYP1-like expression in an integrated biomarker approach with *Mytilus galloprovincialis* from a contaminated estuary (S2-OC-26)

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The lower Tagus estuary is a multi-stressor system where metals, hydrophobic organic contaminants and emerging contaminants co-occur, making biomarker-based approaches especially relevant for environmental assessment. In marine invertebrates, the regulation and functional roles of CYP1-family genes remain largely unresolved, and molluscan sequences are consequently regarded as CYP1-like paralogues. This study evaluated site-related differences in CYP1-like expression in *Mytilus galloprovincialis* collected from six locations (Cabo Raso, Terreiro do Paço, Seixal, Algés, Trafaria and Cacilhas), and integrated these responses with biochemical biomarkers and histopathology. Gills and digestive glands were analysed for molecular and biochemical endpoints, while histopathology was assessed in gills, gonads and digestive glands. CYP1-like expression varied among sites and tissues, with higher expression generally observed in digestive glands of mussels collected from Terreiro do Paço, Algés and Cacilhas, and in the gills of mussels from Cacilhas, indicating responsiveness under field conditions but also differential sensitivity between organs. Biochemical biomarkers showed clear spatial and organ-specific patterns, with digestive glands providing better distinction among sites than gills. Mussels from Terreiro do Paço, Algés and Trafaria frequently showed enhanced metabolic and detoxification-related responses, while mussels from Seixal were characterized by lower enzymatic activity and signs of oxidative stress. Histopathological condition indices further supported the relevance of the digestive gland as the organ with the strongest site-related variation, whereas gills and gonads were more homogeneous. The results support an integrated multi-biomarker approach for estuarine biomonitoring and suggest that CYP1-like expression is most effective when interpreted together with biochemical and histopathological responses rather than as a standalone biomarker.

Combined effects of increased temperature and PFOA exposure on two different populations (Atlantic *versus* Mediterranean) of *Mytilus galloprovincialis* on the fitness, bioaccumulation, and biochemical responses (S2-OC-06)

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Perfluoroalkyl substances (PFAS) are persistent synthetic compounds widely distributed due to extensive use, posing risks to terrestrial and especially aquatic species. Perfluorooctanoic acid (PFOA) is among the most prevalent PFAS in aquatic environments. Rising temperatures from climate change may intensify contaminant effects, yet their combined impacts remain unclear. This study evaluated the effects of increased temperature and PFOA on (1) the fitness, (2) PFOA bioaccumulation, and (3) oxyradical metabolism in two populations of the mussel *Mytilus galloprovincialis* (Atlantic vs Mediterranean). Mussels were collected in S. Bartolomeu do Mar beach (SBM, Esposende, Portugal) and in Conero Riviera (Adriatic Sea, Italy) and exposed to a factorial design experiment manipulating temperature [ambient (PT:18 °C; IT: 20°C) and warming (P: 22 °C; IT: 24°C), and the PFOA (control: seawater no PFOA; PFOA1–100 ng/L and PFOA2–1000 ng/L), in a total of 6 treatments, for 15 days. Specimens were divided by treatments (9 replicates/treatment), in a total of 54 mesocosms. Based on preliminary tests, water was renewed every 72 hours to ensure stable PFOA concentrations. The condition index (CI) measured showed significant differences between temperatures in both populations, with the ambient temperature associated with a higher CI than the warming scenario. For the Atlantic population, the Ct and PFOA1 treatments, at both temperatures, the levels of PFOA detected were below the limits of detection. On the other hand, for the highest concentration (i.e., PFOA2), concentrations ranged between 0.88 ng/g ww for the lowest temperature and 1.10 ng/g ww for the highest temperature. Significant differences between them were found. Results on the Mediterranean population are being elaborated. For the digestive gland tissues, in Atlantic mussels, CAT activity increased with PFOA exposure, while GST was affected by the PFOA and temperature interaction, showing induction only at the highest PFOA level under elevated temperature. In Mediterranean mussels, CAT increased under higher temperature, whereas GST was induced by PFOA regardless of temperature. PFOA also affected TOSC ROO• in Atlantic mussels, mirroring CAT activity, while no effects were

observed on TOSC ROO• or HO• in the Mediterranean population. These findings suggest the importance of addressing population-specific sensitivity to multiple environmental stressors.

Dietary strategies for enhancing the resistance of *Paracentrotus lividus* (Lamarck, 1816) to thermal stress (S2-OC-11)

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Rising ocean temperatures are a severe threat to the aquaculture industry, including sea urchin farming, by compromising the health and productivity of edible species. This increases metabolic demands and triggers oxidative stress, a chemical imbalance that produces harmful molecules known as reactive oxygen species (ROS). These molecules cause cellular damage and lipid peroxidation, which ultimately weakens animal health and increases mortality. Sea urchins rely on carotenoids provided by their diet, which are powerful natural antioxidants that neutralize ROS and enhance immune resilience. Therefore, integrating natural carotenoids into aquaculture feeds is a vital strategy for maintaining the health of the sea urchins in a changing climate. This study explored how dietary carotenoids can help the purple sea urchin (*Paracentrotus lividus*, Lamarck, 1816) cope with high seawater temperatures through their ability to store these nutrients in their gonads (roe), manage oxidative stress (i.e., superoxide dismutase; catalase and lipid peroxidation), and modulate heat shock protein expression (*hsp70* and *hsp90*). Over four months, urchins were reared under two temperature scenarios: a control temperature representing local environmental conditions (18°C) and a warming scenario (+3.5°C) and fed with two formulated diets: a high carotenoid (HC) diet and a low carotenoid (LC) diet. Sea urchins maintained at +3.5°C and fed HC diet showed the highest levels of carotenoid accumulation in their gonads (67.46 µg/g). This suggests a maternal investment strategy to increase offspring resilience and ensure reproductive success in warmer waters. The HC diet provided the strongest antioxidant response, effectively

minimizing cellular damage under thermal stress. In contrast, urchins on the LC diet were unable to mitigate oxidative stress, resulting in high levels of cellular damage, which was further evidenced at a molecular level by the upregulation of *hsp70* and *hsp90* at +3.5°C. The combination of heat and carotenoid deficiency creates a synergistic stressful effect. The high temperature directly induces protein misfolding and ROS production, while a low carotenoid diet weakens the sea urchins' ability to cope with oxidative stress. These results highlight dietary carotenoids as a key factor enabling sea urchins to cope with thermal stress.

Physiological and Ecological Responses to Thermal Stress in *Mytilus* along the Iberian Peninsula (S2-OC-29)

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Climate change is intensifying thermal stress in rocky intertidal habitats, where organisms are regularly exposed to rapid fluctuations in temperature, desiccation and solar radiation during low tide. Mussels of the genus *Mytilus* are both climate-sensitive organisms and key ecosystem engineers, forming beds that support associated biodiversity. This study investigated physiological responses to tidal stress and the ecological role of mussel beds along a latitudinal gradient on the Iberian Peninsula. Field sampling was conducted from October 2024 to April 2025 across 17 rocky shores grouped into northern, central and southern regions. At each site, cardiac activity of *Mytilus* was recorded non-invasively during low tide in microhabitats differing in solar exposure. Associated biodiversity was assessed using photoquadrats collected inside and outside mussel beds. Chamber experiments quantified the thermal buffering capacity of mussel beds and compared thermal tolerance between mussels from colder and warmer regions under realistic temperature regimes. Field results showed that heart rate was a sensitive proxy of thermal stress, tracking local temperature fluctuations during emersion. Mussels from northern sites showed lower and more stable values, whereas mussels from southern sites reached higher values and experienced broader thermal oscillations, suggesting narrower thermal safety margins. Biodiversity analyses showed that mussel beds significantly increased species richness, although regional conditions were the main factor shaping diversity patterns. Experimental trials confirmed that

mussel beds reduced thermal peaks and promoted more stable physiological responses under cover than in exposed positions. They also revealed clear differences between regions: mussels from the colder region remained stable under their local thermal regime but collapsed rapidly under the warmer profile, whereas mussels from the warmer region showed high mortality even under their native regime, indicating that these populations may already live close to their upper thermal limits. Overall, this study support that *Mytilus* as a useful bioindicator of thermal stress and highlights the importance of mussel beds as biogenic refugia in coastal ecosystems under climate warming.

Trophic transfer as an important pathway for microplastic contamination in corals and its potential molecular impacts (S2-OC-27)

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Coral reefs are among the most threatened ecosystems worldwide due to different anthropogenic stressors, including microplastic pollution. However, the behaviour of microplastics within these ecosystems and their effects at the molecular level remain poorly understood. Although trophic transfer of microplastics in coral reef ecosystems has been observed in field studies, this ingestion pathway has not yet been investigated under controlled laboratory conditions. Furthermore, research on the molecular pathways underlying the physiological effects of microplastics on the coral holobiont have primarily focused on direct exposure to pollutants. Here, we examined this possible pathway and its effect at molecular level by exposing two scleractinian corals, *Stylophora pistillata* and *Pocillopora damicornis*, under two different experimental designs. First, a short-term exposure of microplastics, directly from the water column and indirectly through contaminated prey (*Artemia nauplii* previously feed with microplastics), to determine the possible trophic transfer of micropalstics under laboratory conditions. Second, a one-month experiment with *Stylophora pistillata*, under the same experimental conditions, to identify, by means of metatranscriptomic analysis, the molecular pathways that initially respond to the stressor, and the long-lasting effects of the exposure. Our results demonstrate that microplastic ingestion via contaminated prey was significantly higher than when microplastics are free in the water column, indicating that trophic transfer represents a highly efficient and potentially dominant pathway for microplastic ingestion in coral reef ecosystems. Metatranscriptomic analysis are currently

ongoing: we hypothesise that pathways linked with oxidative stress, energy metabolism, photosynthesis, and carbon fixation may be affected and will test this using enrichment analysis of gene ontologies. These results are important because studies on microplastic effects have largely overlooked more environmentally realistic scenarios in which microplastics may impact species indirectly through the food chain.

Effects of polymetallic and sediment plumes in *Adreus fascicularis* (Porifera: Tethyida) under hyperbaric conditions: a case study for deep-sea mining (S2-OC-15)

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Marine sponges play a fundamental role in benthic ecosystems, particularly in deep-sea environments where they often form extensive sponge grounds that act as biodiversity hotspots and contribute to biogeochemical cycling. Anthropogenically generated sediment and rock plumes coupled with increased particle settling can influence sponge physiology, affecting feeding efficiency, respiration and survival. The impact of particle settling becomes particularly critical in the context of deep-sea mining, an emerging industrial activity targeting polymetallic nodules, seafloor massive sulphides and cobalt rich crusts. Such activities will generate sediment and rock fragment plumes that can disperse dozens of miles through the water column. To better understand how sediment and rock particle plumes might affect benthic taxa in both subtidal and deep-sea ecosystems, *Adreus fascicularis* (Bowerbank, 1866) (Tethyida: Hemiasterellidae) sponges were exposed to increasing concentrations of suspended sediments – SED (0.25, 0.5 and 1 g/L) and crushed polymetallic sulphide particles – MIN (0.05, 0.125 and 0.25 g/L), under pressurized conditions (5 Bar) for 96 hours. A metabolic indicator, the respiration rate, and the transcriptomic profile were analyzed for both experimental conditions. For sponges exposed to MIN, the microbial community was also analyzed. Results showed changes in respiration capacity, with a significant increase in 0.5 g/L SED

and a 50 % decrease in 0.05 g/L MIN when compared to control. The transcriptomic profile of exposed sponges, to SED and MIN, revealed several potentially altered pathways including immune response and apoptosis. A preliminary microbiome analysis of MIN exposed sponges showed a decreasing trend in both species' richness and diversity, matching the increase in MIN concentration. Overall, results indicate that sponges are negatively affected by suspended sediments and polymetallic sulphide particles. Given the ecological role of sponge grounds and their particular vulnerability to environmental disturbance, understanding the interactions between sponges and plumes is essential to predict impacts of deep-sea mining activities in benthic ecosystems.

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Ice Fish's Shield: How Hemoglobin's Absence Battles Mercury in Antarctica (S2-OC-22)

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As legacy contaminants continue to accumulate in Antarctica, understanding how polar species respond at the physiological level is increasingly important. Icefish (family Channichthyidae) are among the most physiologically unique vertebrates, having evolved in the freezing waters of the Southern Ocean while lacking functional hemoglobin. Here, we aim to assess if this unique physiology influences how contaminants accumulate in their tissues? To address this aim, we analysed mercury concentration (Hg) in more than 50 individuals across three species: *Champscephalus gunnari*, *Gobionotothen gibberifrons*, and *Nototothenia rossii*. We found that *C. gunnari* shows strikingly lower Hg concentrations ($0.0178 \pm 0.008 \mu\text{g g}^{-1} \text{dw}$) compared to closely related nototheniids ($0.174 \pm 0.064 \mu\text{g g}^{-1} \text{dw}$ in *G. gibberifrons* and $0.184 \pm 0.078 \mu\text{g g}^{-1} \text{dw}$ in *N. rossii*), despite similar diets and only slightly lower trophic positions. We propose that this reduced Hg accumulation in *C. gunnari* may be linked to the absence of hemoglobin and the

consequently lower iron (Fe) content in its tissues. Given the strong affinity of Hg for iron-binding sites in biological molecules, reduced iron availability may limit Hg retention capacity in icefish. These findings suggest that beyond ecological drivers such as diet and trophic position, species-specific physiological traits can substantially influence contaminant accumulation. Understanding how evolutionary adaptations modulate contaminants dynamics provides new insight into Hg transfer in Antarctic ecosystems and highlights the importance of physiology in ecotoxicological risk assessments. This research contributes to the ongoing efforts to safeguard polar ecosystems while shedding light on the complex interactions between essential biological processes and environmental contaminants.

Seagrass bleaching: the Mediterranean Sea as a case study (S2-OC-24)

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The seagrass *Posidonia oceanica*, endemic to the Mediterranean Sea, is facing multiple stressors that can alter ecosystem functioning and plant traits. Among these, leaf bleaching, a senescence-related depigmentation process, has been observed in some areas of the Mediterranean Sea. Bleaching was related to processes that lead to a low structural investment, but the main drivers that distinguish it from brown necrosis remain unclear. This study aimed to identify the environmental factors influencing leaf bleaching across the Mediterranean Sea through a correlative and mensurative approach. In summer 2025, over 70 researchers collected 419 observations on the presence/absence of bleached meadows, while environmental variables were obtained from Copernicus Marine datasets. Morphological and structural data, including leaf area, brown necrotic and bleached area, and leaf mass per area (LMA), were collected from shoots in 32 sites. Cumulative Link Model, used to correlate environmental satellite data to bleaching occurrence, indicated that higher depth, higher chlorophyll-a concentrations and higher salinity were associated with reduced bleaching incidence, while high temperature and nitrate concentrations increased bleaching. The interaction between nitrates and temperature suggested a weakening of nitrate effects under warmer conditions, highlighting complex stressor interactions. Generalized linear mixed models, used to

correlate the bleached leaf area to structural and morphological variables, showed that bleaching was higher in larger shoots, potentially reflecting compensatory growth, but decreased with higher LMA, indicating that leaves with greater structural investment are less susceptible. Spatial variability among sites explained a substantial proportion of the observed variance. In contrast, brown necrosis did not show significant relationships with the explanatory variables, suggesting different underlying mechanisms from bleaching. Overall, leaf bleaching was more frequent in shallow meadows and under stressful environmental conditions such as low salinity, eutrophication, and high temperature, and was associated with structurally weaker leaves. Leaf bleaching may affect plant resilience to multiple stressors and understanding both individual and interactive environmental drivers for the conservation and management of this key Mediterranean species become pivotal.

Spatial and seasonal distribution of PFAS in water, suspended particulate matter, and biota from the Douro and Tagus estuaries (Portugal) (S2-OC-30)

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Per- and polyfluoroalkyl substances (PFAS) are persistent contaminants commonly found in aquatic environments, mainly due to continuous human inputs. This study evaluated the occurrence, distribution, and composition of PFAS in water, suspended particulate matter (SPM), and biota from the Douro and Tagus estuaries (Portugal), considering spatial and seasonal variability. PFAS were detected in all environmental matrices, with higher concentrations generally observed in the Douro estuary, particularly at sites D4 and D5 (up to 25.07 ng/L), and a clear seasonal pattern with higher levels in winter. In contrast, the Tagus estuary showed lower overall concentrations (0.06–10.18 ng/L), although a pronounced peak was observed at T3 during summer (25.67 ng/L). Long-chain PFCA, particularly PFOA, dominated in water, while PFOS showed a stronger association with SPM, reflecting its higher affinity for the particulate phase, with higher partitioning coefficients (logK_d). In biota, PFAS concentrations were generally low but showed clear spatial and seasonal variability. In the Douro estuary,

macroalgae (*Fucus*) consistently exhibited low concentrations (0.03–0.75 ng/g ww), whereas higher levels were observed in the bivalve *Scrobicularia plana* (0.20–1.85 ng/g ww), with increased values in spring and autumn. In the Tagus estuary, greater variability was observed, with higher concentrations in macroalgae *Gracilaria* (0.47–1.51 ng/g ww), particularly at T4 during summer, while macroalgae *Fucus* and *Ulva* showed consistently low levels. Among fauna, *S. plana* (0.10–0.98 ng/g ww) showed higher concentrations than the crustacean *Carcinus maenas* (0.05–0.39 ng/g ww), especially at T4. Ecological risk was mainly associated with PFOS in both estuaries, with more frequent and higher risk levels observed in the Douro, while the Tagus showed mostly low to moderate risk with occasional peaks. Overall, these results emphasize the need for continued monitoring of PFAS in estuarine systems influenced by human activities, as well as the importance of expanding knowledge to other Portuguese aquatic environments.

Global warming and an invasive kelp species jointly accelerate carbon turnover in Northeast Atlantic (S2-OC-21)

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Kelp forests are major contributors to coastal blue carbon dynamics, providing key ecosystem services through dissolved and particulate organic carbon release, burial, and export to deep-sea sinks. However, the combined effects of ocean warming and biological invasions on detrital carbon persistence remain poorly quantified. This study investigates how temperature and species identity influence the decomposition kinetics of the native kelp *Laminaria hyperborea* and the invasive *Undaria pinnatifida*, and assesses the implications for blue carbon export at a rear-edge Portuguese site (Angeiras). A fully factorial mesocosm experiment was conducted using two species, two tissue types (blade and stipe) and four temperatures (10, 14, 18 and 22 °C), with four replicates per treatment combination. Tissue fragments were incubated for 40 days under controlled aerobic conditions, and biomass loss was tracked to derive decay rate constants (k) using linear mixed-effects models. Export potential was projected using a modelled coastal residence time of 36 days, complemented by strong (17 days) and weak (60 days) upwelling scenarios. Results showed that species identity was the dominant driver of decomposition, with *U. pinnatifida* decomposing one to two orders of magnitude faster than *L. hyperborea* across all tissue × temperature combinations. *Laminaria hyperborea* stipe exhibited a non-linear thermal response, with near-zero decay at 10–14 °C and a nearly eightfold increase above 18 °C, suggesting a critical thermal threshold

for this recalcitrant tissue. Export potential was effectively zero for *U. pinnatifida* across all treatments, while *L. hyperborea* stipe retained 85–96 % export potential at current ambient temperatures, values exceeding those reported for any site in published Atlantic kelp datasets. Projected warming under RCP4.5 would reduce stipe export potential by ~49 %, while biological replacement by *U. pinnatifida* would collapse it to ~0 % regardless of temperature, a discrete functional transition rather than a gradual response. These findings demonstrate that warming and invasion act as compounding threats to blue carbon function in Northeast Atlantic kelp forests and underscore the importance of incorporating species identity and non-linear thermal responses into macroalgal carbon assessments.

A nutritional trap at the invasion front: how *Rugulopteryx okamurae* dismantles herbivore resistance in Mediterranean reefs (S2-OC-03)

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The invasive brown macroalga *Rugulopteryx okamurae* has rapidly expanded across southern European and North African coasts since its detection in the Strait of Gibraltar in 2015, monopolizing rocky benthic habitats and displacing native macroalgal assemblages. Using a multi-scale approach integrating field surveys, long-term laboratory experiments, mesocosm trials under simulated marine heatwave (MHW) conditions, and preliminary underwater video surveys, we assess the capacity of native herbivores to regulate this invasion in the Alboran Sea. Benthic surveys at 10 sites revealed strong community restructuring: macroalgal diversity and species richness declined sharply

above 40% *R. okamurae* cover, with invasion intensity explaining nearly half of all community variation. The keystone grazer *Paracentrotus lividus* showed a unimodal density response, almost collapsing at high-invaded sites, where GSI was reduced and Ivlev's electivity strongly negative. Stable isotope and fatty acid analyses revealed a depletion of essential PUFAs linked to the replacement of native algae, consistent with a nutritional trap: urchins avoid the invader but face scarce, nutritionally poor native resources—impairing reproduction and weakening top-down control in a positive feedback that reinforces invasive dominance. Laboratory experiments confirmed that physiological damage accumulates with invasion time, with 60% mortality in long-term exposed individuals on a strict *R. okamurae* diet versus 20% in recently invaded ones; mixed diets largely buffered these effects. MHW experiments showed that *R. okamurae* was consistently the least consumed species across all temperatures, and grazing nearly ceased at 27°C—progressively eroding residual herbivory control.

Fish video surveys and faecal pellets of the herbivorous fish *Sarpa salpa* are under. Together, these results show that *R. okamurae* dismantles biotic resistance through a dual mechanism—nutritional impairment and climate amplification—with critical implications for the management of Mediterranean rocky reef ecosystems.

Shifts in macroalgal traits and metabolic processes along a pH gradient (S2-OC-10)

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Coastal marine ecosystems are critically valuable worldwide due to their high biodiversity and the essential ecological services they provide. They are structured by marine benthic species such as macroalgae, seagrasses, and corals, which are increasingly threatened by global change, especially marine heatwaves (MHWs) and ocean acidification (OA). OA poses a severe threat to many calcifying species, such as coralline algae, whose growth depends on calcification. Declines in these species can trigger cascading effects on coastal communities, leading to shifts in ecosystem structure, function, and resilience. There is an urgent need to understand how coastal benthic species respond to global environmental change, especially in the Mediterranean Sea, which represents a climate-change hotspot.

In this context, trait-based approaches can provide important insights into the ecological roles of species and their links to ecosystem processes. Trait-based approaches

target species functional traits, which are ecological traits that influence species responses to environmental factors and have a causal relationship with a clearly specified ecosystem function. Shifts in the occurrence of these traits within individuals across species under changing environmental conditions can reflect different ecological strategies, such as variable morphologies, sizes, growth, and metabolic rates.

This study will investigate CO₂ vent systems along the coast of Ischia (Naples, Italy), where CO₂ bubbling from the seafloor causes local seawater acidification. CO₂ vents serve as natural analogues to assess species and ecosystem responses to future OA conditions. We target key Mediterranean macroalgae, including calcifying (*Ellisolandia elongata*, *Jania rubens*, *Padina pavonica*) and non-calcifying species (*Dictyota dichotoma*, *Halopteris scoparia*, *Flabellia petiolata*). We quantify intraspecific trait variation by measuring different morphological traits (e.g., thallus length, surface area) and metabolic data using incubation chambers (e.g., photosynthesis, calcification) along a pH gradient. Combined, these results provide new insights into how variable pH conditions affect the performance of macroalgal species, which represent a key component of Mediterranean coastal benthic systems.

Climatic and ecological drivers of the decline of a canopy-forming macroalgae (S2-OC-28)

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Climate change has widely impacted marine ecosystems, especially those in the rocky intertidal. One of the most widespread consequences being shifts in species distribution. Canopy-forming brown macroalgae are foundation species with an important structuring role in coastal ecosystems which have been suffering local extinction at their warm distribution edges – a phenomenon often associated with biodiversity loss. A striking example is the macroalgae *Himanthalia elongata*, this species used to occur from Scandinavia to central Portugal, with a distribution gap in the warmer Bay of Biscay. However, in the last decades, its distribution retreated hundreds of km northwards along

the Portuguese coast and the distributional gap in the Bay of Biscay has been widening eastwards. Our project aims to understand the mechanisms underlying this shift. Is the decline related to increasing temperature? If so, which aspects of temperature are responsible? Or could warming be modifying the intensity of ecological interactions, contributing to increased herbivore pressure on *H. elongata* at its southern range edge? If this is the case, is warming raising herbivore consumption rates, or facilitating the introduction of warm-adapted grazing species? We started by reconstructing the historical and current shifts in the species distribution and found that these shifts are closely correlated to warming in the region. However, both field and lab experiments showed us that temperature alone could not explain this drastic of a decline. Indirect impacts of warming, such as variations on interspecific interactions must also be contributing to the regression of the canopy forming macroalgae. Therefore, we set out to study the how herbivory pressure on *Himanthalia elongata* could be dictating the species decline. In the field, we used algae baits associated with video monitoring to identify and quantify herbivory pressure. In the lab, we used custom-made, automatically controlled aquaria systems, which were programmed to simulate realistic tides, that allowed us to study the direct effect of regional climate on herbivore pressure. Combining traditional and novel technologies, like video analysis, advanced low-cost loggers and more, we demonstrate how the disappearance of a single species can cascade through ecosystems. Our work shows that a species decline often results from interacting processes, highlighting the importance of examining both climatic and ecological drivers together.

Sunscreens in the sea: nano-TiO₂ threatens the Mediterranean canopy-forming alga *Ericaria amentacea* (S2-OC-05)

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Ericaria amentacea is a Mediterranean habitat-forming brown macroalga that has undergone severe decline under increasing anthropogenic pressure. Among emerging coastal pollutants, sunscreen-derived titanium dioxide nanoparticles (nano-TiO₂) are of growing concern in shallow bathing waters, yet their effects on habitat-forming macroalgae remain poorly understood. Here, we experimentally assessed, for the first

time, the effects of nano-TiO₂ on adults and germlings of *E. amentacea* under controlled laboratory conditions. Both life stages were exposed for 20 days to 0, 5, 50, and 500 µg L⁻¹ nano-TiO₂, including environmentally relevant concentrations reported for Mediterranean coasts. In adults, photosynthetic performance and gross primary production were measured after 10 and 20 days, while in germlings F_v/F_m was assessed at day 20. In both life stages, chlorophyll-a, superoxide dismutase, lipid peroxidation, and total proteins were quantified, and SEM-EDS analyses were used to detect nanoparticle accumulation in tissues. Nano-TiO₂ induced concentration-, time-, and life stage-dependent responses. Adults showed a limited short-term adjustment at low exposure, but higher concentrations impaired photosynthetic efficiency and gross primary production, particularly after prolonged exposure. Biomarker responses indicated declining chlorophyll-a and increasing antioxidant activity with rising nano-TiO₂, consistent with oxidative stress. SEM-EDS confirmed nanoparticle accumulation in adult tissues at 50 and 500 µg L⁻¹. Germlings were more sensitive than adults: even 5 µg L⁻¹ significantly reduced F_v/F_m , while chlorophyll-a declined and oxidative stress markers increased with dose. Nanoparticles were detected in germling tissues at all concentrations ≥ 5 µg L⁻¹. These results suggest that early developmental stages represent the most vulnerable phase of the life cycle and that recruitment may be particularly exposed during the summer tourist season, when sunscreen inputs peak. Overall, our findings identify sunscreen-derived nano-TiO₂ as a previously overlooked stressor for Mediterranean fucoid forests and highlight the need to include nanoparticle pollution in future ecological research and coastal conservation strategies.

Beyond the Host: Host-Associated Microbiomes and Regime Shifts in Marine Macroalgal Forests (S2-OC-17)

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Increasing climate and local anthropogenic pressures are raising the risk of catastrophic shifts in coastal marine ecosystems such as macroalgal forests. Yet, despite substantial progress, key challenges remain in mapping regime shifts, identifying ecological thresholds, and developing early warning signals of impending transitions. We argue that part of this shortfall reflects a host-centred perspective that largely overlooks host-associated microbiomes, even though these microbial partners can shape resilience by modulating stress tolerance, promoting recovery, and contributing to the stabilization of alternative states. To address this gap, we developed antimicrobial protocols for manipulative experiments across multiple habitat-forming macroalgal hosts in both

intertidal and subtidal habitats. Microbial disruption consistently reduced host photosynthetic yield and altered oxygen production and respiration across algal species, while the treatment application methods themselves showed no detectable artefactual effects, providing a robust framework for experimental microbiome manipulation in the field. In parallel, we are developing canopy-thinning experiments to reconstruct degradation gradients, map regime-shift dynamics, identify potential thresholds, and assess early warning signals of collapse. Together, these complementary approaches lay the groundwork for future integration of microbiome manipulation and regime-shift experiments in marine forests.

Session 6 - Citizen Science and Participatory Monitoring

Citizen science actions in marinas to detect non-native species: “*What’s growing under your boat?*” (S6-OC-01)

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Public awareness of marine bioinvasions is still very limited despite the fact that non-native species (NNS) are considered one of the most important causes of biodiversity loss. Even less understood is the role of recreational boating in the introduction of NNS via biofouling, a vector poorly known and not perceived important by boaters. We developed a series of citizen science events in recreational marinas, targeting boaters and marina staff, as part of the Horizon Europe funded GuardIAS project (Guarding European Waters from Invasive Alien Species). One of GuardIAS’ aims is to actively engage societal actors in addressing challenges related to aquatic invasive alien species. In 2025, we organized 6 events in different Italian marinas, aiming to increase awareness of biofouling as a major vector for the introduction and spread of NNS by engaging stakeholders in the collection of data about NNS in fouling communities. Each event started with a brief presentation about the project and marine bioinvasions, followed by the active involvement of participants in a survey in the port. We used before-and-after questionnaires to assess participants’ initial level of awareness on NNS and the role of biofouling in their introduction and spread, as well as measuring changes in their knowledge and perceptions at the end of the event. Moreover, a call-to-action encouraged volunteers to take part in monitoring by ‘adopting’ a passive fouling collector in proximity of their berths, and committing to send periodic photographs of the organisms colonizing a PVC panel. This first-year experience of the citizen science events in marinas allowed us to interact with specific end users, raising awareness about future biofouling regulations and better understanding public perceptions. We found that respondents were largely aware about marine bioinvasion issues in general. After participating in the activity, their level of knowledge about NNS present in the ports increased, as well as their willingness to perform good practices to limit the spreading of NNS with their boat. The long-term engagement of volunteers is on-going, with 65 photos collected so far, thereby contributing to standardized observations and extending the monitoring capacity of researchers.

BioMARatona: Leveraging Citizen Science for Intertidal Biodiversity Monitoring (S6-OC-02)

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The intertidal zone is a landscape of extremes. Twice a day, during the low tide, marine organisms are exposed to terrestrial conditions. In this system, the impacts of a warming climate are felt first and most intensely, providing a direct, visible link between meteorological shifts and the health of our intertidal biodiversity. Yet, despite their ecological importance, our understanding of these areas is fragmented. We face a lack of long-term information needed to track how species are shifting, disappearing or struggling to adapt. Traditional scientific methods cannot be everywhere at once. This is where the power of the collective comes in. Citizen science has emerged as an essential tool for marine monitoring, bridging knowledge gaps by increasing the volume of observations across large spatial and temporal scales. The ANERIS project was born from the idea that the best way to monitor our vast coastlines is to empower the people who live along them. At the heart of this effort is the BioMARatona, launched in 2024 in Portugal, that reimagines the traditional BioBlitz as an extended, months-long journey running from mid-spring to mid-fall. By designing tools that are as intuitive as they are scientifically robust, the project aims to turn the general public from passive observers into "coastal sentinels". The public engagement is overwhelming, with participants ranging from amateur naturalists, students and the general public, recording species occurrences through a mobile application and an online platform (MINKA). In its inaugural year, over 100 volunteers documented more than 1,200 observations, identifying 170 species. By 2025, these figures rose to over 3,400 observations and 260 species, demonstrating the rapid scalability of the model. To ensure that the community's contributions are scientifically accurate, each observation passed through a curation and validation process supported by taxonomic experts. Ultimately, the BioMARatona is about Ocean Literacy in action. By involving schools, municipalities, and local organizations, we are fostering a deeper sense of stewardship and environmental responsibility. The evolution of this project offers a scalable blueprint for the future. By addressing the challenges of data quality through community engagement and expert validation, we are paving the way for a more inclusive form of marine research. As we look toward a even larger 2026 edition, it is clear that uniting cutting-edge technology and local passion is the key to the future of marine conservation, happening in the hands of the many.

Session 3 - Marine Conservation, Management & Policy

***Posidonia oceanica* beach wrack management: Benefits and drawbacks for dune plant seedlings (S3-OC-05)**

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Wrack deposits play fundamental ecological roles in coastal environments. Despite their importance, wrack deposits are frequently removed since they are perceived as a nuisance by beachgoers. Wrack is often moved from beaches to adjacent dunes, important habitats included in the European Directive, but the potential benefits/drawbacks of such practice for dune plants responsible of the formation and stability of dunes have never been assessed. This is critical since beach cleaning operations are extensively conducted along coasts, and dune habitats are currently threatened by several factors including those related to climate change. This study investigated the effects of placing *Posidonia oceanica* wrack layers of different thickness (2, 4, 8 cm) and composition (wrack or wrack mixed with sand) on the toe of embryonic dunes on the survival of established seedlings of dune plants and on the recruitment success and growth of new seedlings. It also evaluated the individual and combined effects of wrack deposition (no wrack, wrack, wrack mixed with sand ratio 1:1) and precipitation amount (current vs. reduced according to SSP2-4.5 scenario) on the establishment and growth of dune plant species. *Thinopyrum junceum*, *Calamagrostis arenaria*, *Euphorbia paralias*, and *Cakile maritima* were used as model species. The placement of the thickest wrack layer (8 cm) decreased survival of established seedlings up to 70%, regardless of species and wrack composition. Wrack, regardless of composition, decreased seed recruitment success more than 50%. The thickest wrack layer reduced the aboveground organ growth of newly emerged seedlings of the perennial species *T. junceum* and *E. paralias* while favoured that of the annual species *C. maritima*. Neither wrack nor precipitation affected seed germination and seedling emergence success of the investigated species. Reduced precipitation decreased root development while wrack promoted seedling aboveground elongation, regardless of composition. Reduced precipitation also decreased biomass production in *T. junceum* and *C. arenaria* but only without wrack. The findings suggest that placing stranded wrack at the dune toe can hinder their natural colonization by emerging seedlings, highlighting

potential drawbacks for vegetation and questioning about the ecological sustainability of this practice. On the other hand, the findings also reveal potential benefits of wrack for vegetation since it could mitigate the effects associated to the reduced precipitation in perennial dune plants by providing them more available water. Overall, managers should plan tailored wrack management activities specific for each beach site in order to limit the potential impacts of such practices while maximize the benefits associated to wrack.

The effects of light intensity on *Chara tomentosa* thallus and rhizoid growth (S3-OC-10)

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Shallow coastal areas are important for the biodiversity of aquatic environments. In the shallow bays of the Baltic Sea, one of the key macrophytes is *Chara tomentosa*. This large charophyte species forms habitats for various animals. The abundance of charophytes has been declining due to human impact, including eutrophication, causing increased water turbidity and decreased light penetration. In this aquarium experiment we investigated how different light intensities affect the growth and survival of *C. tomentosa*. Apical cuttings of *C. tomentosa* were collected from a brackish water bay and cultivated in aquaria in six light intensities (10, 25, 50, 100, 200 and 450 $\mu\text{mol}/\text{m}^2/\text{s}$) with a 16 h day length. At the end of the experiment the length of main thallus, side branch and rhizoid growth was measured, as well as the width of the widest branchlet whorl of main thallus and side branches. The colour of charophytes was visually determined. The length of main thallus growth and the maximum width of branchlets whorls were the longest in the light intensity of 50 $\mu\text{mol}/\text{m}^2/\text{s}$, and decreased towards the darker and brighter light intensities. The length of side branches and rhizoids increased with increasing light intensity up until the intensity of 50 $\mu\text{mol}/\text{m}^2/\text{s}$ after which increasing light intensity did not further enhance charophyte growth. The colour of charophyte thalli in the brightest light intensity was clearly more orange and red compared to the thalli in the darker aquaria, where the main thalli and side branches were greener. There was no mortality in any of the light intensities during the experiment. These observations indicate better charophyte growth in light intensities $\geq 50 \mu\text{mol}/\text{m}^2/\text{s}$ with slight growth inhibition in the brightest light intensity. Our results can aid the assessment of light climate suitability and selection of potential charophyte habitat restoration sites.

Priming winter-dormant fragments improves attachment performance in *Gelidium corneum* restoration (S3-OC-16)

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In temperate coastal ecosystems, habitat-forming macroalgae are declining due to the combined effects of climate change and anthropogenic pressures, with major consequences for biodiversity and ecosystem functioning. *Gelidium corneum*, an ecosystem-engineering red alga exploited for agar production, exemplifies these trends through the regression of natural populations along European Atlantic coasts. As large-scale cultivation remains unfeasible, restoration strategies based on vegetative propagation represent a promising alternative. However, attachment and rhizoid development are critical bottlenecks for successful outplanting, and the influence of seasonal physiological states, particularly winter dormancy, remains poorly understood. This study evaluates the effect of laboratory preconditioning on the attachment capacity of winter-collected fragments of *G. corneum*. Fragments were collected during winter dormancy and maintained under controlled conditions to enhance their physiological status prior to spring reintroduction. A total of 64 fragments (5 cm length) were assigned to two treatments: a winter control (15 °C) and an optimal growth condition (18 °C), with controlled temperature and photoperiod in phytoclimatic chambers. The experiment consisted of two successive 30-day phases. The pre-conditioning phase assessed physiological status, while the attachment phase evaluated fixation on 5 cm diameter concrete discs used as artificial substrates. An additional control group (n = 32) of freshly collected fragments was included. Growth, survival, and photosynthetic performance (PAM fluorometry) were monitored. Pre-conditioned fragments showed improved physiological performance, reduced necrosis, enhanced rhizoid development, and higher attachment success compared to controls, consistent with previous studies on temperature and irradiance effects. These findings highlight the importance of seasonal physiological condition in restoration strategies and support the use of nursery-based pre-conditioning to improve *G. corneum* restoration success.

Evaluating green gravel as a restoration strategy for *Laminaria ochroleuca* kelp forests along the Portuguese coastline (S3-OC-24)

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Kelp forests are key marine ecosystems that support biodiversity, sustain fisheries, protect shorelines, and contribute to carbon and nutrient cycling. These habitats are increasingly threatened, with reported widespread declines across European coasts. Developing effective and scalable restoration strategies is therefore a priority. Traditional approaches have shown mixed success and are often difficult to scale-up. The “green gravel” method emerges as a promising strategy, with this study aiming to evaluate the feasibility of applying this method to restore *Laminaria ochroleuca* forests along the Portuguese coastline. These trials build on recent restoration efforts in the region. Green gravel was produced using zoospores from *L. ochroleuca* collected in Peniche, with limestone gravel (3–5 cm) seeded and reared in closed seawater systems over a 14-week period. Environmental conditions, including salinity and nutrient availability, were controlled and monitored. Cultures were maintained until juveniles reached a size of 50 ± 20 mm. These cultivated gravel batches were then deployed at previously surveyed sites along the Portuguese coast. Post-deployment monitoring was carried out using replicated belt transects and quadrats (0.5 m²), assessing retention, density, size, and health of kelp individuals. Associated fish, invertebrate, and algal communities were also surveyed. Environmental variables, including temperature, hydrodynamics, substrate characteristics, and nutrient availability, were recorded. Preliminary results indicate that flatter, continuous rocky substrates, combined with sufficient water movement, enhance retention and survival of deployed gravel. Gravel size and aggregation also appear to influence retention rates and may improve integration into the natural substrate. Retention rates observed in these trials are comparable to those reported in other green gravel restoration efforts, despite the high-energy conditions of the Portuguese coast. Biotic interactions also play a significant role. Monitoring recorded more than three dozen fish species, including several grazers, as well as invertebrate herbivores. Regression analyses suggest that grazing pressure, together with reef morphology, are key drivers of restoration success. These trials represent the first applications of the green gravel method for kelp restoration on the southern European coastlines. Initial deployment success rates of up to 12% demonstrate that this approach is feasible under challenging conditions. Encouragingly, recent monitoring indicates continued growth and attachment of individuals from previous deployments, suggesting potential for longer-term establishment. With continued optimization and sustained deployment efforts, the green gravel method shows strong potential to support the large-scale restoration of *L. ochroleuca* forests along the Portuguese coast.

Sustaining seagrass restoration: long-term preservation of *Posidonia oceanica* seeds and seedlings (S3-OC-25)

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Seagrass meadows are declining globally due to human pressures and natural disturbances, causing the loss of critical ecosystem services. In the Mediterranean, *Posidonia oceanica* meadows are among the most productive coastal ecosystems, yet their restoration remains challenging. Traditional methods based on lateral cuttings are costly, labor-intensive, damage donor meadows, and limit genetic diversity. Seedling-based propagation offers a promising alternative by preserving genetic variability, but it is constrained by the unpredictability of seed stranding events and the short window for seed collection and transplantation. To overcome these limitations, we investigated long-term storage methods for seeds and seedlings to extend restoration and transplanting opportunities beyond natural germination periods. We evaluated the effects of light conditions, storage density, and seedling developmental stage on viability during six months of cold storage at 4 °C, and tested whether dormancy could be induced using abscisic acid (ABA) and paclobutrazol. Our results show that light is essential for maintaining viability, as all samples stored in darkness failed to survive. Seedlings aged 1–2 months exhibited significantly higher survival rates (70–90%) compared to freshly collected seeds (40%), while storage density had no significant effect, supporting scalability. Attempts to induce dormancy were unsuccessful. This study provides the first effective protocol for extended storage of *P. oceanica* seeds and seedlings, enabling year-round planning of seagrass restoration projects and improving their flexibility, feasibility, and overall efficiency.

Assessing diving pressure to support MPA management (S3-OC-07)

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Scuba diving is a popular activity in coastal areas, being Marine Protected Areas (MPAs) attractive destinations for this practice. However, frequentation in MPAs can

cause a significant pressure on the biodiversity that they are intended to conserve, becoming a management challenge. Protected for over 40 years, the Medes Islands Marine Reserve (Girona, Spain) has become one of the most popular diving areas in the Mediterranean, with around 70,000 dives made annually. Diving management in this MPA follows an adaptive approach, where annual quotas are set based on the conservation status of sensitive species such as gorgonians and bryozoans. To better understand diving-related pressures, a specific monitoring was recently implemented. Divers are followed underwater for 10 minutes to record their contacts with the seabed and benthic organisms, and to evaluate the effects that these contacts cause. Diver profiles are also recorded and the spatial use is tracked during dives. In 2024 (152 dives and 434 divers monitored) and 2025 (160 dives; 453 divers), visitors made an average of 5.2 ± 0.7 and 2.5 ± 0.3 contacts per 10 minutes, respectively. Most contacts were caused by fins (60-70%) and mainly affected algae and seagrasses (70-80%), although impacts on sensitive species such as gorgonians were also recorded (4-6%) with some resulting in branch breakage (0.2-0.6% of total contacts). More experienced divers (over 50 years old; >10 years of experience; >200 dives logged) were identified as the most impactful, and the use of equipment such as reflex cameras (especially for macro photo) and torches increased the number of contacts across all diver profiles. Spatial analysis revealed a high degree of overlap among diving sites, showing the cumulative pressure that certain areas suffer. In contrast, the presence of official diving guides underwater and doing complete pre-dive briefings with specific ecological and behavioural recommendations (ecobriefings) significantly reduced the number of contacts. These findings support specific management measures, including training programs for diving centres and targeted awareness campaigns. This monitoring of diving-related pressures provides valuable data for decision-making within the MPA and contributes to promote more sustainable practices among the diving community.

Informing Marine Protected Area networks design: the importance of ecological connectivity (S3-OC-08)

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Ensuring ecological connectivity among Marine Protected Areas (MPAs) is pivotal for developing coherent reserve networks and promoting the resilience of marine communities to perturbations. However, quantifying and effectively incorporating connectivity into the design of MPAs remain a major challenge. In this study, for the first time, we adopted an integrated approach, combining β -diversity, ocean circulation and particles dispersion models, to evaluate whether existing protection settings adequately account for ecological connectivity. We applied this approach to four MPAs covering a scale of hundreds of kilometers in the Western Mediterranean Sea. We investigated the taxonomic β -diversity of benthic seascapes including habitat forming species and tested the observed dissimilarities against connectivity matrices derived from Lagrangian particle model forced by the Regional Ocean Modeling System. Our results demonstrate an asymmetrical connectivity pattern characterized by high levels of self-retention. Three areas (Gulf of Gaeta, Gulf of Naples and Gulf of Salerno) emerged as ecologically meaningful spatial units. Distance–decay in β -diversity indicates an optimal spatial scale of ~10–20 km for maintaining connectivity among low-dispersal species. The Lagrangian model simulations allowed us to identify 32 days as a relevant temporal scale to represent regional connectivity dynamics. In systems characterized by high turnover, strong self-retention, and the presence of high-value species, a denser and more closely spaced network of protected areas is required, although these factors alone are not sufficient to ensure effective network functioning. In contrast, in areas identified as sink or source with low biodiversity value, conservation efforts should prioritize mitigating the pressures that prevent the establishment of healthier communities, rather than expanding protection. These findings can support systematic conservation planning processes aimed at designing coherent MPA networks.

Bridging gaps between Designations and Protections in MPAs in Portugal - Madeira Archipelago as a Case Study (S3-OC-17)

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Marine Protected Areas (MPAs) are vital tools for ocean conservation, and international targets aim to rapidly increase their number and size. However, their effectiveness remains unclear, often due to the lack of a harmonized framework to assess the level of protection effectively provided. This results in a lack of consistency and the potential overestimation of conservation outcomes. This study clarifies the status of MPAs in Portugal by reviewing existing designations and assessing their quality using the MPA Guide framework. It evaluates areas through two lenses: Stage of Establishment and Level of Protection. A comprehensive database of Portuguese MPA designations was compiled by cross-referencing the World Database on Protected Areas with MPAtlas. Overlapping designations were combined into functional conservation units based on spatial relationships. Madeira's MPAs were assessed using the MPA Guide framework. The study reveals a significant discrepancy between legal administrative designations and functional conservation units. While 226 active designations are listed across Portuguese waters, these correspond to only 98 distinct functional units. This redundancy is most pronounced in Mainland Portugal, where the ratio of legal designations to functional conservation areas is nearly 3:1, compared to approximately 2.2:1 in the Azores and Madeira. Although all designations are listed on the MPAtlas, only 31 have been evaluated using the MPA Guide. In the Madeira Archipelago, 83.3% of designated zones are operational, 75% 'Actively Managed', and 8.3% 'Implemented'. The remaining 16.7% are 'Designated' and 'Proposed', lacking active management plans. Within the operational zones, only 20% achieve 'Full Protection', with the remainder classified as 'Highly' (40%), 'Lightly' (20%), or 'Minimally' Protected (20%). These findings suggest that more standardized assessment is needed and that spatial coverage alone is an insufficient proxy for success. A harmonized classification system, such as the MPS Guide, could help reduce confusion created by overlapping designations and support meaningful conservation outcomes.

From Policy Objectives to Operational Indicators: A Participatory Workflow for Monitoring Marine Protected Area Networks (S3-OC-23)

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Marine Protected Area Networks (MPAn) are intended to enhance ecological connectivity, representativeness, and resilience while supporting coordinated management across jurisdictions. Despite their increasing prominence in international policy, evaluation efforts remain largely focused on individual MPAs, limiting the assessment of network-scale properties such as coherence, complementarity, and collective contribution to conservation targets. Effective monitoring of MPAn therefore requires integrated ecological, socio-economic, and governance indicators aligned with network-level objectives. Using Portugal's MPAn, this study developed a structured and participatory methodology to identify and prioritise indicators for network-level monitoring. The process combined a review of national and regional MPA management plans and policy documents with the selection, adaptation, harmonisation, and development of indicators, the formulation of measurable questions (designed to assess whether network objectives are being achieved), and iterative expert engagement. Experts from academia, public authorities, and non-governmental organisations, representing mainland Portugal, the Azores, and Madeira, contributed throughout three workshops, ensuring continuous validation and refinement. The resulting workflow established a transparent pathway from strategic management objectives to operational monitoring indicators. This approach reduced redundancy, improved conceptual clarity, and ensured explicit alignment between indicators and network-level goals. The final framework comprises 55 indicators: 23 governance, 18 socio-economic, and 14 biophysical. This distribution reflects the multidimensional nature of MPAn performance and highlights the importance of governance and social dimensions alongside ecological outcomes. Most indicators were adapted or specifically developed to address the needs of Portugal's MPAn, while maintaining consistency with existing management instruments and scientific knowledge. Overall, this work provides a scientifically robust and operationally feasible framework for harmonised network-level monitoring in Portugal. The methodology is adaptable to other MPAn contexts and offers a practical basis for strengthening evaluation, reporting, and adaptive management in marine conservation.

Towards a Marine Biological Corridor in the European Macaronesia: Status, Gaps and Conservation Synergies (S3-OC-22)

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The oceanic archipelagos of Azores, Madeira (including Selvagens) and Canaries, located in the Northeast Atlantic, support marine ecosystems of notable biodiversity and megafauna, underpinning key economic sectors. Despite the implementation of Marine Protected Areas (MPAs), migratory species remain vulnerable in offshore waters, where they face increasing anthropogenic pressures. We synthesised available evidence on ecological connectivity among the European Macaronesian archipelagos for key groups of marine megafauna, including large pelagic teleosts, elasmobranchs, turtles, seabirds and marine mammals, while considering connections with the broader Atlantic to compare the identified movement patterns, key habitats and major knowledge gaps. Our results indicate that many highly motile species regularly move among the three archipelagos, using them as migratory stepping stones for feeding, breeding and nursery areas. Connectivity patterns follow seasonal trends and are associated with major oceanographic features. Although the strength of evidence varies across taxonomic groups, the literature review conducted points to recurrent connectivity across the region. This assessment provides a scientific basis for considering a marine biological corridor as a transnational conservation tool linking the European Macaronesian archipelagos in Areas Beyond National Jurisdiction (ABNJ). In synergy with existing regulatory frameworks and with the opportunities gained by the recently enacted Biodiversity Beyond National Jurisdiction (BBNJ) Agreement, such a corridor could contribute to major conservation goals in oceanic island systems.

Thursday, 9th July

Session 1 - Marine Biodiversity & Ecosystem Functioning

The functional footprint of small-scale fisheries on Mediterranean coralligenous reefs: selective removal of seascape ecosystem engineers (S1-OC-27)

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Small-scale fisheries (SSF) are often perceived as low-impact activities, yet their cumulative effects on the functional integrity of complex benthic habitats remain poorly quantified. Using a trait-based approach, we assessed the functional footprint of trammel nets on Mediterranean coralligenous habitats by comparing the functional profile of sessile benthic bycatch with standing community inside and outside a Marine Protected Area (MPA). Bycatch accounted for over 25% of total functional space, disproportionately targeting seascape engineers and indicating high potential for functional erosion. The lack of differences in bycatch functional composition between protected and unprotected areas suggests that impacts are driven by gear selectivity rather than fishing effort. This pattern indicates that functional erosion is not site-specific but reflects a widespread issue that should be prioritized in conservation management. Our results challenge the sustainability of current gear regulations within MPAs and highlight the need for trait-based strategies to preserve ecosystem integrity and functioning.

Marine Animal Forests as functional engines: Biotic filtering overrides biogeographic variability in the Mediterranean (S1-OC-15)

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Understanding how local biotic filters imposed by habitat-forming species interact with regional biogeographic constraints remains a central challenge in community ecology. We evaluated the engineering role of the red gorgonian *Paramuricea clavata* across seven Western-Central Mediterranean locations, integrating taxonomic and trait-based approaches along a depth gradient. While benthic assemblages exhibited strong regional taxonomic turnover, functional identity converged strikingly within forests, decoupling species composition from ecosystem functioning. This pattern reveals that marine animal forests constrain ecosystem functioning beyond the limits imposed by regional species pools. Concurrently, engineer tissue necrosis nearly doubled over a single summer, signalling increasing thermal stress. Our results identify *P. clavata* forests as critical yet vulnerable functional engines that buffer environmental stochasticity and stabilize ecosystem functioning across spatial scales under accelerating climate change.

Integrating functional and ecological traits perspective with taxonomic diversity to define marine hotspots at global scale (S1-OC-32)

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At the community level, biodiversity is often assessed through taxonomic and/or genetic diversity, which is intrinsically valuable but misses key functional aspects to fully assess ecological roles and ecosystem services. Therefore, a merely taxonomic perspective on biodiversity is limited, and other complementary visions could be adopted, such as focusing on species' functional and ecological traits. Here, traits are defined as measurable characteristics of a species that directly or indirectly affect its functions and reflect the ecological role that such a species plays in an ecosystem. Trait diversity represents the basis for the assessment of ecosystem functioning, and it is thus more straightforwardly related to key concepts for nature conservation, such as ecosystem services and ecological resilience, than taxonomy. Therefore, we created AMARO, a database of functional and ecological traits for marine species that was built by homogenizing 10 of the most relevant online databases of traits. This database contains data for 31,716 species covering the whole marine food web, from primary producers to marine birds. AMARO has 663 traits covering several perspectives on species ecological functions and roles: from the habitat and environmental preferences to morphology or reproduction strategies. We ran principal component and principal coordinates analyses on the AMARO database, focusing on those traits for which at least a 50% degree of completeness across species was achieved, to detect those traits explaining the largest variance of trait values and to detect groups of traits that are correlated. AMARO was coupled with probabilistic outputs of AquaMaps species distribution models to map global marine biodiversity and hotspots for conservation, both in terms of taxonomic and trait diversity with a resolution grid of 0.5°x0.5°. To do so, we performed a multicriteria analysis combining species richness across world oceans with the diversity of trait values, focusing on traits selected based on their ecological relevance and on the multivariate analysis outcomes. Diversity of trait values over space was evaluated through the Shannon Index. Our results clearly show that considering trait diversity in addition to species richness can change our perspective on spatial biodiversity hotspots in the global oceans, revealing new key areas for conservation. Hence, trait diversity should be accounted for in marine governance.

River plume-driven structuring of coastal ecosystems: pelagic and benthic responses to cumulative stressors (S1-OC-06)

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To enhance understanding of coastal ecosystem dynamics under multiple stressors, we carried out experimental studies in the Gulf of Trieste (northern Adriatic Sea), a shallow, semi-enclosed basin influenced by the Isonzo River, the main pathway of historical mercury (Hg) contamination. A comparative approach was adopted to examine two distinct conditions: an autumn plume (October 2024), following a prolonged dry period, and a late spring plume (May 2025), following moderate but persistent rainfall. Water column properties were measured immediately after the plume formation, while sediment biogeochemical variables were investigated one month later to evaluate the impact of riverine input and Hg on benthic microbial communities. Near the river mouth, dissolved Hg concentrations were five times higher in spring (25.1 ng/L) than in autumn (5.06 ng/L). Conversely, methylmercury (MeHg) in surface sediments was higher in autumn (up to 9.34 µg/kg) than in spring (<2 µg/kg). This indicates seasonal decoupling between dissolved Hg inputs and MeHg accumulation in sediments. Primary production in the water column was low near the river mouth due to high turbidity. In contrast, benthic heterotrophic processes dominated in late spring, characterized by an increase in prokaryotic carbon production (+40.2±31.5%). Despite strong currents, a well-developed microphytobenthic community was observed, exhibiting high benthic primary production, with an abundance of diatom species associated with organic enrichment near the river mouth. These results highlight how river plumes seasonally modulate coastal ecosystems under combined stressors, providing insight into ecosystem resilience and biogeochemical dynamics.

Integrating benthic nematode and bacterial communities to assess spatial-temporal dynamics and ecosystem functioning in estuarine sediments (S1-OC-29)

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Estuarine sediments are important carbon reservoirs. Biogeochemical key processes such as recycling of nutrients and degradation of pollutants, occur in intertidal and subtidal sediment habitats. Benthic communities dominated by microorganisms and metazoans play a central role in mediating these processes and energy pathways being powerful bioindicators of the habitat condition. The distribution patterns and the relationships between bacteria and nematodes communities reflect critical sediment ecological conditions that can be integrated to better understand sediment trophic conditions and the impact on energy pathways.

This study aimed to investigate the spatial and temporal interactions between benthic bacteria and nematodes communities and sediment biogeochemical conditions in the Sado Estuary (Portugal). Combining morphological and molecular approaches, such as 16S metagenomics, it was explored how biodiversity patterns reflect environmental gradients and ecosystem functioning. These groups exhibited distinct ecological response scales. Nematode assemblages showed strong spatial and temporal variability, responding rapidly to site-specific environmental changes, whereas bacterial communities were mainly structured by spatial variability, directly linked with sediment biogeochemical properties. Combining different approaches bacterial and nematode communities proved to be powerful ecological indicators capable of capturing the dynamics of benthic food webs of the Sado estuary.

Different scale responses of nematode and bacterial communities can provide a powerful framework linking biodiversity patterns with ecosystem functioning. Such functional insight can contribute to improving the evaluation and the development of future predictive frameworks that combine biodiversity data, metabolic pathways analyses, and advanced modelling approaches to assess carbon sequestration potential and support restoration and conservation strategies.

Unravelling megabenthic communities in cold-water coral mounds of the Angola Margin (SE Atlantic) (S1-OC-12)

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Cold-water corals (CWCs) are key deep-sea ecosystem engineers that form Vulnerable Marine Ecosystems (VMEs), yet the megabenthic communities they support remain understudied, especially beyond the NE Atlantic. In the Angolan margin, CWC mounds are covered by living reefs of *Desmophyllum pertusum* and *Madrepora oculata* within a present-day oxygen minimum zone ($\approx 0.5\text{--}1.5\text{ mL L}^{-1}$). This study investigates the occurrence, composition, and spatial distribution of megabenthic communities associated with these low-oxygen CWC reefs to improve knowledge of these habitats. Seafloor video and still imagery were collected during seven ROV georeferenced transects across six mound structures between 250–500m. The imagery was used to identify megabenthos and compile a morphospecies catalogue. Functional traits were assigned to each morphospecies, with emphasis on feeding mode, and taxa were cross-referenced with standardised image-based taxonomic reference/classification frameworks. Potential commercial relevance and conservation status were explored using different available sources (e.g. FAO and ICES). Annotation and quantification were performed in BIIGLE to describe taxonomic composition and spatial distribution. A total of 314 morphospecies were identified, dominated by sponges (28%), cnidarians (26%), and fishes (18%). Morphological diversity included various sponge growth forms (30%) and branching cnidarians, including black corals and octocorals (16%), which can contribute to three-dimensional habitat formation. Suspension/filter feeding were the main feeding modes (56%), reflecting dependence on particulate organic matter flux. Many taxa showed multiple trait modalities, which could be further explored as potential functional plasticity linked to morphology or ecological role. In total, 36,078 organisms were annotated, with cnidarians (44%) and sponges (43%) dominating abundance. Associated fauna included echinoderms (2%), fishes (3%), decapods (3%), and molluscs (0.12%), with variation among dives. Reef frameworks occurred together with sponge grounds, octocoral gardens, coral rubble, soft sediments, and authigenic carbonate structures, revealing habitat heterogeneity within and between mounds. Only a limited subset of morphospecies could be explored for commercial relevance and conservation status, and many taxa remain unevaluated or data deficient, limiting management inference. These observations show that scleractinian corals can persist under lower oxygen conditions than previously assumed and that oxygen-limited CWC habitats sustain diverse and complex megabenthic communities.

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Thriving benthic communities sustained by complex seafloor and ocean circulation beneath an Antarctic ice shelf (S1-OC-35)

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Antarctic ice shelves are floating extensions of the continental ice sheet, hundreds of meters thick that play a critical role in controlling global sea levels and have been retreating intensively in the last decades, affecting the ocean circulation and exposing areas of seafloor that had been covered for centuries. Ecosystems and water masses under ice shelves remain inaccessible for logistical reasons; a few drilling experiences and underwater vehicles data, limited in space and time, have only offered a glimpse of these enigmatic environments. We present the very first and most comprehensive ecological, oceanographic and geomorphological study of environments under ice shelves, carried out immediately after a massive calving event in the George VI ice shelf. ROV dives and sediment sampling revealed diverse and well-established communities, long-lived specimens and complex associations, with marked spatial heterogeneity. Large, slow-growing taxa, including sponges estimated to be centuries old, were widespread. Frequent epibiotic associations and the presence of taxa with limited dispersal capacity further support persistent, structured populations. Furthermore, taxonomic overlap with adjacent Antarctic shelf faunas indicates that these communities are not isolated, but part of a broader regional system in which exchange across ice-shelf margins contributes

to maintaining biodiversity and population structure. Meiofaunal assemblages were similarly diverse and consistent with typical deep-sea systems, reinforcing the interpretation of ecosystem maturity across size classes. The seafloor morphology is variable due to past glacial activity, and sediment composition indicates a transition from glacial to deglacial conditions. Ocean circulation and nutrient and pigment contents in sediments and water column suggest advection under the ice shelf, sustaining the communities. This study provides baseline data to assess future changes in these ecosystems due to ice shelf retreat, highlighting the potential for ecological transitions, disruption of carbon sequestration, and impacts on biodiversity and climate feedbacks.

Towards better understanding and predicting of *Calanus* patchiness using both marine and atmospheric drivers (S1-OC-23)

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Advances in high-resolution observations and data integration are transforming ocean monitoring and forecasting, enabling improved detection and prediction of ecological patterns. Understanding the distribution of *Calanus* spp. is particularly important, as these copepods represent a key energetic link between primary producers and higher trophic levels in North Atlantic and Arctic ecosystems. However, zooplankton distribution is inherently patchy, forming dense and short-lived aggregations that vary over spatial scales of kilometres and temporal scales of hours. Previous studies have primarily linked observed patchiness to hydrographic conditions such as temperature, salinity, stratification, and chlorophyll a. Yet atmospheric forcing can also rapidly influence the vertical and horizontal positioning of *Calanus* spp., affecting both its distribution and availability. Here, we analyse a unique multi-year, high-resolution dataset of plankton and particle observations collected using a Laser Optical Plankton Counter (LOPC) along repeated transects in European Arctic waters between 2010 and 2024 (0–50 m). These observations were complemented by concurrent CTD measurements and meteorological data collected onboard the R/V Oceania (Institute of Oceanology PAN). In addition, meteorological variables, including wind speed and direction, wave height, atmospheric pressure, cloud cover, and solar radiation, were supplemented with data from external online datasets and operational forecast products. This combined dataset enables a comprehensive assessment of how atmospheric and oceanographic processes jointly

shape zooplankton patch structure, with a focus on *Calanus* spp. The main objective of this study is to develop a methodological framework for assessing the role of atmospheric forcing in shaping zooplankton patchiness across spatial and temporal scales. All datasets were harmonised, quality-controlled, and integrated within a unified R-based workflow, enabling consistent analysis of driver–response relationships. This approach facilitates identification of conditions that enhance or disrupt aggregations and improves understanding of the physical mechanisms controlling surface zooplankton distributions. Ultimately, this work aims to support prediction of *Calanus* spp. patch occurrence, intensity, and structure under varying atmospheric conditions, contributing to biodiversity conservation, fisheries management, and the assessment of climate-driven changes in marine ecosystems.

Age estimation of the European flying squid *Todarodes sagittatus* in the Central Mediterranean Sea (S1-OC-02)

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Todarodes sagittatus (Lamarck, 1798) is a pelagic cephalopod widely distributed in the Mediterranean Sea and the Northeast Atlantic, where it plays a key role in marine biodiversity and pelagic food webs. It also represents an important resource for both small-scale and industrial fisheries, however, biological knowledge in Mediterranean waters remains limited hindering reliable stock assessment and the development of effective, sustainable management strategies. In this study, the age and growth of *T. sagittatus* from the Central Mediterranean were investigated using two hard structures: statoliths and beaks, based on 152 wild specimens of both sexes and maturity stages collected around Sardinia and Sicily. Daily growth increments were analysed in both structures, with beaks explored here for the first time as a novel approach. Significant differences in growth and weight-length relationship were observed between sexes (Kolmogorov-Smirnov test with *p-value* <0.05), due to females reaching a larger

size than males. All statoliths and beaks showed well defined growth increments and low IAPE and CV values, confirming the accuracy and good reproducibility of age readings. Statoliths (100-286 [189±48]) and beaks (107-290 [185±55]) showed a number of increments consistent with the size and maturity of the specimens. The ANOVA test confirmed a strong significant relationship between the number of growth increments in beaks and statoliths, suggesting that the beak can be considered a valid alternative to statoliths for age estimation in *T. sagittatus*. The absolute growth rates gradually decreased within age classes in both sexes however females grow faster than males. According to a semelparous cycle, the estimated ages for the largest mature female (ML=420 mm, TW= 2960, 286-290 days) and mature male (ML=290 mm, TW= 1004g; 229-230 days) suggest a lifespan of less than one year.

Alginate utilization drives variations in bacterial community dynamics in coastal ecosystems (S1-OC-04)

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Macroalgae play a key role as primary producers in coastal ecosystems, serving as an important reservoir of organic matter. Among the compounds they contain, alginate is the most abundant polysaccharide in brown algal biomass. This complex substrate represents a significant carbon source that is remineralized by heterotrophic bacteria in these environments. In this study, we address the dynamics of microbial community structure in a kelp-dominated pool during alginate degradation. We employed high throughput 16S metabarcoding sequencing to survey the taxonomic composition of the epibiotic and water-column bacterial communities. Meanwhile, shifts in the microbial community structure over time were monitored in a microcosm experiment under two conditions: a seawater control and seawater supplemented with a low concentration of alginate. We found that the alginate consumption in the microcosms was correlated with an increase in bacterial growth rate within 17 hours, as well as with a higher intraspecific diversity over time compared to unamended controls. β -diversity analysis further revealed that variation in the microbial community structure was driven by the source (seaweed surface or seawater), incubation time, and alginate enrichment in seawater treatments. We could detect several fluctuations in the relative abundance within seawater bacterial communities. Over the course of time, *Vibrio* and *Pseudoalteromonas* (Gammaproteobacteria) became the most abundant genera in the alginate-enriched community, while *Arcobacteraceae* dominated the control. Different patterns were

detected in the taxonomic composition in seaweed communities, with *Hellea* (Alphaproteobacteria), *Blastopirellula* (Planctomycetia) and the Sva0996 marine group (Acidimicrobiia) being the most relevant members. These results provide evidence of differences in the microbial community dynamics in environments where alginate is an important carbon source such as in brown algae biofilms and the surrounding seawater. We evidenced how the enrichment of seawater with a low input of alginate can reveal the succession in the bacterial community within a few days, due to the utilization of this substrate by specialized members in coastal ecosystems.

Comparative physiological response of native and nonnative Northern European bivalve species to temperature and seston composition (S1-OC-22)

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In Europe, non-native Manila clam, *Ruditapes philippinarum*, has expanded its range with the coastal Wadden Sea (southern North Sea) representing one of the newest, highest-latitude populations. We compared physiological and behavioral responses to seston composition and temperature between nonnative Manila clam and native cockle, *Cerastoderma edule*. First, bivalves were exposed to increasing turbidity at varying food concentrations. Significant differences in baseline physiology were found, with clearance rate, respiration, and valve opening consistently higher for cockle than Manila clam. However, trends in response to increasing turbidity were comparable. Next, rates of clearance, ingestion and respiration, and valve movement and absorption efficiency were measured after acclimation to a high turbidity, low food environment at two discrete temperatures (15 and 25°C). Significantly different valve strategies were found between the species at both temperatures, with cockle retaining active and open valve behavior, while Manila clam had passive valve behavior, marked by a narrow opening and little fluctuation. At 15°C, respiration and ingestion were not significantly different between the species. At 25°C, both species reduced ingestion, but only cockle had increased rates of respiration. The passive valve activity, reduced ingestion and relatively low respiration rates by Manila clam are energetically efficient and align with its broad thermal tolerance.

The reduced ingestion and increased respiration by cockle, however, would lead to an energy deficit if conditions remain long-term. Increasing water temperatures in the Wadden sea could thus result in a competitive displacement of native cockle by Manila clam.

When reproduction meets infection: *Perkinsus olseni* in Manila clams (S1-OC-39)

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Bivalve reproduction represents a major energetic investment that constrain resources available for maintenance and defense, potentially modulating susceptibility to parasitic infection. This trade-off is particularly relevant in the ecosystem engineer Manila clam *Ruditapes philippinarum*. This species is frequently infected by the protozoan *Perkinsus olseni*, but the extent to which host reproductive stage influences the effects of parasitic infection on its engineering activity remains poorly understood. This study aimed to assess whether the impact of *P. olseni* infection on the ecosystem behavior of *R. philippinarum* varies depending on reproductive stage. Uninfected clams at pre- and post-reproductive stages were experimentally exposed to a sublethal dose of the parasite. Two weeks post-infection, individuals were placed in sediment cores to quantify their impact on sediment particle transport and influence on sediment oxygen demand and nutrient fluxes (NO_x, dSi, PO₄³⁻). Infection intensity was quantified using qPCR on gill tissues. At the pre-reproductive stage, parasitic infection had no significant effect on the sediment transport activity of the bivalves, nor on their influence in nutrient cycling. However, a marked reduction in inter-individual variability was observed in infected clams compared to uninfected ones, suggesting a homogenization of the bivalve's functional responses under infection stress. Such a loss of behavioral variability may reflect constrained energetic allocation and/or altered physiological regulation, which could have ecological implications, such as changes in the modulating role of the bivalve influencing sediment dynamics or benthic community structure. Analyses of the post-reproductive stage are ongoing, but stronger negative effects are expected due to the reduced physiological condition of clams following reproduction. Overall, these results highlight the importance of host physiological state in mediating parasite effects and suggest that sublethal infections may alter ecosystem

functioning by reducing functional variability within populations rather than by affecting the mean activity of the host population.

Linking trophic ecology and larval condition in Baltic herring using CSIA-AA and RNA:DNA ratios (S1-OC-08)

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Elucidating the trophic pathways that sustain fish larval development remains a major challenge in marine ecology. In this study, we use spring-spawning herring (*Clupea harengus*) larvae from the Vistula Lagoon (southern Baltic Sea) as a case study. We evaluate whether compound-specific stable isotope analysis of amino acids (CSIA-AA) can better resolve trophic positions and identify basal carbon sources supporting larval growth, compared to bulk stable isotope analysis. During two spring 2025 sampling campaigns, herring larvae, mesozooplankton, suspended particulate organic matter, and sedimentary organic matter were collected at two stations in the Vistula Lagoon. All samples were analyzed for bulk stable isotope ratios ($\delta^{15}\text{N}$, $\delta^{13}\text{C}$), while herring larvae were additionally assessed for growth metrics and CSIA-AA ($\delta^{15}\text{N}$, $\delta^{13}\text{C}$). We find that CSIA-AA improves the resolution of trophic pathways and basal carbon sources relative to bulk stable isotope analysis, thereby enhancing understanding of carbon and nitrogen dynamics supporting early life stages of fish. To further link trophic support with larval condition, we extend the CSIA-AA approach by integrating RNA:DNA ratios measured in the same individuals. Herring larvae will be collected in spring 2026 to apply this combined approach, enabling direct coupling of individual feeding histories with physiological condition. This integrative approach advances our ability to link trophic pathways with larval condition, providing a more mechanistic understanding of early life stage dynamics in marine ecosystems.

Bright and dark spots after the heatwave: shifting fish contributions to Nature and People on temperate reefs (S1-OC-13)

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Climate change is reshaping marine ecosystems, yet it remains unclear how direct and indirect disturbances affect the capacity of fish communities to sustain ecosystem functioning and human well-being. We addressed this by translating reef fish composition, abundance, and size data into two averaged synthetic scores representing contributions to nature and people. “Nature for nature” captures the ecosystem’s ability to sustain its own health and ecological functions, whereas “Nature for People” reflects the benefits humans receive from the ocean, including fisheries potential, food security, and essential micronutrients. The underlying indicators included total biomass, the distribution of biomass across functional groups, secondary production, turnover, diversity, and micronutrient content in reef fish, derived from standardized underwater surveys conducted from 2017 to 2024 along a ~600 km latitudinal gradient across the Baja California Peninsula following the 2014 to 2016 marine heatwave. Our results suggest a mosaic of “bright” and “dark” spots shaped by local ecological conditions, disturbance history, and management context. Contributions to nature and to people were positively related, with benefits for people such as fish biomass and productivity increasing where proxies for ecosystem functioning were greater. This relationship disappeared when people-related contributions were based only on biomass-standardized nutrient density, as the nutritional value per fish and per portion remained broadly similar despite declines in biomass and productivity. By linking ecological indicators to fisheries and nutrition, this study helps track ecosystem responses to climate change and supports management in advancing progress toward SDG 14 (Life Below Water) and SDG 2 (Zero Hunger).

Dolphin Diet Detectives: Unveiling Dolphin Diets and Engaging Communities in Cardigan Bay, West Wales, UK (S1-OC-07)

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Bottlenose dolphins *Tursiops truncatus* in Cardigan Bay, Wales UK, are important for the blue economy. Dietary ecology knowledge gaps hinder safeguarding prey species, and in turn dolphins, under Special Areas of Conservation (SAC) management frameworks. We used mixed methods to investigate marine community assemblages, including seasonality, abundance, and dolphin prey selection. Seawater and dolphin faecal environmental DNA (eDNA) metabarcoding was complemented by baited remote underwater video stations (BRUVS) deployed seasonally. Preliminary analysis reveals a diverse diet of at least 25 fish taxa, including pelagic (e.g. mackerel, garfish) and demersal or reef-associated species (e.g. whiting, gurnard). Scarcity of small pelagic fish DNA in faeces was surprising given water eDNA abundance, while certain demersal fish were prevalent in faeces but not in water. Diet largely aligns with trends reported from conventional studies: gadid fish (whiting) are staple prey, supplemented seasonally by clupeids (herring), coastal fish, and squid. This suggests selective and opportunistic feeding with prey not consumed proportionally to availability. Ongoing analysis will elucidate high resolution spatial and temporal trends, including habitat and prey associations, and individual dolphin behaviours. Abundance trends were evident in BRUVS data. Gadidae (e.g. whiting) and Trachinidae (e.g. lesser weever) showed highest overall relative abundance, with whiting, greater weever, and Atlantic horse mackerel highest overall at species level. Callionymidae and Carangidae peaks in September 2025 were driven by dragonets and Atlantic horse mackerel, respectively, with whiting and greater weever peaks in June 2025. Whiting seasonality aligns with findings from the Severn Estuary, UK, while estimated sizes suggest Cardigan Bay as a nursery, warranting further attention given dolphin diet importance elsewhere. Dietary overlap with harbour porpoises may increase competition during high prey availability and seasonal influxes. Cardigan Bay dolphins appear to adjust prey with availability, reflecting a generalist predator that can specialise opportunistically. Our findings are the first regional empirical evidence of its kind. Despite relevance for regional SAC networks, further research should not only target high resolution insights for development of place-based management, but is urgent given environmental change that threatens these key marine predators.

Session 2 - Global Change and Multiple Stressors in Ocean Health

Toxicophenomics: A New Frontier in Marine Contaminants of Emerging Concern (CECs) Mixture Toxicity Screening (S2-OC-09)

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Coastal ecosystems are increasingly subjected to complex mixtures of contaminants of emerging concern (CECs), necessitating the development of rapid and sensitive methodologies capable of capturing biologically significant responses beyond traditional single-endpoint bioassays. In this study, we introduce toxicophenomics as a novel approach methodology (NAM) for high-throughput screening of marine contaminant mixtures, utilising the model diatom *Phaeodactylum tricornutum*. Cultures were exposed to environmentally relevant gradients of CEC mixtures in accordance with OECD-based growth inhibition assays, and stress responses were evaluated through pulse-amplitude modulated fluorometry. The complete chlorophyll a fluorescence induction curve (Kautsky effect), consisting of 456 fluorescence data points per measurement, was employed to generate high-resolution phenotypic fingerprints of exposure. Variable fluorescence signals were normalised to controls and analysed using linear discriminant analysis to classify exposure levels and derive an optical toxicity index (OPTOX) calibrated against growth descriptors. The fluorescence fingerprints effectively discriminated cells exposed to increasing mixture concentrations, with the most pronounced deviations observed at the highest exposure levels. All OPTOX versions efficiently tracked environmental relative concentrations and demonstrated strong correlations with growth inhibition and specific growth rate, affirming the robustness of the approach for toxicity prediction. By integrating bio-optical phenotyping with multivariate modelling, toxicophenomics offers a rapid, scalable, and mechanistically informative framework for marine ecotoxicology. This workflow enhances sensitivity in mixture toxicity screening, captures metabolic perturbations overlooked by traditional endpoints, and provides a transferable platform for other autotrophic organisms and stress scenarios following appropriate calibration. Toxicophenomics thus emerges as a promising next-generation tool to support coastal contamination assessment, environmental monitoring, and NAM-based ecotoxicological innovation.

Influence of field CO₂ enrichment reveals *Zostera noltii* response to ocean acidification (S2-OC-14)

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Under future ocean acidification scenario, seagrasses may benefit from the effect of increased seawater $p\text{CO}_2$, although their response may be species-specific and may also depend on several ecological factors. This study investigated the morphology and physiology of the seagrass *Zostera noltii* under the effect of increased CO₂ concentrations, using a field manipulative approach, and taking advantage of the presence of natural shallow submarine vents in Vulcano Island, Italy. A manipulative approach was used to compare transplanted plants from control pH sites to low pH site with translocated control pH plants, investigating the short-term acidification effect. A further observative approach was used to investigate the long-term acidification by comparing untouched plants living in control pH and low pH site. An overall improvement of the above-ground morphology was observed by the short-term acidification, although these differences were no more evident on the long-term acidification. Indeed, pigment contents were always higher in seagrass leaves under short- and long-term acidification effects. Therefore, *Z. noltii* could respond positively to the future acidification, as the observed rapid plasticity response may lead to an initial acclimation.

Out of Sync? How ALAN impacts circadian regulation in *Posidonia oceanica* (S2-OC-18)

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Life on Earth has evolved under the relentless alternation of day and night, leading to the development of highly conserved endogenous molecular clocks, known as circadian clocks. Many aspects of physiology, behaviour, and development are mediated by these biological timekeepers. However, the extensive adoption of electric lighting has exposed organisms to unprecedented artificial light at night (ALAN) for the first time in Earth's evolutionary history. Importantly, circadian clocks are synchronized to the daily light-dark alternation. Thus, by disrupting the natural light-dark cycle, ALAN also affects the alignment of biological processes to daily light cycles. In coastal marine environments, where seagrass meadows of *Posidonia oceanica* play an essential ecological role, the impact of ALAN on these rhythmic molecular processes remains largely unexplored. To address this gap, we designed a time-series experiment where *P. oceanica* beach-cast seeds were collected and grown for three months under two distinct photocycles: 1) a control light-dark cycle with a 14:10 h light: dark photoperiod and daytime irradiance of 40 mmol m⁻² s⁻¹; 2) and artificial light at night (ALAN), maintaining the same daytime parameters but introducing a nocturnal light intensity equivalent to 2% of the daytime irradiance. This approach aimed to identify the effects of light pollution on the development and physiology of *P. oceanica* by measuring morphology, photosynthetic parameters, and gene expression. Furthermore, after sample collection under LD, seedlings from both conditions were exposed to 48 hours of constant light (LL), with the same daily irradiance, to detect potential alterations of circadian rhythmic patterns in gene expression due to ALAN. Our preliminary results showed alterations in morphology but not in the photosynthetic parameters of seedlings exposed to ALAN compared to the control condition (LD). RNA-seq analysis revealed robust daily regulation, with 36% vs. 14% of the *P. oceanica* transcriptome exhibiting rhythmic expression in LD vs. LL cycles under control light conditions. These results provide the first high-resolution characterization of the seagrass molecular clock and suggest a strong dependency on external light cues for maintaining temporal orchestration in this foundational species.

Standing at water edges: Ecohydrological interactions between coastal groundwater discharge and intertidal community dynamics under global change (S2-OC-23)

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The intertidal zone of rocky shores is a critical ecological interface that supports high biodiversity and provides essential ecosystem services such as nurseries and refuges. However, these dynamic environments are increasingly threatened by the synergistic effects of global change and multiple anthropogenic stressors. While the role of submarine groundwater discharge (SGD) in coastal ecosystems is well-established, the specific impacts of Intertidal Groundwater Discharge (IGD) on rocky habitats remain scattered and understudied. This work introduces the IGD concept to provide a standardized framework for distinguishing direct inland groundwater discharge into intertidal zones from other coastal flows. Coastal groundwater serves as a significant pathway for nutrient enrichment, which can stimulate primary productivity, but it also transports multiple stressors, including chemical pollutants, pesticides, and heavy metals from agricultural and industrial activities. Under the pressure of global change, these ecohydrological interactions are becoming increasingly complex. Climate-driven shifts such as rising sea levels, altered precipitation patterns, and increasing temperatures are expected to modify the volume, frequency, and chemical composition of IGD, thereby altering the salinity and thermal regimes of intertidal habitats. These changes directly influence species distribution, vertical zonation patterns, and the overall stability of these biodiversity hotspots. By integrating hydrogeochemical insights with ecological observations, this review identifies critical gaps in current knowledge and proposes a multidisciplinary methodological framework for assessing groundwater-mediated processes. The results highlight how IGD acts as both a resource and a stressor, shaping the resilience and adaptability of marine life. This synthesis is essential for developing informed conservation strategies, such as those aligned with the EU Water Framework Directive, to safeguard the functionality of vulnerable coastal habitats against cumulative environmental shifts. A robust understanding of these interactions is crucial for predicting how intertidal ecosystems will respond to the combined impacts of human activity and a changing climate, ensuring the long-term sustainability of ocean health.

***Nucella lapillus* in the Atlantic shores of the Iberian Peninsula. Range shifts, changes in reproductive pattern and maybe a refuge (S2-OC-20)**

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The dogwhelk *Nucella lapillus* used to be a widespread species in rocky intertidal shores of the Iberian Peninsula, where it reaches its southern limit of distribution. During 2014, 168 rocky shores were visited along the Atlantic coast of the Iberian Peninsula. At each rocky shore, the presence and abundance of *N. lapillus* was recorded. Southern to Lisbon, only 2 individuals of *N. lapillus* were found in a rocky shore. Between Lisbon and Aguda (North Portugal), the species was irregularly present in few rocky shores whereas in northern Portugal and Galicia, it was frequent and relatively abundant. Therefore, a clear northward shift in the historical distribution of *N. lapillus* was documented. Similar range shifts have been observed in many intertidal species in the study area, generally related to global warming. However, experiments showed that *Nucella* tolerates air temperatures about 36°C and water temperatures about 33°C. Therefore, changes on its distribution and abundance seems to be related to sublethal effects of temperature. Its reproductive pattern was monitored, for a year, in exposed rocky shores at northern Portugal and Galicia. Prior research on temperate areas shows that *Nucella* can breed during the whole year, with a peak in spring. However, our data showed that currently, the reproductive activity of *Nucella* reached a peak in January, then decreasing fast during winter and early spring and disappeared from May to October, where reproductive activity restarted. Thus, our results showed a reduction in the reproductive period of *Nucella* that may compromise the viability of its populations. However, during this monitoring, the presence of reproductive activity in the inner part of the Ría de Pontevedra was observed even during summer. Thus, during the next year, reproduction was monitored in the inner part of Ría de Pontevedra. Results showed a variable but

continuous reproductive activity, in contrast with exposed rocky shores. Therefore, inner part of Rías and other sheltered habitats may serve as refuge for *N. lapillus*. Moreover, previous research showed that *N. lapillus* populations within Rías are genetically different to those from exposed rocky shores. Therefore, future experiments will be needed to explore the role of environmental conditions or genetic differences in shaping its reproductive pattern in exposed and sheltered *N. lapillus* populations.

Benthic communities and their environmental drivers in the Tagus estuary: 20 years of change (S2-OC-16)

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Estuaries are dynamic transitional zones shaped by strong physical, chemical and biological gradients, making them highly productive yet vulnerable to natural and anthropogenic pressures. The Tagus estuary, the largest in Portugal, hosts diverse benthic communities influenced by long-term environmental changes, including pollution, climate change, impacts of fishing activities and biological invasions. Understanding temporal ecological responses in such systems is essential for effective monitoring and adaptive management. Long-term changes in benthic macroinvertebrate communities in the Tagus estuary were assessed in this study over a 20-year period, together with the ecological factors that underlie these changes. Four ecological indicators were examined using occurrence(o)- and abundance(a) data: Bottom-Trawling Sensitivity (BTS), Non-Indigenous Species (NIS), Ecological Quality (EQ), and Climatic Affinity (CA). Spatio-temporal variations were evaluated using multivariate analyses (PERMANOVA, PCO) and non-parametric tests (Friedman with Dunn–Bonferroni post hoc). Results showed significant changes in the taxonomic composition over time, with a gradual increase in taxonomic richness across two decades and a marked decline in total abundance from 2003 to 2014. Early years were dominated by polychaetes linked to degraded conditions, while later years showed a shift towards species typical of improved environmental quality. Indicator responses differed between weighting methods. Occurrence-based indicators were more stable over time, with Cao reflecting persistent dominance of temperate Iberian species. Ego increased, consistent with ecological recovery. NISO showed a slight increase. BTS increased, indicating recovery of benthic species sensitive to bottom disturbance. Abundance-based indicators showed stronger shifts, increasing until 2021, stabilizing thereafter, suggesting a community re-equilibration. Temporal

changes in the ecological attributes were much stronger than those associated to spatial variation. Community changes were mainly driven by an improvement in ecological quality, an increase of non-indigenous species, and complex responses to benthic disturbance. This supports the use of a multi-indicator index that integrates the resilience and vulnerability of estuarine ecosystem as a management tool.

CCTBON: Temperature and biodiversity monitoring on rocky shores across the entire Atlantic Ocean (S2-OC-12)

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The CCTBON (Coupled Coastal Temperature and Biodiversity Observation Network) project is an initiative aimed at monitoring temperature and biodiversity patterns in rocky shore ecosystems across the entire Atlantic Ocean. Recognizing the importance of these ecosystems in the context of climate change, the project provides a standardized, cost-effective methodology for recording coastal temperature and biodiversity data across vast spatial and temporal scales, which is crucial for sustainable coastal resource management. By the end of 2026, CCTBON is expected to encompass approximately 360 operational sites representing a wide diversity of rocky shore ecosystems, spanning both margins of the Atlantic, from polar to tropical regions, and from macro- to micro-tidal environments. The network has already begun generating unprecedented datasets and will continue to do so over the coming decade, offering novel insights into the interplay between temperature and biodiversity. It is advancing our understanding of climate change impacts on coastal ecosystems, identifying climate refugia, and highlighting biodiversity hotspots essential for conservation and management strategies. This presentation will provide an overview of the CCTBON network, focusing on the practical aspects of establishing and managing a large-scale environmental monitoring program, including technological innovations, logistical challenges, and collaborative strategies. As the project transitions into its consolidation phase, we are actively seeking new partnerships to expand its scope and secure its long-term sustainability.

Integrating ecological modelling approaches in the digital twin of the ocean (S2-OC-13)

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This work develops an integrated ecological modelling tool within the DTO-BioFlow Project to support sustainable macroalgae aquaculture by combining mechanistic and spatial approaches in the Digital Twin of the Ocean (EDITO). Traditional habitat suitability models are widely used to identify environmentally suitable areas but do not represent temporal dynamics or ecological processes; this study addresses that gap by coupling process-based and statistical/spatial numerical approaches. A dynamic ecological model based on ordinary differential equations was implemented in STELLA and R to simulate kelp growth and biomass production (*Laminaria ochroleuca* and *Saccorhiza polyschides*), integrating environmental variables such as solar radiation, temperature, salinity, and light attenuation in the water column derived from observational and reanalysis datasets (CMEMS, ERA5). The model represents physiological processes, including growth, respiration, mortality, nutrient uptake, and internal nutrient quotas, and incorporates ecological interactions through grazing and the influence of surrounding macroalgal biomass, enabling representation of biodiversity effects and system-level responses. Climate data includes both historical data and future projections under high-emission scenarios (GLORYS, SSP5-8.5), allowing assessment of climate-driven variability in biomass. Preliminary simulations show temporal variability in kelp growth and biomass under present conditions, while climate change scenarios are being implemented, and model calibration and sensitivity analyses are ongoing to improve robustness and reduce uncertainty. In parallel, spatial modelling approaches will be coupled with dynamic outputs to identify suitable aquaculture areas by integrating environmental conditions, ecological interactions, and projected climate changes. The next phase focuses on integrating these coupled models into the EDITO infrastructure, linking spatial suitability with ecological dynamics to support marine spatial planning, site selection, and adaptive management of macroalgae aquaculture along the Portuguese coast, generating outputs relevant for aquaculture operators, marine planners, and regulatory agencies.

Session 3 - Marine Conservation, Management & Policy

Fate tracking of *Acropora cervicornis* colonies post-outplanting reveals genotype-specific responses to marine heatwaves (S3-OC-21)

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Caribbean coral reefs have suffered severe declines over the last several decades, leading to local extirpation and functional extinction of the critically endangered species, *Acropora cervicornis*. In response, coral restoration has become central to conservation efforts, yet genotype-specific stress resilience remains poorly integrated into restoration design, limiting overall success. Here, we evaluated thermal performance among *A. cervicornis* genotypes from a coral nursery at Little Cayman Island and subsequently monitored their physiological responses in the field during a 16-month common garden outplanting experiment that spanned the 2023 marine heatwave. Thermal performance curves (TPCs) generated under controlled conditions revealed visually distinct profiles among genotypes, but modeled thermal parameters did not differ significantly, suggesting broadly similar thermal ranges. In contrast, field-based physiological and survival data revealed significant genotype-specific differences in bleaching susceptibility, disease prevalence, and mortality. One genotype (OB) exhibited the highest thermal resistance, maintaining photosynthetic efficiency despite substantial endosymbiont loss, but also showed elevated disease susceptibility, suggesting a trade-off between tolerance traits. These results indicate that laboratory-derived TPCs may underestimate ecologically relevant variation in stress tolerance and highlight the need to maintain diverse genotypes in restoration programs. However, the limited genetic diversity within the *A. cervicornis* population at Little Cayman Island likely constrains its adaptive potential, leaving the future of both restoration success and species persistence in this region uncertain.

Advancing deep-ocean exploration and observation in Portugal: TwinDEEPS as a model for capacity and community building (S3-OC-11)

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The sustainable management and conservation of marine biodiversity is a critical challenge of our times that has been recognized at the highest levels of the scientific and political agendas globally. While technological advances allow us to explore previously inaccessible environments, systematic deep-sea exploration and observation remains restricted to a few countries due to inequitable access to tools and infrastructures, and limited human and institutional capacity. Funded by the Horizon Europe Research and Innovation framework programme, under the Widening mechanism, the TwinDEEPS project brings together CIIMAR (Portugal), NIOZ (The Netherlands), IMR (Norway), and AWI (Germany) to strengthen research and innovation capacity in deep-sea exploration and observation at CIIMAR and, more broadly, in Portugal. Using an integrated strategy combining participatory mapping and assessment, advanced training and networking, and stakeholder engagement, TwinDEEPS is implementing a comprehensive programme to train a new generation of highly skilled deep-sea researchers, build a national community of practitioners, and co-design a multidisciplinary deep-ocean observing strategy for Portugal, in line with national, European and global sustainable development objectives. To date, TwinDEEPS has trained over 55 researchers in various stages of their careers, from ECRs to principal researchers, through shipboard experiences, staff exchanges, technical workshops, and career development activities. Through the deployment of various observation and sampling tools, the TwinDEEPS campaign to the Gorringe Bank resulted in high-resolution visual surveys of the seafloor (48h of video collected with a towed camera and ROV), targeted sampling of biological material (120+ samples) and eDNA (45+ samples), in-situ monitoring of physical and chemical conditions at the benthic boundary layer (3-day benthic lander deployment), and detailed characterization of the water column (25 CTD casts). Outreach and communication activities implemented through school seminars, TV/newspaper pieces, social media posts, and science fairs, have reached over 800,000 people. Currently underway is the

establishment of a national network of deep-sea practitioners to discuss challenges and identify opportunities to advance this field of research in a coordinated way, and co-design a multidisciplinary deep-ocean observing strategy for Portugal. Notably, TwinDEEPS was endorsed as a UN Ocean Decade project under the Deep Ocean Observing Strategy (DOOS) global programme. Through this project we demonstrate how structured and multidisciplinary capacity-building and collaboration can strengthen a country's R&I capacity in a given scientific field. Linking to well established European and global networks further ensures the project's longer-term sustainability and impact. Learn more at: <https://twindeeps.eu> and follow TwinDEEPS on LinkedIn.

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Vulnerable Marine Ecosystems indicator taxa in the Bay of Biscay and the Iberian Coast ecoregion (S3-OC-12)

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Benthic communities regulate ecosystem processes through nutrient cycling, bioturbation and bioirrigation. They are a link in marine food webs supporting commercial fisheries and are fundamental to the integrity and health of marine ecosystems. Within these communities some taxa, such as corals, sponges, and sea pens, act as essential habitat-formers and are classified by FAO as Vulnerable Marine Ecosystem (VME) indicators, based on their uniqueness, functional significance, fragility, life-history traits, and structural complexity. VMEs are biodiversity hotspots characterized by high sensitivity and low resilience. Due to the longevity and slow growth and of their habitat-former species, VMEs are exceptionally susceptible to anthropogenic impacts, with recovery potentially taking centuries. This study aims to analyze the distribution of VMEs along the Portuguese Margin to provide critical data for conservation. Data on VME indicator taxa, EUNIS habitat distribution, anthropogenic activities, and seafloor characterization across the Iberian Margin and Bay of Biscay Marine Ecoregion were integrated from ICES database, EMODnet, EUSeaMap, and GEBCO. All spatial

analyses were conducted using QGIS 3.44. The results reveal a significant disparity in data availability across the ecoregion. While the Bay of Biscay and the Cantabrian Seashore show a high density of VME occurrences, the Portuguese Margin exhibits a striking lack of reported records. Overall, VME indicator taxa are most abundant in the transition between the continental shelf and slope. Further on the analysis, EUNIS habitats from the upper bathyal have 2-3 times more VME indicator taxa than the circalittoral, particularly regarding stony corals, black corals and gorgonians. Conversely, circalittoral habitats are dominated by sponge aggregations and sea-pen fields. We conclude that the data gap on the Portuguese Margin does not imply an absence of VMEs, but rather a deficit in systematic seafloor observations. There is an urgent need for targeted deep-sea surveys and non-invasive predictive modelling. Future efforts should prioritize ROV surveys in unexplored areas of the ecoregion, particularly the Portuguese Margin for a more accurate biodiversity knowledge to support conservation measures and provide a robust foundation for marine spatial management.

Short-term colonisation of artificial substrates in degraded habitats under different upwelling conditions: different outcomes of the same mitigation strategy (S3-OC-13)

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Recreational marinas are increasing worldwide to meet the growing demand for leisure boating. However, their construction and functioning have multiple environmental impacts, including extensive habitat fragmentation and loss, increased pollutant concentrations, and the introduction of non-indigenous species (NIS). These impacts compromise native biodiversity and ecosystem functioning, making marinas degraded habitats where mitigation strategies are needed. In marinas, enhancing habitat complexity through the addition of artificial substrates (AS) has been shown to facilitate the colonisation of native ecosystem engineers (EE). They increase biodiversity by its associated epibionts, reduce the occurrence of NIS, and improve water quality through

filtration and carbon sequestration. However, the influence of environmental conditions on the effectiveness of these strategies remains poorly understood. To investigate this, a short-term colonisation experiment was conducted in four marinas of the NW Iberian Peninsula under two different upwelling conditions: two marinas in northern Portugal, a region under strong upwelling influence (hereafter Upwelling), and two in NW Spain, with no upwelling influence (hereafter Non-Upwelling). At each marina, four AS were deployed for three months, and colonising assemblages were examined. Upwelling conditions significantly shaped the abundance and multivariate structure of sessile assemblages, whereas species richness and Shannon diversity index were not affected. The abundance of sessile epibionts was 16 times higher in Upwelling than in Non-Upwelling, driven by the large dominance of two native EE—the mussel *Mytilus galloprovincialis* and the barnacle *Perforatus perforatus*—which were scarce in Non-Upwelling. In contrast, assemblages under Non-Upwelling were dominated by the spirorbid *Janua heterostropha* and the NIS bryozoans *Tricellaria inopinata* and *Watersipora subatra*. Our findings demonstrate that, at short-term, AS under upwelling influence promote native EE, which in turn enhance biodiversity through their associated sessile and mobile epibionts. Conversely, under non-upwelling influence, the same AS may favour the colonisation of NIS rather than natives, compromising ecological improvement. These results highlight that the outcome of mitigation strategies is context-dependent and provide relevant insights for their implementation under the recently approved Nature Restoration Law (EU 2024/1991).

Integrating Habitat Modelling and Cumulative Effects Assessment to Support MSFD Implementation in the Continental Portuguese Deep Sea (S3-OC-15)

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The increasing intensity and spatial overlap of human activities in deep-sea ecosystems demand integrated approaches to assess cumulative pressures and support ecosystem-based management under the Marine Strategy Framework Directive (MSFD). However, the limited resolution and coverage of benthic habitat data remain a major constraint for robust risk assessments in the Portuguese deep sea. To address this gap, we developed a non-hierarchical, top-down habitat modeling approach aimed at improving the mapping of deep-sea habitats within the Exclusive Economic Zones of mainland Portugal by integrating terrain variables, near-seafloor oceanographic conditions, and water mass characteristics. The habitat classification was then refined

using substrate-type predictions from a Random Forest model, along with the potential distribution of cold-water corals, key components of Vulnerable Marine Ecosystems, derived from publicly available ecological niche models. The habitat model estimated higher spatial heterogeneity than previously described, particularly along continental slopes, seamounts, and submarine canyons. These habitat layers were integrated with spatial pressure data to conduct a Cumulative Effects Assessment (CEA) and identify areas at higher risk of ecosystem degradation. This framework was implemented with the TIKTA tool, developed within the GES4SEAS project, which enables the integration, analysis, and visualisation of environmental data to support CEA and MSFD implementation. The resulting outputs enable comparison with previous assessments, facilitating the evaluation of alternative scenarios and the exploration of associated uncertainties, thereby helping to guide future research priorities and support the implementation of the MSFD.

Can enhanced thermal tolerance adaptation be another key factor explaining invasiveness of *Rugulopteryx okamurae*? (S3-OC-03)

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Global ocean warming and the proliferation of non-indigenous species (NIS) represent synergistic threats to marine biodiversity. Overall, rising temperatures and the increase in frequency and intensity of extreme warming events may act as environmental filters that disadvantage native organisms while facilitating the colonisation by NIS. Since 2016, the invasive brown alga *Rugulopteryx okamurae* has caused severe ecological and socioeconomic disruption in the Mediterranean and the Strait of Gibraltar. This study investigates whether the invasive success of *R. okamurae* is driven by superior thermal tolerance capacity and adaptability compared to the native species *Halopteris scoparia*. Two morphotypes of *R. okamurae* (thick, ROG; intermediate, ROI) and native *Halopteris scoparia* were collected from the coast of Málaga, Spain. To simulate the accumulation of acute thermal stress (TS), samples were subjected to continuous temperature ramps

(15°C to 48°C) over varying durations (3, 6, 12, and 24 hours) following acclimation to 15°C or 24°C. TS was monitored via chlorophyll a fluorescence (Diving-PAM) to determine thermal tolerance curves and upper critical thermal limits. Physiological recovery was assessed after a 48-hour post-stress period. Results revealed significant phenotypic plasticity within the invasive species. For *R. okamurae*, the ROI morphotype exhibited higher resistance to acute heat stress than the ROG morphotype. Notably, *R. okamurae* demonstrated enhanced resilience to higher maximum temperatures for shorter TS exposure times when acclimated to winter temperatures (15°C), suggesting an expanded environmental tolerance that may favor its expansion during transitional seasons. Comparative analysis showed divergent survival strategies: *R. okamurae* seemed highly resistant to acute, short-duration thermal spikes, whereas the native *H. scoparia* demonstrates superior physiological resilience to chronic, prolonged thermal stress. However, the invasive ROG morphotype showed poor recovery capacity (<20%) post-stress, highlighting a potential vulnerability to extreme events exceeding its threshold. Thermal resilience and adaptive capacity to temperature changes are decisive factors in shaping community composition. *R. okamurae*'s ability to withstand sudden, intense thermal spikes provides a significant competitive advantage in a volatile climate. Understanding these distinct thermal niches is essential for predicting the future restructuring of temperate benthic ecosystems, and adapt management strategies for NIS under climate change.

A Comparative Analysis of Risk Assessment Tools for Prioritization of Marine Non-Indigenous Species (S3-OC-19)

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Biological invasions are widely recognized as a major driver of biodiversity loss and ecosystem change in marine environments. As the rate of introductions of non-indigenous species (NIS) continues to increase, risk assessment tools (RATs) have become essential instruments for identifying, prioritizing, and managing potential invaders. Numerous tools have been developed for this purpose, but they differ substantially in structure, scoring frameworks, data requirements, and output formats. These differences can lead to divergent assessments when applied to the same species, complicating comparisons and management prioritization. This study compares the performance and

outputs of multiple commonly used RATs for marine NIS. Madeira was used as a case study, and ten marine NIS representing a wide range of taxa and ecological strategies were selected. Nine RATs without spatial or pathway restrictions were applied: AS-ISK, CMIST, GABLIS, GISS, GISS-IUCN, Harmonia+, NISST, WISC, and EICAT. RATs outputs were normalized to enable direct comparison of species rankings and scores. For prioritization purposes, RATs that provide a score proved more useful than those assigning species to categorical impact classes. Differences across RATs emerged in their structural and conceptual organization, particularly in the number and depth of questions and in the presence and structure of confidence scoring systems. In addition, RATs were analysed according to the impact categories they cover. While highly invasive NIS were continuously ranked among the highest-risk species across the applied RATs, including *Pterios volitans* or *Rugulopteryx okamurae*, other NIS, *Distaplia magnilarva* and *Asparagopsis taxiformis* generally ranked as lower risk taxa. In contrast, species such as *Cronius ruber* and *Branchiomma bairdi* showed substantial variability in their rankings across the used RATs. These divergences in rankings were largely attributed to structural and content-related differences in RATs, such as the impact categories covered or the depth of questioning. Furthermore, research intensity can act as a bias driver, as RATs outputs are strongly influenced by available information on each NIS. These findings highlight the importance of carefully selecting RATs for prioritization purposes, as each tool has specific applications and limitations. Overall, the comparison demonstrates variations in the final ranking of RATs and differences in their structural and conceptual organization.

Spatial-temporal variation of fouling alien species in Mediterranean port environment and its relationship with the biogeochemical variables (S3-OC-26)

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Port environments are highly anthropized coastal systems and key hotspots for biological invasions, where artificial substrates support diverse fouling assemblages often dominated by non-indigenous species (NIS). Understanding how environmental and biogeochemical factors influence their colonization is crucial to assess impacts on marine biodiversity and ecosystem functioning. Within the OMNIS project (*Organic Matter and Non-Indigenous Species success in ports*), this study investigates the spatial–temporal variability of fouling communities in the port of Livorno (Italy), focusing on NIS and their relationships with environmental drivers, with particular emphasis on dissolved organic matter (DOM) dynamics. Colonization experiments were conducted in commercial and touristic harbour sectors using concrete panels immersed for 30, 45, and 60 days over five sampling periods (January 2024–March 2025). Environmental variables, including temperature, nutrients, total suspended matter (TSM), and DOM quantity and quality (DOC, CDOM optical properties, humic-like substances), were monitored monthly and integrated with biological data through multivariate analyses. Results showed clear spatial–temporal patterns, with richness and abundance of fouling communities and NIS peaking in summer and decreasing in winter. NIS were consistently more abundant in the touristic harbour, particularly during warmer periods. Community structure differed significantly between harbour types across most sampling periods, highlighting the role of local environmental conditions. Temperature emerged as the main driver of temporal variability, especially for NIS. DOM showed contrasting relationships between harbour sectors: in the commercial harbour, NIS were positively related to DOM aromaticity and negatively to CDOM and humic-like components, while in the touristic harbour they were positively correlated with DOC, CDOM, humic substances, and nutrients. These findings highlight how spatial heterogeneity and DOM dynamics modulate fouling community assembly and NIS success, with potential consequences for biodiversity patterns and ecosystem functioning in port environments.

Session 4 - Sustainable Food Production and Fisheries

Evolution of maturity parameters of Black-bellied anglerfish (*Lophius budegassa*) in Atlantic Iberian waters (S4-OC-01)

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Maturity schedules shape stock productivity and underpin assessments, biological reference points, and spatial measures protecting essential habitats. We investigated long term changes in length at first maturity (L50) for 1,400 females black bellied anglerfish (*Lophius budegassa*) from commercial landings in the Cantabrian Sea and Galician waters (ICES 8c, 9aN) spanning 1996–2025. Macroscopic gonad staging were attributed (ICES scale) and logistic models were applied (binomial GLMs with Firth correction) in overlapping multi year windows, to estimate period specific ogives. Environmental covariates (near bottom temperature and salinity from the DEMERSALES survey) and stock status indicators (relative fishing mortality, F/F_{msy} ; relative biomass, B/B_{msy}) were related to L50 using Kendall correlations and multiple linear regression with full diagnostics. Across almost three decades, L50 declined by >15% (from ~53–55.5 cm to ~46.7 cm), with ogives shifting over time and significant length×period interactions, consistent with reports for other demersal stocks. Despite reduced fishing pressure and subsequent increases in population density (higher B/B_{msy}), we did not observe an immediate rebound in L50, suggesting demographic inertia and/or fisheries induced changes. Correlation analyses showed a strong negative association between L50 and density (B/B_{msy}) and a positive association with fishing mortality (F/F_{msy}); in the multivariate model, F/F_{msy} emerged as the strongest predictor of L50, while temperature had a secondary positive effect within a narrow near bottom thermal range (<0.5 °C interannual amplitude at depth). Salinity showed limited explanatory power once other drivers were included. Our results provide an updated baseline for *L. budegassa* reproductive parameters and indicate that maturation schedules remain influenced by historical exploitation, with environmental variability modulating but not reversing long term trends. These findings support integrating life history dynamics into harvest rules and spatial management aimed at safeguarding nursery and spawning habitats in the Iberian Atlantic.

New evidence of the population structure of *Sardina pilchardus* from the Portuguese coast, obtained through microsatellites (S4-OC-03)

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The study examines the genetic structure of the European sardine (*Sardina pilchardus*) along the Portuguese coast. Although the species is managed according to areas defined by ICES, these divisions may not reflect its true biological structure, raising concerns about management effectiveness. Previous research suggests that sardines may be divided into several populations, but there is limited information specifically for Portugal. Therefore, this study aimed to assess the genetic structure using a larger number of microsatellites. Samples were collected from three regions (Matosinhos, Peniche, and Quarteira), and results showed very low genetic differentiation between them. However, these differences were statistically significant, indicating the possible existence of some population structure rather than a single homogeneous population. The use of microsatellites, which are more sensitive than other genetic markers, may explain the detection of these subtle differences.

In conclusion, the study suggests a weak but significant genetic structure in sardines along the Portuguese coast, although further research is needed to confirm these findings and improve management strategies.

Copper-induced oxidative dynamics reveal the potential of *Ulva* sp. for targeted mineral biofortification (S4-OC-02)

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This study investigates the potential of targeted biofortification in *Ulva* sp. through short-term Cu exposure, aiming to enhance its nutritional profile for food and biotechnological applications. Specimens were exposed to 1.7 and 3.4 mM Cu for 24 h, and samples were collected at seven time points (0, 0.5, 1, 2, 5, 12 and 24 h) to assess temporal variations in malondialdehyde (MDA), hydrogen peroxide (H₂O₂), and mineral element composition, and to relate these changes to fatty acid profiles and carotenoid content. Copper exposure rapidly triggered oxidative responses, with H₂O₂ levels increasing within the first hour, particularly at 3.4 mM Cu, indicating an early reactive oxygen species (ROS) burst. This initial increase was followed by a decline between 2 and 5 h, suggesting activation of antioxidant defense mechanisms. However, ROS levels rose again after prolonged exposure (24 h), indicating sustained oxidative stress, requiring enhanced and prolonged protective responses. MDA levels were approximately 80% lower in Cu-treated samples compared with the control during the first 12 h, consistent with limited lipid peroxidation, but increased at 24 h, indicating delayed membrane damage. Cu exposure also altered element composition, with increased Na and decreased K, P, Mg, Mn, and Zn, reflecting disruption of ionic homeostasis and nutrient uptake. The observed dynamics of H₂O₂ and MDA indicate that the early ROS burst induced protective biochemical responses. Adjustments in fatty acid composition, particularly increases in polyunsaturated fatty acids (PUFAs), including ω -3 and ω -6, together with elevated carotenoid levels, likely contributed to limiting lipid peroxidation during the initial exposure period. Overall, these findings demonstrate that *Ulva* sp. rapidly activates protective mechanisms to cope with Cu-induced oxidative stress, supporting its potential as a resilient candidate for controlled mineral biofortification strategies aimed at improving nutritional value.

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Session 5 - Blue Biotech Innovations: From Marine Biodiversity to Bioactive Solutions

Marine biopolymers: linking biodiversity and innovation (S5-OC-01)

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Marine ecosystems are a rich source of biopolymers with diverse structures and functions, supporting a wide range of biological processes and offering significant potential for biotechnological applications. Among these, collagen and chitin/chitosan derived from marine organisms have gained increasing attention due to their biocompatibility, biodegradability, and versatility across well-being, industrial, and environmental sectors. This study assesses how marine biodiversity supports innovation in these biopolymers by integrating bibliometric and patent landscape analyses. Scientific publications (n = 877) and patent documents (n = 3515) were analysed to identify temporal trends, geographic distribution, taxonomic sources, and application domains. Results reveal a high diversity of marine taxa used as sources of collagen and chitin/chitosan, including fish, crustaceans, molluscs, and invertebrates such as jellyfish, coral and sponges, reflecting broad functional potential. Research activity has increased markedly since 2010, with global contributions, while innovation remains geographically uneven, with strong patenting activity in Asia and high scientific output in Europe. Applications are primarily focused on biomedical, cosmetic, and food/feed sectors, whereas environmental uses remain underexplored. Despite the wide taxonomic scope in research, innovation pathways are concentrated on a limited number of taxa, driven by constraints related to biomass availability, scalability, and economic feasibility. Sustainable sourcing strategies, including the use of fisheries by-products and proliferating species, as well as bioinspired approaches, emerge as key considerations to reduce ecological impacts. Overall, this study highlights marine biodiversity as a critical driver of innovation in blue biotechnology, while emphasising the need for integrated approaches that align ecological sustainability with technological development.

Biological and biochemical activity of the R-Phycoerythrin and iota-carrageenan extracted in sequence from *Solieria filiformis* biomass cultivated in Ceará, Brazil (S5-OC-10)

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Red seaweeds are autotrophic marine organisms and a renewable source of biomass for bioproducts such as pigments and polysaccharides. Their pigments (phycobiliproteins) contain chromophores with distinct color and fluorescence, used in food and cosmetics as natural colorants and, in high purity, as analytical tools in immunoassays. The polysaccharides, mainly sulfated galactans like carrageenan, act as stabilizers in beverages and moisturizers in cosmetics due to their high water-binding capacity. This study evaluated the cosmetic potential of R-phycoerythrin (R-PE) and iota-carrageenan (ιCar) sequentially extracted from the seaweed *Solieria filiformis*, through cytotoxicity assays on human skin cells (HaCaT line) and biochemical tests. R-PE extraction involved homogenizing wet seaweed in phosphate buffer, filtration, freeze-thaw cycles, centrifugation, and desalting. The total extract (TE) was purified by anion-exchange chromatography, yielding fractions P-0.2, P-0.35, and P-2.0 eluted with NaCl. The solid waste was treated with NaOH and bleach. ιCar was extracted in water-hot, filtered, and dried. Cytotoxicity was assessed by MTT assay. Non-cytotoxic concentrations (cell viability >70%): TE at 3 µg/mL (97.1%), P-0.2 at 10 µg/mL (92.6%), P-0.35 and P-2.0 at 30 µg/mL (110.1% and 91.6%, respectively). Purification increased safety, with fractions (P-0.35 and P-2.0) showing higher viability. ιCar was non-cytotoxic at tested concentrations. In the antioxidant assay (ABTS), EC50 values were: TE (428.6 µg/mL), P-0.35 (386.0 µg/mL), P-2.0 (117.9 µg/mL), and ιCar (22.1 mg/mL). Fraction P-2.0, despite lower purity, showed higher antioxidant activity than P-0.35. ιCar's low activity indicates carbohydrate integrity and no contamination. In the hyaluronidase inhibition assay P-0.35 showed no effect; P-2.0 reduced enzyme activity by 37.2% (30 µg/mL) and ιCar by 36.3% (100 µg/mL). The estimated Sun Protection Factor (SPF) was 2.95 for P-0.35 and 6.41 for P-2.0, related to aromatic amino acids that absorb UV radiation. ιCar showed low absorbance in this region. In conclusion, the purification process is essential to maximize the molecular potential. The R-PE fractions (P-0.35 and P-2.0) and ιCar demonstrated cell safety, antioxidant activity, anti-hyaluronidase effects, and UV protection, indicating strong potential for use in cosmetic formulations.

Marine Macroalgae as a Source of Neuroprotective Agents: The Role of Sphaerococcenol A Analogues (S5-OC-07)

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Alzheimer's disease (AD) is a multifactorial neurodegenerative disorder characterised by β -amyloid accumulation, cholinergic dysfunction, oxidative stress, and neuroinflammation. Marine macroalgae represent a promising source of bioactive compounds with neuroprotective potential. The aim of this study was to evaluate the neuroprotective effect of sphaerococcenol A (SPA), isolated from the red seaweed *Sphaerococcus coronopifolius*. SPA and three hemi-synthetic analogs (1-3), against hydrogen peroxide (H₂O₂)-induced neurotoxicity in undifferentiated and retinoic acid (RA)-differentiated human neuroblastoma cells (SH-SY5Y), along with the study of the associated oxidative stress and apoptosis-related pathways. The cytotoxic and neuroprotective activities of compounds (1 - 100 μ M; 24 h) were evaluated by the MTT method, and the biomarkers related to reactive oxygen species (ROS) levels, mitochondrial dysfunction (MMP) and Caspase-3 activity were evaluated in the presence of H₂O₂ (200 μ M). Additionally, in silico and in vitro analyses were performed to investigate the binding affinity of SPA analogues toward acetylcholinesterase (AChE) and b-secretase 1 (BACE1), key enzymatic targets implicated in AD. In undifferentiated cells, SPA (1 μ M) and SPA3 (3 μ M) increased cell viability, promoting recovery from H₂O₂ damage by 15% and 55%, respectively, after H₂O₂-induced toxicity in SH-SY5Y cells. The neuroprotective activity of these compounds was mediated by the protection of mitochondrial function, decreased ROS production and decreased Caspase-3 activities. Regarding RA-differentiated cells, SPA-1 (0.3 μ M) and SPA-2 (1 μ M) increased cell viability, promoting recovery from H₂O₂ damage by 25% and 40%, respectively. Exposure to H₂O₂ significantly enhanced oxidative stress, while SPA and its analogues did not reduce H₂O₂ levels. Nonetheless, these compounds seemed to preserve mitochondrial function, in particular SPA and SPA-1, which reduced Caspase-3 activity. These results

seem to suggest that the neuroprotective action is not due to direct antioxidant activity, but instead through preservation of mitochondrial integrity and inhibition of apoptosis under oxidative stress. In silico and in vitro analyses suggest that SPA analogues may interact with AD-related targets, such as AChE and BACE1, highlighting their potential to modulate key pathways involved in AD progression. Overall, *S. coronopifolius*-derived compounds show potential neuroprotective effects, which supports their potential as multifunctional neuroprotective agents.

Extraction of Functional and Colouring Compounds from Brown Macroalgae for Textile Applications (S5-OC-12)

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Macroalgae are promising natural sources of bioactive and colouring compounds with increasing relevance for sustainable textile applications. However, the rigid structure of macroalgal cell walls limits the efficient extraction of intracellular compounds, requiring optimised extraction strategies. This study aimed to optimise the extraction of functional and colouring compounds from brown macroalgal biomass and to evaluate their application in textile dyeing and functionalisation. Different solvents (water, ethanol and 50% (v/v) water-ethanol), extraction methods (Soxhlet and ultrasound-assisted extraction (UAE)) and biomass concentrations (2%, 6% and 10% m/v) were initially assessed using *Laminaria digitata*, *Saccharina latissima*, *Alaria esculenta* and *Ascophyllum nodosum*. Based on preliminary results, aqueous UAE yielded the highest extraction efficiency for both bioactive and colouring compounds, as well as for textile functionalisation and colouration. In the subsequent optimisation trials, extractions were performed using 5% biomass, water as solvent and UAE cycles (1 min ON, 5 min OFF, total 5 min), with and without temperature control, following biomass pre-treatments of grinding and maceration. Extracts were applied to previously cationised 100% cotton fabrics by exhaust dyeing (50 °C, 120 min, liquor ratio 1:20). The textiles were evaluated in terms of colour strength (K/S), ultraviolet protection factor (UPF), washing and light fastness. Among the macroalgae tested, *L. digitata* extracts exhibited the highest antioxidant activity (2463.8 mg/L) and phenolic content (717.0 mg/L), followed by *A. nodosum* with 595.0 mg/L and 404.3 mg/L, respectively. Functionalised textiles showed high antioxidant activity, reaching 94.4% and 95.1%, respectively. Textiles treated with *A. nodosum* extracts achieved the highest colour strength (K/S value around 1.3) and UPF (around 47.2), along with good washing fastness of 4-5 and moderate light fastness of 3-

4 on the grey scale rating. Overall, these results highlight the potential of brown macroalgae as sustainable sources of functional and colouring agents for textile applications.

Marine-derived compounds: a promising source of novel neuroprotective agents for Parkinson's Disease (S5-OC-16)

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As life expectancy increases, so does the incidence of Parkinson's disease (PD), a chronic and progressive neurodegenerative disorder characterized by the loss of dopaminergic neurons in the *substantia nigra pars compacta*, leading to motor dysfunction. Current therapies are primarily symptomatic, failing to halt disease progression and often leading to motor complications. Marine ecosystems, particularly macroalgae, represent a rich source of bioactive compounds with potential neuroprotective and anti-neuroinflammatory properties. In this study, the neuroprotective capacity of six compounds: eleganolone (Eleg), fucosterol (Fuc), loliolide (Lol), bromosphaerol (Bromo), alloaromadendrene (Alloa), sphaerococcenol A (SA), and two semi-synthetic SA derivatives (SA5 and SA6) was evaluated. Furthermore, the underlying mechanisms of action were investigated by assessing hydrogen peroxide (H₂O₂) production levels, mitochondrial membrane potential (MMP), and nuclear morphology using DAPI staining. After defining non-cytotoxic concentrations (0.01 - 100 µM), the neuroprotective potential of the compounds was evaluated in retinoic acid and phorbol-differentiated SH-SY5Y cells in the presence of 6-hydroxydopamine (6-OHDA) using the MTT assay. While 6-OHDA reduced cell viability by 55-60%, treatment with Alloa (0.1 and 1 µM) and Eleg (0.01 µM) significantly restored cell viability (by 14%, 18% and 13%, respectively). Mechanistic studies revealed that these compounds attenuated 6-OHDA-induced mitochondrial membrane potential depolarization by 35% and reduced apoptotic nuclear alterations after 6-OHDA treatment. However, no significant reduction in H₂O₂ levels was observed following 6-OHDA exposure. These results suggest that the neuroprotective effects of Alloa and Eleg are primarily mediated by the preservation of mitochondrial function and the modulation of apoptosis, rather than by direct antioxidant scavenging of H₂O₂. Overall, these findings highlight marine-derived

metabolites as promising candidates for further development in neuroprotective strategies against PD.

Process Optimisation in Algae-Derived Textile Dyeing: Improving Colour Fixation and Functional Performance (S5-OC-14)

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The textile industry has significant environmental impacts, particularly in wet finishing processes, due to the high consumption of water, energy and chemicals, and the production of contaminated effluents. Natural colourants have emerged as promising alternatives to conventional synthetic dyes, with marine resources such as algae offering a wide diversity of pigments and functional compounds. In this study, microalgae were cultivated in controlled conditions, with particular focus on the optimisation of growth parameters to enhance biomass yields and promote the production of metabolite of interest. After cultivation, the biomass was processed to obtain dried biomass and extracts rich in pigments and functional compounds. These algal species and extracts were applied to textile substrates through exhaust dyeing, padding, coating and spray-coating techniques to evaluate their colouring potential and functional properties, such as antioxidant activity. Although a diverse colour palette was achieved, limitations in colour fastness to washing and light was observed. Therefore, optimisation strategies, including mordanting treatments, were investigated to enhance these properties, with natural-based mordants rich in tannins presenting very promising results in colour fixation after washing and light exposure.

Blue biotechnology meets nanomaterials: green synthesis of silver nanoparticles for biomedical applications (S5-OC-13)

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Infectious diseases caused by pathogenic microorganisms are a major global concern due to rising healthcare-associated infections and antibiotic resistance. Marine biotechnology and nanotechnology offer promising solutions to mitigate this problem. Silver nanoparticles (AgNPs) biosynthesised using marine fungal cell-free filtrates (CFFs) provide an eco-friendly and cost-effective approach, as fungal metabolites act as reducing, capping, and stabilising agents. Within the NanoFilm project, these AgNPs can be incorporated into electrospun polymeric nanofibers for non-woven textiles or medical device coatings, representing a sustainable strategy for advanced antimicrobial materials in biomedical applications. The present study aimed to biosynthesise AgNPs using CFFs from the marine fungi *Aspergillus fructus* and *Emericellopsis maritima*, and to evaluate their antimicrobial potential against clinically relevant microorganisms (*Pseudomonas aeruginosa* ATCC 15442 and *Candida albicans* ATCC 10231). CFFs from both fungi were obtained at two time points to assess reproducibility. AgNPs were biosynthesised under optimised conditions (pH 10, 100 °C, 105 min, 1.5 mM AgNO₃, and 40% (v/v) CFF) and further characterised by UV-vis spectroscopy, dynamic light scattering, zeta potential, Fourier transform infrared spectroscopy (FTIR), and Scanning Electron Microscopy (SEM) and quantified by Inductively Coupled Plasma -Atomic Emission Spectrometry. The best-performing CFFs were pooled. Results demonstrated reproducible AgNPs production, with a localized surface plasmon resonance peak at 410 nm, indicating predominantly theoretical small and spherical AgNPs. *E. maritima* showed a higher production, while AgNPs from *A. fructus* exhibited smaller average size. AgNPs from both CFFs displayed moderate-high polydispersity and good stability. FTIR suggest possible chemical groups involved in AgNPs synthesis, capping, and stabilization and SEM imaging confirmed mostly spherical/quasi-spherical AgNPs with some aggregation/agglomeration. The biogenic AgNPs demonstrated antimicrobial activity against *P. aeruginosa* and *C. albicans*. These findings highlight the potential of marine fungal produced AgNPs as sustainable and effective antimicrobial agents for biomedical applications, including their integration into electrospun nanofibers.

Bridging marine annelid regeneration and biomedical applications by integrating transcriptomics and histopathology (S5-OC-05)

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The ability of healing and regenerating body sections following autotomy or amputation is relatively widespread across Eumetazoa, however, its extent is also highly variable. Since the regenerative process and tumour development share some hallmarks, novel therapeutics may be developed by merging these two processes to fine-tune cell proliferation and differentiation. Marine annelids are emerging as models within regeneration biology due to their capability to regenerate posterior and more rarely anterior body sections, which is, nonetheless, variable between species. Understanding the cellular and molecular mechanisms underlying regeneration and its restrictions in some animals could help address key questions in developmental biology and regenerative medicine. *Hediste diversicolor* enduring posterior and anterior regeneration 7 and 14 post days of amputation were analysed morphologically and histopathologically. The gene expression profile of these marine annelids was investigated through RNA-Seq-based transcriptomics and advanced computational tools that ranged between differential gene expression and active-subnetwork-oriented pathway analyses. Overall, posterior regeneration held a higher success rate and at 14 days post amputation, a new pygidium and segments were formed. Inversely, anterior regeneration yielded more variable outcomes between incomplete or unsuccessful regeneration regardless of time, sometimes accompanied with oocytes apoptosis. The transcriptomic portrait revealed a proximity between posterior regeneration and the non-amputated annelids and identified 2 888 differentially expressed genes between amputated *H. diversicolor* and non-amputated controls. While there was an apoptotic and mitogenic balance during posterior regeneration, the molecular pathways related with the response to different stressors and inflammation were disrupted in anterior regeneration. From dysregulated pathways, Wnt, mTOR and NF- κ B signalling pathways were identified as key players in annelid regeneration. Altogether, *H. diversicolor* enduring posterior regeneration have a profile seemingly more similar to a normal growth, whereas the anterior regeneration in these annelids holds hindered probability of success. Further research on the regulatory networks and key upstream regulators can aid understanding why some animals are not able to regenerate and potentially find a way how to recover this ability with the ultimate goal of unravelling novel therapeutics.

Friday, 10th July

Session 3 - Marine Conservation, Management & Policy

Floating offshore wind farms: A SWOT analysis of its implementation on the Portuguese coast (S3-OC-06)

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Europe has invested in sustainable and clean energy sources in the last decades, to reduce greenhouse gas emissions by 2030. Offshore wind presents an untapped potential, given the vast marine space at Europe's disposal. As such, the European Union predicts that offshore wind will supply 30% of its electricity demand by 2050. Portugal has been in the forefront of floating offshore wind (FOW) development, with various pilot projects, and, in 2025, has formally approved 2 GW of offshore wind capacity to be installed by 2030. This study evaluates the potential of offshore wind development in Portugal through a SWOT (strengths, weaknesses, opportunities, threats) analysis based on a comprehensive review of scientific literature, policy documents, and technical reports. Results indicate that Portugal benefit from successful pilot projects demonstrating the feasibility of semi-submersible technologies, and effective site selection supported by stakeholder engagement, reducing conflict with other marine uses. Despite the potential of early collection of environmental and fisheries data enabling informed Environmental Impact Assessments (EIAs) and creation of long-term monitoring programs, regulatory delays, lack of specific EIA requirements, and limited baseline environmental data continue to introduce uncertainty. Also, the displacement of fishing activities also raises socioeconomic concerns. Opportunities to improve the FOW development include the adoption of international best practices, investment in port infrastructure could stimulate regional growth and job creation, implementation of compensation mechanisms, and co-location with fisheries and aquaculture may enhance sustainability and reduce costs. Additionally, FOW development can promote systematic environmental monitoring, helping to address existing knowledge gaps regarding baseline ecological conditions. In contrast, delays from policy, lack of specific EIA requirements for offshore wind farms, competition from more mature markets, supply chain constraints, and potential public opposition driven by environmental and socioeconomic impacts present some challenges. Overall, Portugal demonstrates strong potential for FOW expansion, but regulatory, environmental, and infrastructural challenges must be addressed. Strengthening governance frameworks, improving baseline data, and fostering

stakeholder engagement and international cooperation will be critical to ensuring sustainable offshore wind development.

Incorporating seasonality influences climate change vulnerability estimation of marine species (S3-OC-09)

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Climate change impacts on marine fishing resources vary by species, region, habitat, and temporal scale. To address this, climate vulnerability assessments based on species life-history traits were developed. We estimated the climate change vulnerability of the 74 most relevant commercial marine species of Portugal using seasonal exposure estimates and compared the resulting classifications with a previous assessment based on annual data. Assessments were conducted for two climate projections in three areas of the Portuguese coast. Significant differences were detected between annual and seasonal vulnerability assessments. Overall, assessments using seasonal exposure yielded lower vulnerability categories than the annual assessment, for species in the moderate and low vulnerability categories due to lower exposure scores. In contrast, species classified in the high and very high vulnerability categories remained mostly consistent between annual and seasonal assessments. Regional and scenario contrasts were less evident than the differences observed between annual and seasonal classifications. These results indicate that incorporating seasonally estimated exposure information can

influence expert-based vulnerability classifications and provide a more temporally explicit basis for climate vulnerability assessments.

Integrating Climate Risk and Vulnerability into Marine Spatial Planning: Insights from the Portuguese Case Study (S3-OC-20)

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The accelerating impacts of climate change are reshaping marine ecosystems, challenging the way we manage ocean spaces. To align Marine Spatial Planning (MSP) with long-term climate resilience, it is essential to integrate comprehensive risk and vulnerability assessments that capture ecological, social, and economic dimensions. This study presents the development and application of a composite climate risk index designed to support “climate-proof” MSP. Drawing upon methodological foundations from the Intergovernmental Panel on Climate Change (IPCC) and the Organisation for Economic Co-operation and Development (OECD) guidelines for constructing composite indicators, our approach quantifies and spatially represents climate-related risks across multiple sectors within the Portuguese maritime space. This index aggregates information on hazards, exposure, and vulnerability dimensions to identify risk hotspots under different climate scenarios. By integrating existing ocean planning datasets with expert consultation, we evaluate how current marine uses – such as fisheries, aquaculture, tourism and renewable energy – may be affected by climate-related factors, including ocean warming and acidification, sea-level rise, and extreme events. Results provide actionable insights for policymakers to prioritise adaptation measures, guide sectoral coordination, and enhance climate integration in future MSP processes. Beyond the national context, this research offers a transferable tool for integrating climate considerations into marine governance worldwide. Our work contributes to advancing evidence-based marine management, directly supporting the transition towards adaptive, ecosystem-based, and climate-informed ocean planning. It also highlights the

importance of the science-policy interface in translating risk assessments into governance mechanisms that foster sustainable and equitable ocean use.

Open occurrence data to reveal monitoring gaps and distribution signals for Habitats Directive marine mammals in Europe (S3-OC-14)

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The EU Habitats Directive plays a central role in structuring biodiversity reporting in Europe, requiring Member States to assess the conservation status of protected species and habitats under Article 17. However, the Directive's effectiveness is constrained by uneven evidence availability across regions, taxa, and time, limiting robust large-scale assessments and the detection of trends. Marine mammals, listed under the Directive, exemplify these challenges. Their high mobility, uneven detectability, and limited offshore monitoring result in fragmented and spatially biased occurrence data, contributing to recurrent gaps in reporting capacity and uncertainty in conservation status assessments. Within the B-CUBED HEU project, we developed a reproducible, bias-aware workflow to operationalise open occurrence data from GBIF. We construct simple, standardised biodiversity "data cubes" that organise records across space, time, and taxon, enabling rapid exploration of (i) where and when species are recorded, (ii) how coverage changes over time, and (iii) how sampling bias may shape apparent distributions. Applying this workflow to marine mammals listed under the Directive shows that GBIF-mediated occurrence data are available for a large proportion of species and have increased markedly over time, largely driven by citizen science and improved data mobilisation. Nevertheless, cube diagnostics reveal persistent and policy-relevant gaps, particularly offshore under-sampling and uneven coverage across European sea basins. Despite these limitations, which reflect well-known constraints in current EU Habitats Directive reporting, our results highlight that open occurrence data can, in some cases, help bridge critical evidence gaps. In particular, bias-aware data cubes provide a simple and reproducible way to assess where and how open data can complement existing monitoring efforts, supporting more robust insights on species status, trends, and distribution shifts. We demonstrate how this approach can complement dedicated surveys by pinpointing where open data can strengthen evidence and, critically, which types of data and datasets are most effective in addressing persistent gaps for European marine mammals, thereby supporting data mobilisation and improved integration of existing evidence.

From willingness to pay to willingness to act: bridging governance gaps in deep-sea restoration (S3-OC-18)

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Deep-sea ecosystems provide critical services to society, yet restoration science and governance remain underdeveloped compared to coastal systems. Focusing on the Condor Seamount at depths between 185-2000m (Azores, Portugal), this study integrates a nationwide contingent valuation (CV) survey with a governance arrangement analysis to explore whether public support and institutional configurations align with the implementation of deep-sea restoration under the EU Nature Restoration Regulation (NRR). The CV survey (n = 750 adults residents in Portugal) introduced deep-sea coral and sponge habitats, anthropogenic impacts and a national restoration programme including a 100 ha pilot site at Condor. Respondents were asked whether they would pay an earmarked tax (10, 50 or 150 euros per year over 10 years) to finance this programme. Socioeconomic and statistical analysis was performed to define the key marine benefits people value the most as well as their willing to pay values. The subsequent governance analysis draws on 17 stakeholder interviews (scientists, NGOs, fisheries, regional and national authorities, philanthropic actors), examining discourses, actor coalitions, rules and resources shaping deep-sea restoration at Condor. Results show strong public support of marine benefits: 81% of the respondents agree deep-sea areas should be preserved or restored, and a majority are willing to pay for that at lower and intermediate tax levels, motivated by natural heritage, biodiversity, climate regulation and moral responsibility. Nonetheless, many “no” responses reflect affordability concerns and a preference that restoration should be funded from existing public budgets. In contrast, the governance arrangement found for the Condor Seamount is dominated by a conservation-precaution discourse and a science-led, risk-averse coalition that prioritises MPAs, closures and monitoring, while treating active restoration as experimental and

politically sensitive. Fragmented competences, under-resourcing and a leadership vacuum further limit the scaling of pilot actions such as REDRESS coral transplantation at Condor. The combined evidence reveals a misalignment: citizens are broadly willing to finance deep-sea restoration, but governance structures remain locked into a protection-only equilibrium. Harnessing this social support to action will require dedicated frameworks for active deep-sea restoration, more stable and socially acceptable funding mechanisms informed by CV results, and more inclusive coalitions that embed fishers and local communities as co-producers of restoration. The NRR offers a key opportunity to transition from isolated pilots to integrated passive-active restoration strategies at Condor and across Europe's deep-seas.

Session 5 - Blue Biotech Innovations: From Marine Biodiversity to Bioactive Solutions

Neuroprotective Potential of Sphaerococcenol A and Its Derivatives against Parkinson's Disease: Integrated *in silico* and *in vitro* evaluation (S5-OC-09)

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Parkinson's disease (PD) is the second most prevalent neurodegenerative disease in the world, affecting more than 10 million people and projected to reach 25.2 million cases by 2050. It is characterized by the accumulation of α -synuclein (α -syn) aggregated (Lewy bodies), which impair mitochondrial function and increase of oxidative stress ultimately contributing to dopaminergic neuron degeneration. Due to their high metabolic demand, dopaminergic neurons are particularly vulnerable to mitochondrial dysfunction, leading to both motor and non-motor symptoms associated with PD. Macroalgae are rich in bioactive compounds, some of which present neuroprotective activity, including antioxidant and anti-neuroinflammatory. In this study, the neuroprotective potential of sphaerococcenol A (SA), biosynthesized by the red alga *Sphaerococcus coronopifolius*, and four of its semi-synthetic derivatives (SA1–SA4) was evaluated, combining *in vitro* assays with *in silico* analysis of ADMET properties and molecular interactions. *In silico* analysis of ADMET properties was performed using Deep-PK, while molecular docking studies with α -synuclein (PDB: 6CU7) were conducted using UCSF ChimeraX and AutoDockTools. Ligand structures were prepared using Avogadro. For *in vitro* assays, SH-SY5Y and Caco-2 cells were treated with SA and its derivatives (1–100 μ M) to assess

cytotoxicity using the MTT assay. Neuroprotective activity was evaluated in SH-SY5Y cells using non-cytotoxic concentrations in the presence of 6-hydroxydopamine (6-OHDA; 100 μ M). Oxidative stress and mitochondrial dysfunction were assessed by measuring intracellular ROS and H₂O₂ levels, as well as mitochondrial membrane potential (MMP). *In silico* analysis showed favourable ADMET properties for all compounds, with good absorption, low plasma protein binding, potential CYP3A4 inhibition, and varying binding energies, especially SA-4. Neuroprotective assays revealed that SA was effective at 0.1 and 0.3 μ M, SA-1 and SA-2 at 1 and 3 μ M (with SA-2 also active at 10 μ M), and SA-3 and SA-4 at 0.3 and 3 μ M, respectively. Overall, integration of *in silico* and *in vitro* data highlights SA-2 and SA-3 as the most promising candidates, combining neuroprotective activity with improved predicted safety profiles.

Microbial Life Inside *Posidonia* Seeds: Beneficial Endophytes and Implications for Marine Plant Health (S5-OC-02)

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Plant–microbe interactions are key drivers of plant health and ecosystem functioning, yet their roles in marine environments remain poorly understood. The seagrass *Posidonia oceanica*, a foundation species in the Mediterranean Sea, forms complex associations with microbial communities that influence its development and stress tolerance. Here, we provide the first evidence of culturable bacterial and fungal endophytes inhabiting *P. oceanica* seeds collected from central Mediterranean, a region representing a major center of the species' genetic diversity. Using two different marine culture media, we isolated a diverse assemblage of endophytes, predominantly affiliated with *Marinomonas*, *Celerinatantimonas*, *Vibrio*, *Halomonas*, *Kocuria*, *Bacillus*, *Metabacillus*, *Lysobacter*, and *Aureimonas*, along with the fungi *Paecilomyces maximus* and *Halophytophthora* sp. Most bacterial isolates displayed plant growth–promoting (PGP) traits such as indole-3-acetic acid production and nitrogen fixation, supporting their potential contribution to seed germination and early seedling establishment. The detection of *Candidatus Celerinatantimonas neptuna*, a nitrogen-

fixing symbiont previously described in *P. oceanica* roots, suggests a possible route of vertical transmission. Although fungal endophytes were less frequent, their presence indicates that *P. oceanica* seeds may serve as a reservoir of both beneficial and potentially pathogenic taxa. These findings expand our understanding of the *P. oceanica* holobiont, highlight the role of seeds in the persistence and dissemination of endophytic communities and lay the groundwork for the biotechnological use of seed-associated microbes in marine plant restoration and conservation, and in crop stress tolerance.

Exploring Coral-Associated Bacteria as a Source of Novel Bioactive Compounds for Blue Biotechnology (S5-OC-11)

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The discovery of novel bioactive compounds is crucial because of the rise of drug-resistant bacteria. There is a clear need for new bioactive compounds for biotech applications such as pharmaceutical, cosmeceutical, and environmental uses. The ocean has proven to be an excellent source of secondary metabolites, largely due to its vast, unexplored ecosystems, such as coral reefs. Their rich microbial diversity makes them a promising source of new bioactive compounds. Coral-associated microbes (CAMs) are of great interest in this search. Associated bacteria in this system play a fundamental role in coral defense, protecting them from environmental stressors through the production of bioactive compounds. This unique microbial diversity makes corals a promising source for discovering new compounds with potential biotechnological applications. This study aimed to isolate rare bacteria associated with corals from Magoodhoo Island (Maldives) and evaluate their biotechnological potential. A total of 198 strains were isolated, and after a screen, a total of 31 different isolates of different genera were screened for antimicrobial, antioxidant, biosurfactant and siderophore production. Following this, a

genomic exploration of some selected strains was performed to assess their biosynthetic potential, and among them, the orange bacterium *Pseudoalteromonas piscicida* 39 was prioritized for further investigation. Members of this genus are known for their capacity to produce diverse bioactive secondary metabolites. Genome analysis revealed the presence of halogenase encoding genes, suggesting the strain's potential to biosynthesize halogenated metabolites, which are known to possess a wide range of biological activities. Based on these findings, the strain was subjected to largescale cultivation in an enriched medium supplemented with potassium bromide (KBr) to promote the production of halogenated compounds. The resulting extracts were fractionated and evaluated for their bioactivity, displaying strong antimicrobial activity against MRSA (methicillin-resistant *Staphylococcus aureus*), *Staphylococcus aureus* 6538 and *Vibrio anguillarum*) and UV-protectant effect towards HaCaT cells. Chemical analysis indicated the presence of novel (halogenated) metabolites related to the alterochromide family, alongside additional previously uncharacterized brominated compounds. Ongoing work focuses on targeted isolation and structural elucidation to confirm their structures and bioactivity. These findings highlight the still unexplored potential of pigmented *Pseudoalteromonas spp.* in the field of compound discovery.

The anatomy and biochemistry of squid's camouflage and its biotechnological value (S5-OC-03)

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The vast biodiversity of the oceans makes them an almost inexhaustible source of novel bioproducts with significant biotechnological potential. Among the great biodiversity of marine invertebrates, cephalopods, a taxon that includes squids, octopuses, and cuttlefishes, garnered considerable attention due to their production of bioactives and biopolymers with valuable properties. In their layered skin, cephalopod-specific proteins (reflectins) contribute to their unique and dynamic camouflage mechanism, offering a reflective ability that responds to neural stimuli. These proteins can be produced by recombinant expression and be processed to develop safe and sustainable materials. However, so far it has not been possible to fully understand

reflectins assembly and behaviour *in vivo* and *in vitro*, hindering the design of biomimetic materials. The current work aims to develop a pipeline that combines molecular and computational biology with advanced microscopy methods to identify novel reflective proteins and obtain new insights into their organization *in vivo*. Microanatomical comparisons across different body regions of *Alloteuthis media*, a less-studied squid common along the Portuguese coast, enabled the identification, characterization, and reproduction of 3D models of the structures resulting from the assembly of the reflective proteins. At the molecular level, we focused on isolating novel sequences of biotechnological interest from the squid skin, which involved *de novo* transcriptome assembly, R-based computation, and annotation of the predicted coding regions by contrasting against available sequences in databases. Our results allowed us to better comprehend the ultrastructure organization of reflective cells (the iridocytes) in the squid's skin, as well as to unravel the proteins present in these tissues. Future work will focus on understanding the biological significance and mechanisms underlying the expression and regulation of these proteins *in vivo*, as well as their production and processing into optically-active biomaterials. By adopting this multidisciplinary approach, we aim to contribute to Blue Biotechnology by transposing biological functions into bioengineering, thereby advancing the understanding of marine proteins' self-assembly *in vivo* and improving the development of engineered materials inspired by cephalopod camouflage and communication.

The venomous saliva of cephalopods: A deep dive into its biotechnological potential (S5-OC-17)

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Marine organisms offer an exceptional reservoir of unexplored bioactive substances, and their venoms and secretions are gaining recognition as valuable resources for bioprospecting. Some Cephalopoda, especially octopuses and cuttlefishes, are known to secrete a venomous saliva, a cocktail of proteinaceous toxins that may have evolved to interact with specific molecular targets, such as enzymes and ion channels. The bioactive substances represent a promising yet understudied resource for the development of new therapeutic solutions. The current work combined microscopy techniques with *de novo* transcriptome assembly to characterise the salivary glands of the common octopus

(*Octopus vulgaris*) from the Portuguese West coast, searching for toxins and other bioactive proteins, with potential value for biotechnology and biopharma. The microanatomy and transcriptomics profiling suggest distinct yet complementary functions between the two salivary glands of *O. vulgaris* – anterior and posterior. Both salivary glands are formed by blind-ended branched tubules that bear a simple (single-cell thick) secretory epithelium, however with significant differences between them. The anterior salivary gland, mostly known as the cephalopod mucus gland, is composed of simpler blind-end tubules with a single secretory epithelium, whereas the posterior salivary gland shows a more complex arrangement of tubules with two distinct epithelia and higher diversity of cell types (such as goblet, striated and cistern cells). Transcriptomics results revealed that the anterior salivary gland produce chitin-binding proteins, phospholipases, peptidases and hyaluronidases – enzymes that act extracellularly in chitin and lipid degradation and therefore contributing to digestive processes. On the other hand, the posterior salivary gland is more specialised in venom production, including cysteine rich venom proteins such as neurotoxins and unknown toxin like proteins, as well as permeabilising agents. The combined outcomes of microanatomy and transcriptomics highlight that the anterior salivary gland is involved in the upkeep of protein function and activity whereas the posterior salivary gland produces proteinaceous toxins. Together, these glands constitute a valuable reservoir of bioactive molecules – including neurotoxins and matrix-directed enzymes – with considerable promise for bioprospecting.

Poster Presentations



Session 1 - Marine Biodiversity & Ecosystem Functioning

Exploring new technologies for the sampling of parabenthos in the proximity of Marine Animal Forests (S1-PC-01)

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The study of hyperbenthos and parabenthos in general, defined as the group of organisms thriving in the water column in strict association with any type of substrate, faces significant difficulties from the methodological point of view, especially in presence of 3D benthic structures. The sampling of small, vagile fauna supposed to live within complex 3D structural assemblages remains unexplored. Dredges and other conventional devices are designed for flat, soft bottoms and risk to be damaged by hard 3D substrata, or to irreversibly harm fragile ecosystems such as Marine Animal Forests (MAFs). These sheltered water spaces, circumscribed by high structural heterogeneity, make current strategies inadequate to quantify the true diversity and biomass of free-swimming organisms often characterized with high mobility. To overcome these limitations, the present contribution proposes an innovative device designed for non-invasive sampling of parabenthos within 3D complex structures. The instrument features an inverted filtering net with a customizable mesh size, equipped with a pump. Like traditional towed nets, this instrument can be lowered vertically to the desired depth. The suction system starts only when the device is on the bottom and is projected to catch only organisms from the water column and not from the bottom sediments. The device was designed as “user-friendly” (and simple to build), with a slender profile (to easily enter in flexible 3D structures of MAFs), with an internal battery (and not a umbelical electronic connection with the sea surface), a snouth to suck suspended material (and organisms) only from the sides (not from the bottom), a videocamera recording the habitat situation object of the sampling, and a system to close the net mouth at the end of the sucking time (some minutes). The efficiency of this device will be tested through a comparative sampling design, involving different benthic structures, with the aim of comparing abundance, taxonomic composition and biomass of different parabenthos. This technology may help to explore and quantify the full ecological role of MAFs, adding new information about the biodiversity associated to sessile benthic organisms that we already know. Furthermore, future perspectives will focus on using this device as a key tool for MAF monitoring in restoration programs, using parabenthos (and referred ecological indicators) as an additional element to judge the efficacy of restoration actions.

Astaxanthin ester fingerprints reveal prey signatures in an Arctic central-place forager (S1-PC-02)

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Astaxanthin is a dominant carotenoid in Arctic zooplankton and a functionally important trait linked to antioxidant protection, lipid metabolism, survival, and reproduction. Because it occurs in free and esterified forms, its chemical structure may provide more ecological information than total carotenoid content alone. Here, we tested whether ester-resolved astaxanthin composition in little auk (*Alle alle*) food loads and dominant prey taxa can provide a biochemical signature of prey identity and prey-field structure beyond traditional taxonomic diet description. Food loads carried by adult little auks to chicks were collected in 2023 from five colonies representing contrasting Arctic marine settings: Ukaaleqteq in East Greenland, and Bjørnøya, Hornsund, Kongsfjorden, and Magdalenefjorden in Svalbard. In each food load, we quantified free astaxanthin, monoesters, diesters, and five monoester fractions (A-C18:3, A-C18:2, A-C18:1, A-16:0, and A-C18:0). We also analysed monoester fingerprints in dominant prey taxa, including *Calanus glacialis* fifth copepodite stage (CV), *C. hyperboreus* CV and adult females (AF), *C. finmarchicus* CV, *Euphausiacea* furcilia, *Themisto* spp., and crab larvae. Food loads differed clearly among colonies in astaxanthin architecture. East Greenland showed the highest esterified astaxanthin fraction, and mean monoester fingerprints differed among colonies, with elevated A-C18:2 and reduced A-C18:1 relative to the other sites. Region-specific variation was also evident within dominant prey taxa. These patterns suggest that astaxanthin ester fingerprints are shaped not only by prey identity, but also by local environmental and trophic context. Different astaxanthin forms may also differ in stability and bioavailability, potentially influencing the efficiency of antioxidant transfer to higher trophic levels. Spatial differences in astaxanthin form and monoester composition may therefore reflect differences in prey biochemical state, including lipid storage context and antioxidant-related properties, and indicate variation in the nutritional quality of prey delivered to chicks. Together, our results show that ester-resolved astaxanthin composition can capture biologically meaningful prey signatures in Arctic zooplankton and predator-delivered diet, supporting its potential as a candidate biochemical indicator of prey-field structure and trophic reorganization in rapidly changing Arctic marine ecosystems.

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Integrating eDNA and Photoquadrats for Large-Scale Biodiversity Assessments of Atlantic Rocky Shores (S1-PC-03)

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Climate change has been linked to the redistribution of several species worldwide, underscoring the need to understand organisms' responses across vast geographical scales. Rocky intertidal ecosystems are suitable models for studying the effects of climate change. By experiencing both marine and terrestrial conditions, these communities are exposed to highly dynamic environments and often approach their thermal limits. Consequently, microhabitats represent significant refuges and may exert a greater influence than broad latitudinal gradients. However, the extent to which microhabitats influence biodiversity along a continental scale is not yet fully understood, largely due to the limited standardized biodiversity data collected across large geographic ranges. This work presents an innovative methodological approach designed to efficiently assess rocky intertidal biodiversity across the Atlantic Ocean, from polar to tropical regions. By integrating imaging with genomics, such as Photoquadrats and environmental DNA (eDNA), we will be able to analyze in-depth biodiversity patterns of rocky intertidal communities and fill gaps in under-studied regions. Photoquadrats offer a cost-effective approach that facilitates faster sampling and detailed post-identification of organisms, along with opportunities for automated taxonomic identification using artificial intelligence. Additionally, eDNA has the capacity to facilitate the simultaneous detection of multiple species, while also overcoming some of the limitations associated with morphology-based taxonomy. Consequently, the combination of these two methods enables a robust analysis of biodiversity, and their standardized application across latitudinal gradients allows for the collection of highly comparable data for large-scale intertidal biodiversity studies. Here, we present a streamlined protocol for both eDNA sampling and analysis and photoquadrat processing of rocky shore communities. A snapshot of species richness and diversity indexes along the Atlantic Ocean reveal the intricate patterns of rocky intertidal ecosystems in the Atlantic.

High Resolution Examination of Benthic Community Composition across the Mesophotic Zone in the Cayman Islands (S1-PC-04)

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While shallow coral reef communities are well-documented, mesophotic coral ecosystems (MCEs)—extending from 30 m to 150 m—remain under-explored. Often considered potential thermal refugia for shallow-water species, MCEs also host unique, depth-specialist communities that necessitate independent conservation strategies. To better understand their ecological function, we characterized the benthic composition of MCEs between 30–60 m in the Cayman Islands using high-resolution, replicated sampling. Our results reveal significant depth-mediated shifts in community structure. Sponge cover was significantly higher at depths of 40–60 m compared to 30 m, while antipatharian (black coral) cover peaked at 60 m. Conversely, scleractinian coral cover declined significantly at 50 m, with shallower depths exhibiting higher overall cover. Species-specific responses were also evident: *Agaricia agaricites* abundance decreased with depth, whereas *Madracis pharensis* increased. Notably, *Mycetophyllia reesi* and *Scolymia lacera* were found exclusively at 60 m, highlighting the presence of depth-restricted specialists. Biodiversity metrics further illustrated this transition; both alpha diversity (species richness) and beta diversity were significantly higher at 30 and 40 m than at 50 and 60 m. These findings underscore the high biological turnover within MCEs and provide critical baseline data for the management and protection of these unique deep-reef habitats.

From deep dives to digital drives: cataloguing marine fauna from scientific expeditions to support Vulnerable Marine Ecosystem assessment and open data sharing (S1-PC-05)

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Imagery acquired during scientific expeditions represents a valuable yet often overlooked resource for biodiversity assessment and conservation planning, particularly in environments where conventional sampling is logistically constrained or ecologically disruptive. On this premise, the present study undertakes a systematic analysis of photography and video datasets obtained during multiple marine expeditions across the Northeast Atlantic region and adjacent European continental margins, with the intent of identifying both benthic and demersal fauna based on distinct morphological characteristics. The resulting observations are then compiled into standardised catalogues, with species identified to the lowest achievable taxonomic resolution, and occurrences are recorded to support a preliminary assessment of spatial patterns in community composition. Particular attention is given to indicator taxa of Vulnerable Marine Ecosystems (VMEs), such as habitat-forming corals and sponges, which play a key role in ecosystem structure and functioning, and are especially sensitive to anthropogenic disturbance. The resulting specimen collection and associated taxonomic records are structured in accordance with data management standards and made publicly available through open-access repositories. In addition, a digital image database archive is compiled in collaboration with The Biological Research Collection of Marine Invertebrates (CoBI), ensuring long-term data accessibility and the promotion of transparent and reproducible research. By facilitating data sharing, this body of work helps address and close existing gaps in baseline biodiversity knowledge and support ongoing efforts in conservation, monitoring, and spatial management. Overall, this study highlights the importance of image-based ecological analyses as a cost-effective, non-invasive approach to biodiversity assessment and reinforces the role of open, accessible data in advancing marine conservation efforts.

Intertidal Biodiversity Mosaics and Thermal Heterogeneity Along the North-Western Iberian Coast (S1-PC-07)

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Rocky intertidal ecosystems are characterized by extreme and rapid environmental fluctuations in temperature, salinity, moisture, and wave action across latitudinal gradients and fine-scale microhabitats. Organisms inhabiting these environments are subjected to daily intense physical stress. The northern Portuguese and Galician coasts form a biogeographic transition zone where boreal and warm-temperate species coexist

under a seasonal upwelling regime. In this region, foundation species such as mussels, rockweeds, and red turf algae, may serve as important biological mechanisms to alleviate the thermal pressure, playing a role in structuring and maintaining these systems. Given the region heavy economic dependence and its vulnerability to changes driven by climate variability, it is critical to track biodiversity patterns and identify possible shifts in community structure and ecosystem composition. In this study, we surveyed intertidal biodiversity across 18 rocky shores along northern Portugal and Galicia using a standardized photographic method. Community composition was quantified using AI-assisted image analysis tools, combining it with high-resolution temperature data from field loggers to assess the role of fine-scale thermal heterogeneity in shaping intertidal community structure. We quantify spatial variation in community structure and evaluate the extent to which local thermal regimes explain patterns in species composition. By linking high-resolution environmental variability with community data, this study provides new insight into the mechanisms shaping intertidal communities in a climate-sensitive transition zone and establishes a baseline for detecting future ecological change.

Hidden in plain sight: introduced bryozoans across natural and artificial habitats of the Slovenian coast (S1-PC-08)

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Fouling bryozoans are among the most common pioneer taxa in marine anthropogenic habitats, with many of the species being introduced. However, their occurrence in natural habitats and their potential influence on native biota remain poorly understood. In this study, we examined the spatial dynamics of fouling communities, with a focus on bryozoans, using passive samplers (fouling plates) deployed at four locations along the Slovenian coast in 2025: two in artificial habitats (harbors) and two in marine protected areas (MPAs). Total biomass differed between two sampling periods (cold and warm) but did not vary significantly between artificial and MPA sites. Biomass was lower during the cold period (February–May 2025) and higher in the warm period (September–December 2025). In both periods, vertically oriented plates showed significantly less growth than horizontally oriented plates. Preliminary results from the cold period indicate spatial differentiation in bryozoan assemblages, likely influenced by position along the coastline and proximity to the largest Slovenian harbor. Differences among assemblages across locations were primarily driven by introduced species, including *Watersipora* spp., *Bugula neritina*, and *Tricellaria inopinata*. Overgrowth, defined as the covering of feeding structures and used here as an indicator of spatial competition, revealed that ascidians

most frequently overgrew bryozoan colonies. Bryozoans outcompeted only polychaetes (Spirorbinae). These interactions, observed in the cold period, do not suggest a negative impact of introduced bryozoans on other taxa. However, analysis of data collected in the warm period is required to better understand these patterns, particularly in light of the high abundance of the alien species *Arbopercula angulata*, which occurred at all sites, including the most pristine location (Pacug). These preliminary results, collected as part of the NISBryoECO project, reveal ecologically significant patterns that will be further explored through expanded temporal sampling, microbiome analyses, and studies of feeding selectivity in selected bryozoan species.

Climate-driven variability in zooplankton biomass and community composition in the southern Adriatic Sea: insights from the ZOOMASS project (S1-PC-09)

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Climate change is increasingly influencing marine ecosystems, particularly through alterations in temperature regimes and associated shifts in biological communities. The ZOOMASS project aims to investigate the effects of climate change on the biomass, taxonomic composition, and seasonal dynamics of zooplankton communities in the coastal waters of the southern Adriatic Sea. Over a three-year period, field sampling is conducted across multiple representative sites, including the Lokrum station with monthly sampling, the Mljet lakes with seasonal sampling, and Lake Mir on Dugi Otok with autumn and winter sampling. Sampling includes vertical profiling above and below the thermocline to assess variations in zooplankton biomass, abundance, and community structure. Particular attention is given to the occurrence and spread of thermophilic and allochthonous species, which are expected to increase with rising sea temperatures. The study combines traditional morphological identification with molecular techniques, specifically metabarcoding, to ensure high resolution and reliable species detection. In parallel, key environmental parameters, including temperature, salinity, and nutrient concentrations, are monitored to characterize the physicochemical context of observed biological changes. Statistical analyses, including correlation and multivariate approaches, are applied to evaluate relationships between environmental drivers and zooplankton dynamics. Preliminary results from the ZOOMASS project will be presented, providing early insights into zooplankton community responses to ongoing environmental change in the southern Adriatic. These findings contribute to a better

understanding of pelagic ecosystem dynamics and support regional and international efforts in marine monitoring and conservation.

Arctic skeletal archives: Variability in elemental composition among benthic calcifiers (S1-PC-10)

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The production of calcium carbonate skeletons by marine animals and coralline algae provides protective exoskeletons and structural support but also serves as a long-term carbon sink, playing a critical role in regulating atmospheric CO₂ over geological timescales. During biomineralization, marine calcifiers incorporate a range of trace elements from seawater, such as e.g. Mg, Sr, Na, Mn, both as Ca substitutes in the crystal lattice and as components of the organic skeletal matrix, creating chemical signatures that can reflect both environmental conditions and species-specific physiological processes. Consequently, elemental concentrations in skeletons can vary between individuals, populations, species, and phyla, as well as between habitats and communities across different geographical scales. Despite this, our understanding of the relative contributions of environmental conditions and biological processes to skeletal geochemistry remains incomplete. Arctic fjords, characterized by strong gradients in temperature, salinity, freshwater input, and carbonate saturation, provide a natural laboratory to investigate these interactions. This study examines how the elemental composition (Mg, Sr, Na, S, Al, P, Fe, Zn, Mn) of three benthic calcifiers (*Semibalanus balanoides*, *Paradexiospira violacea*, and *Harmeria scutulata*) varies across three Svalbard fjords: Isfjorden, Hornsund, and Kongsfjorden and over four years. Geochemical composition was quantified using inductively coupled plasma–atomic emission spectroscopy (ICP-AES). Our results reveal that elemental composition is primarily biologically controlled by species identity, while spatial (fjord and site) and temporal (interannual) variability also contribute to observed patterns. Responses to environmental variables are thus highly species-specific, indicating that elemental concentrations are likely driven by a combination of environmental and biological factors. These findings highlight the importance of considering both species-specific physiology and environmental heterogeneity when interpreting skeletal geochemistry and demonstrate that a multi-elemental approach enhances our understanding of biomineralization processes in dynamic Arctic fjords.

Widespread decline of canopy-forming macroalgae along the Slovenian coastline (northern Adriatic): evidence from an expanded long-term monitoring network (S1-PC-11)

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Canopy-forming macroalgae, particularly *Cystoseira sensu lato* species, are key habitat-forming organisms and important indicators of ecological status (ES) in Mediterranean coastal ecosystems. Previous studies have documented local declines at selected monitoring sites along the Slovenian coast, where benthic macroalgae have been used as a biological quality element for ES assessment since 2006. Here, we extend this assessment by analysing a substantially expanded dataset encompassing multiple monitoring stations along the Slovenian coastline, allowing a more robust evaluation of large-scale temporal trends. Macroalgal assemblages have been monitored seasonally (spring and autumn) since 2007 within the framework of a national monitoring programme. Across 4 coastal Water Bodies, 13 monitoring stations with long-term data series were selected to ensure spatial representativeness and temporal consistency. The ES of coastal waters was assessed using the Ecological Evaluation Index continuous formula (EEI-c), in accordance with the requirements of the Water Framework Directive. Changes in macroalgal communities were evaluated using structural and functional indicators. Temporal trends were analysed using non-parametric approaches (Spearman rank correlation). Our results reveal consistent and significant negative trends ($p < 0.05$) across most indicators. In particular, the proportion of canopy-forming taxa, total algal coverage, and the coverage of ESG I taxa declined over time. Similarly, both the absolute and relative coverage of canopy-forming species showed a marked decrease over time. In contrast, the proportion of ESG I taxa relative to total taxa did not exhibit a significant trend, suggesting that compositional shifts may be masked when considering taxonomic ratios alone. Spatial and seasonal differences were also detected, indicating heterogeneous dynamics among sites. These trends likely reflect the combined effects of multiple stressors, including increasing anthropogenic pressures along the coastline, oligotrophication of the northern Adriatic, and climate-driven changes. Overall, the observed patterns point to a large-scale degradation of structurally complex macroalgal assemblages, characterized by the loss of canopy-forming species and reduced ecosystem complexity. These findings reinforce previous site-specific observations and highlight the need for region-wide conservation and restoration strategies targeting especially brown algal forests.

Can cold-water corals keep up with climate change? A reproductive ecology study on *Desmophyllum pertusum* (Linnaeus, 1758) (S1-PC-12)

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The deep sea is the most remote and, until recently, pristine ecosystem of our planet. Once considered away from anthropogenic influence it is increasingly vulnerable to the effects of climate change. Cold-water corals are indicator taxa for Vulnerable Marine Ecosystems due to their ecological importance, combined with physical fragility and slow rates of recovery from disturbance. Among the most critical architects of these ecosystems is the scleractinian coral *Desmophyllum pertusum*, a framework-forming species with an aragonitic skeleton that provides the structural complexity that helps support diverse faunal assemblages. However, the autoecology of *D. pertusum* makes it particularly susceptible to environmental shifts. The effects of ocean warming and acidification pose a dual threat, 1) increasing the energetic demand for calcification and other metabolic processes, and 2) increasing ocean stratification that will diminish the downward flux of particulate organic matter, further limiting the energy budget of these sessile organisms. To understand these effects, a multifactorial mesocosms experiment was conducted using *D. pertusum* specimens collected from the Bay of Biscay. The study used a novel comparative framework to assess the influence of *in situ* hydrostatic pressure on the physiological responses. Polyps were maintained during four months across two different pressure regimes: 1) atmospheric pressure aquariums, and 2) pressurized aquariums (8MPa). Combined with these regimes, three environmental scenarios were tested: 1) control, 2) an increase of 3°C above the norm, and 3) an increase of 3°C above the norm combined with a reduction of 0.3 pH units. The primary focus of this study is understanding the effects of these stressors on the reproductive cycle of the species. Through histological sectioning of polyps and quantitative and qualitative analysis of the gametogenic stages, we evaluate how increasing energetic costs associated with climate change may lead to the deviation of energy away from reproduction. Furthermore, by comparing results between the atmospheric and pressurized specimens, this research seeks to give preliminary results on the validation of the need for high-pressure systems in deep-sea mesocosm experiments.

Can rubble support reef recovery? Interactive Effects of Rubble Substratum Ecology, Temporal and Spatial Variability on Coral Recruitment Dynamics (S1-PC-13)

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Coral reef ecosystems are increasingly threatened by climate-driven disturbances and local anthropogenic stressors that reduce live coral cover and create rubble fields on the benthic. Although coral recruitment is essential for reef recovery, the role of rubble substrata in supporting settlement and early survival of coral recruits, remains poorly understood. This study investigated coral recruit density and survival across rubble and hard substrata at three coastal locations along the Keaukaha shoreline in Hilo, Hawai'i (Puhi Bay, Wai'olena Beach Park, and Richardson's Ocean Park) over a six-month post-spawning period. Recruitment density and recruits' survival over time were measured conducting SCUBA surveys, comparing recruits' survival rates hard to rubble substrata. In addition to assessing percent cover of crustose coralline algae (CCA), turf algae, sponges, and bare rock on rubble and hard substrata. Hard substratum consistently supported higher coral recruit densities than rubble across all locations, suggesting that substratum stability is a fundamental prerequisite for early recruitment success. Despite CCA being widely recognized as a chemical settlement cue, no significant relationship was found between CCA cover and recruit density on either substratum type, indicating that CCA abundance alone is insufficient to predict recruitment outcomes. Coral recruit density declined significantly over time at most sites, consistent with Type III survivorship. Significant spatial variation in benthic community composition was observed, with Wai'olena exhibiting the highest CCA cover and Puhi Bay the lowest, a pattern likely driven by differences in submarine groundwater discharge intensity, sedimentation, and substratum stability. These findings suggest that reef recovery potential is spatially heterogeneous across Hilo, and that rubble instability, benthic community succession stage, and submarine groundwater discharge-driven water quality changes collectively shape early coral population dynamics in East Hawaii.

Are Perspex panels suitable surrogates for natural hard substrates in ecological studies in the coastal zone? An example from the low-diversity Baltic Sea (S1-PC-14)

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Different eco-engineering methods have strived to mimic benthic processes in natural habitats by providing functionally similar conditions and consistent topographic features on artificial structures. Evidence of the applicability of man-made constructions for ecological studies in the coastal zone is unambiguous and varies across environmental conditions, topographic complexity and location of a substrate. This study was set up to verify the use of artificial panels as a substitute for natural hard bottom (rocks) in investigating the settlement and development processes of macrobenthic faunal assemblages. During a nearly one-year field experiment (March – April), principal community measures (species richness, density and biomass of dominant fouling species) were compared on a seasonal basis between the grey polystyrene (commercial name of Perspex or HIPS) horizontal square panels and cobbles (igneous, metamorphic and sedimentary (carbonate and clastic) rocks) in two shallow (water depth 3.5 m) benthic habitats in the Gulf of Gdańsk, southern Baltic Sea: (1) sheltered medium-grained sand and (2) more exposed gravelly-sandy sediment. The panels and cobbles supported communities of similar taxonomic richness (sessile and associated fauna) and biomass (sessile fauna, i.e. the barnacle *Amphibalanus improvisus* and mussel *Mytilus trossulus*). Dissimilarities were observed for the density of the fouling fauna and its dominant species, *A. improvisus*, which can be attributed to spatial differences in hydrological conditions and, presumably, also substrate texture. At a more sheltered site, resuspension and transport of sediment particles adversely affected the settlement on cobbles relative to the panels whose smooth horizontal surface favoured the formation of organic biofilm facilitating the settling of planktonic larvae. At a more exposed gravelly-sandy site, wind-induced overlying bottom sea currents likely dislodged established individuals from the smooth panels, while the rougher and more porous surface texture of the cobbles enhanced colonisation by creating more diverse light conditions and increasing micro-habitat heterogeneity. The Perspex panels proved to provide a consistent and uniform experimental apparatus for coastal ecological studies with enough mimicry of a complex natural substrate.

The role of mussel reefs as microclimatic refuges under global change: an experimental approach (S1-PC-15)

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Habitat-forming species play a key role in coastal ecosystems by generating structurally complex habitats that can buffer environmental stress and enhance biodiversity. Among these ecosystem engineers, mussel reefs are particularly relevant in temperate rocky intertidal systems, due to their capacity to function as ecological refuges for associated species. This study aims to evaluate the role of mussel reef structure in buffering thermal stress in associated organisms. We hypothesize that higher mussel density and structural complexity enhance thermal buffering, with inner reef areas providing more stable microclimatic conditions than edges. To test this, laboratory experiments will be conducted at BIOPOLIS-CIBIO (Portugal) facilities using intertidal environmental chambers. These self-contained units can simulate the intertidal environment, allowing for control over temperature, tidal cycles, photoperiod, and light intensity. We will compare the buffer effect of low versus high mussel bed density, across three temperature levels (control, moderate and extreme) mimicking real marine and atmospheric heatwaves. Physiological stress will be assessed in both mussels and associated macrofauna using non-invasive sensors to record heart rate as a proxy for metabolic stress. Additionally, parameters such as filtration rates, byssal attachment strength and gaping behavior will be recorded to assess eco-physiological resilience. Expected results are anticipated to show that high-density reef configurations lead to more stable environmental conditions and significantly reduce thermal stress for associated biodiversity compared to low-density or bare rock areas. These findings will provide empirical evidence on how heatwaves and biophysical features modulate the effectiveness of mussel reefs as ecological refuges and will contribute to understanding the role of habitat-forming species as nature-based solutions for coastal conservation under global change.

Epifaunal assemblages associated with non-indigenous and native canopies along the Atlantic coast of the Iberian Peninsula (S1-PC-16)

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The non-indigenous canopy macroalga *Sargassum muticum* has colonised the Atlantic shores of the Iberian Peninsula and nowadays it is very frequent and locally abundant on intertidal rocky shores. Previous studies showed that the assemblage of invertebrates harboured by *S. muticum* is different to that present in native canopies. However, these studies were very local and results may differ among areas depending on environmental conditions. The aim of this study was to compare the invertebrate assemblage associated with the non-indigenous *S. muticum* and the native macroalga *Bifurcaria bifurcata* in four regions along the Atlantic coast of the Iberian Peninsula from Galicia (NW of the Iberian Peninsula) to central Portugal. To achieve this aim, two regions in Galicia (Gulf of Biscay and Costa da Morte) and two in Portugal (north and central) were considered, and two intertidal rocky shores were randomly selected at each region. Six individuals of each macroalga species were collected per region and rocky shore to study their invertebrate assemblages. More than 25 387 individuals and 196 species were reported. Results pointed out a significant interaction between macroalga species and rocky shore for total number of individuals, Shannon's index and the multivariate assemblage structure of invertebrates. It should be highlighted that assemblages associated with *Sargassum* were more homogenous than those harboured by *Bifurcaria*. Regarding the effect of region, the multivariate assemblage of invertebrates was significantly different between north and central Portugal, independently of the macroalga. Moreover, the number of invertebrate taxa showed a significant interaction between region and macroalga species. Our results pointed out that *Sargassum* and *Bifurcaria* harboured dissimilar assemblages; however, differences were dependent on region and shore. The role of macroalgal complexity is also discussed.

The role of *Zostera noltei* as foundation species in anthropogenic areas (S1-PC-17)

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Seagrasses are considered foundation species because they can modify environment conditions by increasing complexity and thus, enhancing the diversity. Moreover,

seagrasses play an important role as nurseries for many animal species; they can also reduce predation pressure, and decrease inter- and intraspecific competition. They are able to mitigate effects of abiotic parameters such as thermal stress and low tide desiccation, slowing current flow, trapping sediment and increasing water clarity. However, the relationship between fauna and seagrass structural complexity vary widely among studies. *Zostera noltei* Hornemann 1832 is a seagrass species distributed along the Mediterranean Sea and North Atlantic Ocean, present in subtidal and low intertidal muddy and sandy flats. In northern Portugal, meadows of *Z. noltei* are present in the Ria de Aveiro and in the Minho estuary. The Ria de Aveiro has been exposed to many anthropogenic activities and disturbances for decades whereas the Minho estuary is an area scarcely impacted compared to other European estuaries. The aim of this study was to compare invertebrate assemblages in two habitats (*Z. noltei* meadows and bare sediment) at both localities (Ria de Aveiro and Minho estuary). To achieve this aim, three intertidal sites (100s of meters apart) within *Z. noltei* meadows and 3 sites in bare sediment were randomly selected in the Ria de Aveiro and in the Minho estuary. At each site and habitat, four replicates were collected to study invertebrate assemblages. More than 7 700 individuals and 48 species were reported. Results pointed out a significant interaction between habitat and locality for the total number of taxa and the multivariate assemblage structure of invertebrates. The number of invertebrate taxa was twice higher in *Zostera* meadows than in bare sediment but only in the Ria de Aveiro. The dissimilarity of invertebrate multivariate assemblage structure between habitats in the Ria de Aveiro was 66%. Twenty-four species were responsible for differences between habitats. Most of these species reached a greater abundance in *Zostera* meadows. Only the gastropod *Peringia ulvae*, the amphipod *Corophium multisetosum*, nematodes, copepods and mysidaceans showed greater abundances in bare sediments. However, differences between habitats in the Minho estuary were not found. Our results pointed out that *Z. noltei* seems to play a significant role as foundation species for invertebrate assemblages in areas with intense human activities such as Ria de Aveiro. Thus, seagrasses in degraded areas could be used to increase biodiversity.

Assessing juvenile fish diversity, abundance, and recruitment using Standard Monitoring Units for Recruitment of Fish (SMURF) (S1-PC-18)

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Marine coastal habitats provide essential refugia and feeding grounds for juvenile fish during their ontogenetic transition from pelagic stages to their adult environments. This study evaluates the effectiveness of Standard Monitoring Units for the Recruitment of

Fish (SMURFs) in detecting spatiotemporal patterns of juvenile fish recruitment in a marine coastal ecosystem. SMURFs offer a simple and low-cost approach that leverages the natural tendency of juvenile fish to aggregate within structural shelters, thereby functioning as standardized, controlled microhabitats. Ten SMURF systems were deployed at two sites along the Israeli Mediterranean coastline, with seven units positioned in the upper water column and three placed near the seafloor at a depth of 12 m. Over sixteen consecutive months, monthly collections and replacements of the SMURFs enabled detailed characterization of species richness and abundance of juvenile and post-larval fishes utilizing these artificial habitats, providing new insights into recruitment dynamics and seasonality. In total, 25 fish species were collected and identified, representing both demersal and neritic habitats and including native as well as non-indigenous species. The most species-rich families were Sparidae and Blennidae, each represented by six species. Notably, three previously unrecorded non-indigenous blenny species were detected along the Israeli coast. This first implementation of SMURFs in the Eastern Mediterranean demonstrates their strong potential as a tool for monitoring fish recruitment, offering valuable data to support conservation planning and management in an ecologically vulnerable region.

Structure of neustonic zooplankton communities sampled weekly in the Sines Leisure Port, Portugal: seasonal and interannual variation (S1-PC-19)

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Zooplankton functions as a crucial link between phytoplankton and higher trophic levels. In this study, we investigated patterns of temporal variation in the structure of neustonic zooplankton communities sampled in the Sines Leisure Port, Portugal. These communities were sampled every week in 2015 and 2019 using a neustonic plankton net with a mesh size of 150µm. Samples were collected approximately 2 to 4 hours before the diurnal high tide. A total of 104 samples were processed. Sub-sampling was performed when the number of specimens of a specific taxon was very high. The identification of the organisms was made to the lowest possible taxonomic level. We identified 26 taxa with copepods (52%), nauplius of cirripedia (28%), cypris of *Chthamalus montagui* (10%), nauplius of other crustaceans (7%), and cladocerans (*Penilia* spp. (3%), *Evadne* spp. (2%)) being the most abundant taxa. We also estimated the biovolume and abundance of blue microplastics in each sample, since, based on previous studies, blue

microplastics were the dominant group of microplastics. Multivariate analyses were performed. Seasonal variation of the structure of these communities (abundance of the different taxa) was observed in 2015 and 2019; however, the seasonal pattern differed depending on the year. In 2015, no differences were found between winter and fall, while spring and summer differed from all other seasons. In 2019, winter and fall differed from all other seasons, while no significant differences were observed between spring and summer. On the other hand, significant differences were observed between 2015 and 2019 across all four seasons. With regard to the taxa that best discriminated the variation between years, in general, a higher abundance of several taxa was observed in 2019 than in 2015. These temporal patterns will be discussed.

River plumes influence on macrozoobenthic communities: spatial patterns and trophic responses (S1-PC-21)

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River plumes can influence coastal ecosystems by altering the physical, chemical, and biological conditions of adjacent coastal areas. This study investigates how the input of freshly deposited organic material from the Isonzo River (northern Adriatic Sea) affects the structure of macrozoobenthic communities following two plume events, one in autumn 2024 and one in spring 2025. In both seasons, potential food sources for the benthic community were collected under in-plume conditions, while macrofauna samples were collected approximately one month later to allow suspended particles to settle into the sediment. Sampling was carried out at six stations along two transects: one coast-offshore (IN1-IN4) and one parallel to the coastline (IN5, IN2, IN6) near the river mouth. Macrozoobenthic communities were sampled one month after a major autumn plume (November 2024) and after several winter-spring plumes (June-July 2025). Community structure was assessed in terms of abundance and biomass, and lipid biomarkers of target species and their potential food sources were analysed. In autumn 2024, the station closest to the river mouth (IN1) showed low abundance (276.7 ind. m⁻²), likely due to limited organic matter deposition associated with high current velocity near the seabed. Abundances decreased moving offshore, with intermediate values at the two

lateral stations (IN5 and IN6). A similar spatial pattern was observed in spring 2025, except for station IN1, where abundance shifted from the lowest value in autumn to the highest value in spring (4083.3 ind. m⁻²). Overall, abundance increased from autumn to spring across stations, while biomass showed no clear spatial pattern in either season. Cluster analysis based on species composition identified three main groups: IN1 was separated from the other stations; IN3 and IN4, characterised by more marine-influenced communities, clustered together; and IN2, IN5, and IN6 formed a third group with similar community structure. In line with this framework, phytoplankton-derived lipid markers (EPA and DHA) showed higher values at offshore stations in autumn 2024, reflecting a stronger marine signal, although with high variability among benthic species, highlighting the complexity of trophic processes and assimilation dynamics.

Dynamics of zooplankton assemblages in Arctic nearshore habitats (S1-PC-22)

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Arctic nearshore zooplankton communities remain poorly described despite their importance for coastal food-web functioning and energy transfer. We analysed zooplankton assemblages collected from shallow coastal stations in Svalbard, using datasets from Bjørnøya (2022) and Bellsund (2023–2024) sampled during summer along short transects located 25–200 m from the shore. The sampling design included transects situated near large seabird colonies as well as reference areas, allowing us to examine zooplankton variability in coastal habitats differing in local ecological context. We focused on total abundance, the relative contribution of major zooplankton groups, and the developmental structure of dominant copepods, particularly *Calanus*. Across all datasets, community composition was dominated by a limited number of major components, but their relative proportions varied strongly among stations, distances from shore, and years. The most pronounced differences were observed in Bellsund between 2023 and 2024. Samples collected in 2023 showed high contributions of copepod nauplii and early copepodite stages of *Calanus*, indicating active recruitment and an earlier phase of seasonal population development. This year was also exceptionally warm in the Svalbard region, providing an important environmental background for the observed community structure. In contrast, assemblages from 2024 were characterized by much lower naupliar contribution and a stronger representation of older copepodite stages, especially within *Calanus*, suggesting more advanced developmental structure. We also

detected significant differences between seabird-influenced and reference transects. These patterns may be indirectly linked to nutrient inputs associated with seabird colonies, but they should be interpreted with caution, as they were likely shaped by multiple interacting drivers, including local hydrographic setting, water-mass dynamics, and the inherently dynamic nature of zooplankton communities. Bjørnøya data showed comparable fine-scale heterogeneity, supporting the view that Arctic coastal zooplankton is highly patchy even over short nearshore distances. These results show that Arctic coastal zooplankton variability is expressed through both shifts in community composition and differences in developmental structure, with likely consequences for trophic pathways and energy transfer in nearshore ecosystems, even at the fine spatial scale of short coastal transects. Our study highlights the importance of taxonomically and developmentally resolved zooplankton analyses for understanding marine biodiversity patterns and ecosystem functioning in Arctic coastal habitats.

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Pathogen microorganisms and parasitic epibionts of crustaceans from areas adjacent to Marine Protected Areas (MPAs) in the Colombian Caribbean (S1-PC-25)

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Decapod crustaceans host a wide range of potentially pathogen microorganisms and epibionts. Notable pathogens include PaV1, a virus specific to *Panulirus argus* that can cause up to 100% mortality, and the dinoflagellate *Hematodinium* sp., which infects multiple crustacean species, and causes bitter crab disease in *Callinectes sapidus*. Besides, epibionts are common in these invertebrates and may reach high densities, potentially becoming parasites and impairing host physiological functions and survival. The main objective of this study was to assess the presence of epibionts and potentially pathogen microorganisms in four commercially important crustacean species across two geographic scales in the Colombian Caribbean. During 2019, field sampling for crustacean captures was conducted in coral reef, coastal and swamp ecosystems of the Colombian Caribbean, in areas adjacent to Marine Protected Areas (MPAs). *Maguimithrax spinosissimus* were collected from coral reef systems (Providencia, Isla Grande, Isla Fuerte), *P. argus* from these sites as well as Tasajera and Cabo de la Vela, and *C. sapidus* and *C. bocourti* from the Ciénaga Grande de Santa Marta – CGSM-. Specimens were measured, haemolymph was extracted, and epibionts were visually inspected prior to

laboratory processing. Tissues (gills, hepatopancreas, and muscle) were analyzed using conventional PCR to detect PaV1 and *Hematodinium* sp. Epibionts were collected and identified to the lowest possible taxonomic level. Physical chemical parameters were measured in the CGSM. A total of 84 *P. argus*, 20 *M. spinosissimus*, 90 *C. sapidus*, and 54 *C. bocourti* were analyzed. PaV1 was detected in six *P. argus* individuals, while *Hematodinium* sp. was detected in three *C. sapidus* and one *C. bocourti*. The most abundant epibiont in coral reef environments was *Octolasmis hoeki* (17,149 individuals in *P. argus* and 3,672 in *M. spinosissimus*), followed by cypris larvae (1,118 individuals in *P. argus*), and coralline algae (1,503 colonies in *M. spinosissimus*). Less abundant taxa included *Balanus* sp. (226), the nemertean *Carcinonemertes* cf. *conanebrioni* (three individuals) in *P. argus*, and a Syllinae polychaete (three individuals) in *M. spinosissimus*. In *C. sapidus* and *C. bocourti* from CGSM, *Carcinonemertes* sp. (350 and 195 individuals), *Myzobdella* sp. (7 adults, 2,191 eggs), a bivalve (Mytilidae, 22 individuals), and *Balanus* sp. (15 individuals) were recorded. Epibiont abundance was positively associated with host size. No significant correlations were found between physical chemical variables and epibiont abundances in the CGSM. This study provides the first records in the Colombian Caribbean of PaV1 and *Hematodinium* sp., as well as epibionts such as *Carcinonemertes* sp. and *Myzobdella* sp. in portunid crabs, and population-level occurrences of *Octolasmis hoeki* in *M. spinosissimus* and *P. argus*. Further research incorporating environmental variables and molecular markers is recommended.

Integrative taxonomy of the deep-sea sponge fauna of the Gettysburg Seamount (Gorringe Bank, NE Atlantic) (S1-PC-26)

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The Gorringe Bank, located 270 km southwest of the Portuguese coast, rises from 5000 m depth and features two shallow peaks, the Ormonde and Gettysburg seamounts. This topographic feature has a unique oceanographic context, due to its geographic position, where different environmental conditions, ocean currents and a wide depth range promote the occurrence of distinct habitats and species. There have been several studies on this area that suggest this is a hotspot of biodiversity, namely for demosponge fauna in the Northeast Atlantic and, in deeper waters, sponges were reported to

dominate benthic assemblages. However, taxonomic studies performed to date focused on samples collected from the shallower areas of the ridge. This work aims to fill this gap and identify the sponge fauna sampled in the upper bathyal of Gettysburg seamount during the TwinDEEPS campaign, using an integrative taxonomy approach that combines morphological and genetic (DNA barcoding) analysis. A total of 72 samples were collected, between 260 and 1500 m depth. Diagnostic morphological characters were analysed under optical microscopy and 66 DNA barcode sequences were obtained for mitochondrial and nuclear markers (COI, 28S and 16S), which were compared with reference databases (GenBank and BOLD). Furthermore, a dataset of sponge occurrences on the Goringe Bank was compiled from the literature and combined with records from OBIS and GBIF, establishing a baseline of 81 species representing 19 orders, 47 families and 79 genera for the area. Preliminary results from morphological and molecular analysis show new records for the Goringe, such as *Murus* sp., *Guitarra* sp. and *Vulcanella gracilis*. Ongoing work is aimed at understanding the phylogenetic relationships of this fauna with neighbouring Atlantic and Mediterranean areas. These results will provide the basis for future ecological studies in the Goringe Bank and support the management plan under development for the proposed MPA in this region.

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Taxonomical reassessment of the gorgonofauna of Tabarca Marine Protected Area (Western Mediterranean) (S1-PC-27)

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Accurate species identification is a cornerstone for effective biodiversity monitoring and conservation, yet even shallow-water gorgonians often present surprising patterns that remain overlooked. In this study, we reexamined octocoral assemblages from the Tabarca Marine Protected Area (Alicante, Spain) by combining historical collections housed at the University of Alicante with recent scuba-based surveys conducted at 8–40 m depth. Our results indicate that the most abundant white gorgonian colonies in shallow zones (≤ 30 m) of the MPA is *Eunicella gazella*, rather than *E. singularis*, which was rarely observed during the transects. In addition, the reexamination of material assigned to *Paramuricea clavata* from “La Roca” (36–50 m), revealed that these specimens correspond to *P. baetica*, representing the easternmost record for this species in the

Western Mediterranean. This work demonstrates that even well-studied shallow-water habitats may conceal unexpected taxonomic diversity. These findings help to fill a major distributional gap between Murcia and the Columbretes Islands, suggesting that *E. gazella* may have been previously misidentified across intermediate regions. Despite its high abundance, *E. gazella* has not been previously detected in the area, highlighting the critical need for taxonomic expertise and careful species verification in ecological surveys. Furthermore, correct species identification is essential for designing effective conservation strategies and ensuring accurate assessments of biodiversity patterns in Mediterranean marine ecosystems, particularly in a group as severely affected by climate change as gorgonians.

Environmental drivers of the microbial community analysed by flow cytometry in a mesotidal estuary (Sado estuary – Portugal) (S1-PC-28)

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Estuaries are dynamic ecosystems where fluctuating physical and chemical conditions strongly influence microbial community structure and activity. These communities play key roles in estuarine biogeochemical processes, however their rapid dynamics and small size often limit comprehensive characterisation. This study investigates the spatiotemporal variability of microbial communities in the Sado Estuary (Portugal) using flow cytometry combined with multivariate analysis. To identify the environmental drivers of microbial dynamics, we analysed two years of observations. Monthly (2022) and biweekly (2023) sampling was conducted across seven fixed stations in the mesotidal Sado Estuary (Portugal). Surface water samples were collected during neap high tide and were analysed for physicochemical parameters (temperature, salinity, pH, dissolved oxygen, turbidity, sechi depth, nutrients and organic and inorganic suspended matter) and biological components (microbial abundances determined through flow cytometry, for pico and nano phytoplankton, bacteria, viruses, and heterotrophic nanoflagellates). Results revealed a pronounced spatial pattern along the estuarine gradient, driven by interacting environmental and hydrological factors. Upstream areas exhibited higher abundances of bacteria, viruses, and heterotrophic nanoflagellates, whereas downstream zones favoured pico- and nanophytoplankton, reflecting differences in light

penetration, salinity, and nutrient conditions. The persistent dominance of small eukaryotes and the seasonal dynamics of cyanobacteria highlights the rapid phytoplanktonic response to fluctuations in temperature and light. Correlated patterns among bacteria, viruses, and heterotrophic nanoflagellates indicate functional coupling between primary production, microbial recycling, and predation. Multivariate analyses identified light penetration as a key ecological driver of spatial differentiation, reinforcing its central role in primary productivity and trophic structure. Overall, the Sado Estuary emerges as a highly responsive and sensitive ecosystem, underscoring its vulnerability to seasonal and environmental variability. This study also demonstrates the value of flow cytometry as a complementary and informative tool for investigating microbial ecology and ecosystem functioning in complex aquatic systems.

Macrofaunal changes as indicators of ecological response to groyne presence on two sandy beaches in the Southern Iberian Peninsula (S1-PC-30)

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Coastal development, driven by human needs, has led to the progressive modification and alteration of sandy beaches. Groynes are among the most commonly used structures for beach stabilization in coastal protection. These structures influence the properties of soft sediments, such as grain size and organic matter content, and also have implications for intertidal macrofauna. This study evaluates the effects of two groynes constructed at the mouths of the Guadiana River (Vila Real de Santo António, Portugal) and the Carrera River (Punta del Moral, Spain) on intertidal macrofauna. Specifically, it compares differences in community composition and physical characteristics among four zones located at varying distances from each groyne (1, 300, 900, and 1500 m). Within each zone, four levels equidistant from the high-tide line were considered. At each level, six replicates (0.05 m², 15 cm depth) were collected for macrofaunal analysis, and one additional sample was taken to assess the environmental characteristics of the sediment. Variations in the extent and profiles of the mesolittoral zone, as well as in sediment characteristics, were observed on both beaches with increasing distance from the groynes. Regarding the macrofauna identified on the two beaches, although species-rich communities were found at both sites, faunal composition varied between beaches and among zones. In Vila Real de Santo António, the most abundant taxa were bivalves and

crustaceans, with bivalves predominating, especially in areas farthest from the groyne. At Punta del Moral, polychaete annelids were the most abundant taxon in the area closest to the groyne, whereas bivalves dominated in the remaining areas. Therefore, a certain trend in the presence and abundance of macrofaunal species associated with the existence of groynes was detected, which should be studied over a longer period encompassing several annual cycles.

Improving *ex situ* feeding strategies for the critically endangered *Pinna nobilis*: insights from fatty acid profiles of food sources (S1-PC-32)

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The fan mussel, *Pinna nobilis*, is a critically endangered bivalve mollusc endemic to the Mediterranean Sea. Since the mass mortality event in 2016 the species has declined drastically. Currently, the only surviving populations are found in areas where environmental conditions surpass the survival limits of the main parasite responsible for this mortality. In Spain, one of the two remaining populations is found in the Mar Menor coastal lagoon (Murcia, SE Spain). However, this population has also declined sharply due to repeated episodes of eutrophication. The *ex situ* maintenance of the species is crucial for its conservation. However, this task has proven more challenging than anticipated, with no records to date of long-term maintenance or clearly defined optimal conditions. One of the key factors yet to be determined is the optimal diet required to meet the species' nutritional needs. The aim of this study was to analyse and compare the fatty acid profiles of wild *P. nobilis* and various species of phytoplankton and zooplankton used to feed individuals from the Mar Menor that are being maintained at the University of Murcia Aquarium. This information aims to contribute to identifying an appropriate diet to meet the nutritional requirements of *P. nobilis* in captivity. Fatty acid extraction, methylation and analysis were performed on mantle tissue samples from adult individuals collected in 2020 and preserved at the University of Alicante. Six species of microalgae and seven species or groups of zooplankton, all of which were cultured at the University of Murcia Aquarium, were analysed as food sources. Principal component analysis (PCA) and cluster analysis revealed that *Acartia tonsa* is the species with the most

similar fatty acid profile to *P. nobilis*, followed by *Tetraselmis chui*, *Brachionus plicatilis*, and a shrimp mix. These results suggest that a combination of these organisms could constitute an optimal, diverse diet for *P. nobilis* adult individuals. The critical status of populations in the Mar Menor and across the Mediterranean requires extreme caution when handling individuals, which currently limits the collection of samples from living specimens for this type of analysis. Nevertheless, the findings of this study represent a first step towards optimising diets and contribute to the conservation of the species.

eDNA metabarcoding for qualitative and semi-quantitative assessment of phytoplankton towards eco-sustainable mariculture in the Mediterranean Sea (S1-PC-33)

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New sequencing technologies have found numerous applications, and among these, research into their use in the environmental field is emerging. Specifically, next-generation sequencing has enabled the analysis of DNA fragments present in environmental samples, such as water and soil, to identify the species present in a particular environment. We have utilized this technology to analyze water samples around a fish farming facility, focusing on the phytoplankton. Phytoplankton communities play a crucial role in the sustainability of mariculture practices, particularly regarding the risks associated with potentially harmful species that can cause algal blooms and toxin production. These harmful species can have devastating effects, not only threatening human health and safety through the contamination of seafood and water supplies but also disrupting the delicate balance of marine ecosystems. Monitoring phytoplankton levels and composition is essential to ensure that mariculture remains environmentally sustainable and safe for consumers. From a quantitative perspective, we evaluated whether the number of sequences obtained could serve as an indicator of the relative abundance of each taxonomic group across different sites. From a qualitative perspective, we were able to characterize the structure of phytoplankton communities around the mariculture plant, detecting a high level of biodiversity. We also identified potentially dangerous species at low abundance, highlighting the potential of eDNA metabarcoding as an early warning system, an essential aspect for ensuring sustainability in mariculture. This study represents a pioneering effort in utilizing eDNA metabarcoding for both the quantitative and qualitative monitoring of phytoplankton in mariculture supporting eco-sustainable management practices.

Sharks of the Gorringe Bank: new records from deep-sea video observations (S1-PC-34)

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Seamounts are important biodiversity hotspots, yet their faunal communities remain poorly documented, particularly at greater depths. Sharks play a major role in these ecosystems, with changes in their populations impacting the entire ecosystem through bottom-up and top-down cascading effects. Despite such importance, knowledge of sharks' diversity in the Gorringe Bank is scarce. The Gorringe Bank is a large seamount complex with two peaks – the Gettysburg and the Ormonde seamounts – that rise from ≈5000m deep to the photic zone. It is a hotspot of biodiversity with over 850 species reported for the area. Yet, only 12 of these are sharks. Most of these species are either oceanic-pelagic or shallow water-demersal, with only four deep-sea demersal sharks being known to inhabit the Gorringe Bank. In this study, we analysed video footage collected during the TwinDEEPS oceanographic campaign to the Gorringe Bank to investigate the biodiversity of deep-sea sharks in the Gettysburg Seamount. Twenty-two individuals from five taxa were observed between 306 and 1714m deep. The most observed taxa were *Galeus* sp., followed by the blackmouth catshark *Galeus melastomus*, the knifetooth dogfish *Scymnodon ringens*, the arrowhead dogfish *Deania profundorum* and the portuguese dogfish *Centroscymnus coelolepis*. While *G. melastomus* and *D. profundorum* were known to inhabit the area, both the *S. ringens* and the *C. coelolepis* were recorded for the first time in the Gorringe Bank. These results emphasise the Gorringe Bank as an important area for marine biodiversity in the Northeast Atlantic Ocean, including deep-sea demersal sharks. However, several threats to the conservation of these species exist in the Gorringe Bank, in particular, demersal fisheries which are a main threat for deep-sea sharks worldwide. This is of particular concern as *C. coelolepis* is classified as Endangered in European waters by the IUCN and is listed by OSPAR as threatened and/or declining. Therefore enhanced protection measures are needed for this area. The ongoing process of designating an offshore MPA in the Madeira-Tore complex, that includes the Gorringe Bank, represents a critical opportunity to protect

these species. However, its effectiveness will require appropriate MPA design and management. This study highlights the Gorringe Bank as an important habitat for threatened deep-sea shark species, calling for enhanced protection of this area to support the recovery of these species' populations.

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Sleeping data awakened: reconstructing 30 years of demersal community data in the Northwestern Mediterranean Sea (S1-PC-35)

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Over the past decades, extensive ecological data have been collected through scientific bottom trawl surveys in the Northwestern Mediterranean, yet a substantial portion remained inaccessible due to lack of standardization and digitalization. In our study, we compile, recover, and harmonize 30 years of “sleeping data” from 20 oceanographic campaigns conducted along the Catalan margin, a region characterized by submarine canyons, high biodiversity, and long-standing fishing pressure. This work is developed within ongoing European research initiatives (DIGI4ECO, REDRESS and TERRATWIN) focused on marine ecosystem monitoring, restoration, and digital integration. The resulting database includes over one thousand hauls spanning multiple depths, locations, and species, encompassing both commercial and non-commercial demersal megafauna. By integrating these heterogeneous datasets into a coherent framework, we enable the first large-scale exploration of long-term changes in community composition, biomass, and spatial distribution across the region. Initial data exploration reveals marked variability in sampling effort over time and space, as well as indications of shifts in species occurrence and relative abundance across decades. While challenges remain due to differences in sampling design, gear specifications, and temporal coverage, this reconstructed dataset provides a critical foundation for future quantitative analyses and ecosystem assessments. It also contributes toward establishing historical baselines in a heavily impacted marine system where reference conditions are largely unknown. This work highlights the value of retrieving ecological data to support

improved understanding of long-term marine ecosystem dynamics and to inform sustainable management and conservation strategies in the Mediterranean Sea.

Megafauna from three newly discovered canyons, offshore the Magellan continental shelf (S1-PC-36)

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Three newly identified submarine canyons offshore the Magellan continental shelf were surveyed in October 2024 during the Fkt241011 expedition aboard R/V *Falkor* (too), providing the first detailed observations from this largely unexplored region. The ROV SuBastian was deployed in the northern sectors of the Ladrillero (49.4°S), Huemul (51.5°S), and Kawesqar (53.2°S) canyons, collecting high-resolution imagery for the characterisation of benthic megafauna and habitats, alongside with biological and geological sampling. Seven ROV dives were completed, covering comparable depth ranges across distinct canyon features (flat areas on the axis; walls, slopes and terraces on the flanks). Over 16.5km of video footage was preliminarily analysed to study the megafaunal morphospecies diversity and map key observations in megafauna composition relative to variations in topography and seafloor structures. Preliminary observations reveal high similarities in the morphospecies present in the three canyons, despite differences in their community distribution within and across the canyon areas explored. Deep, sedimentary rock outcrops and walls of Ladrillero and Kawesqar supported high abundances and diversity of large sessile taxa, particularly of Antipatharia, Primnoidae octocorals, and Actiniaria. Furthermore, echinoderms were also frequent on the walls, alongside smaller sessile fauna, including Serpulidae polychaetes, brachiopods, with sparse occurrences of Hexactinellida sponges, tunicates, bryozoans and hydrozoans. In Ladrillero, sedimented areas between outcrops hosted high densities of deposit feeders, such as Elpidiidae holothurians and Echinoids, differing from the Kawesqar, where a thick sediment layer hosted dense aggregations of tube anemones and various sea-pen (Pennatuloidae) morphospecies. Contrary to the other canyons, Huemul

exhibited a patchy megafauna distribution, with areas of dense aggregations followed by zones with few or no observations. Highlights included the deeper sedimented areas with seapens and tube anemones. The shallower areas were characterised mainly by Ophiuroids and/or Echinoids aggregations. These first observations provide crucial insights into the biodiversity and ecological dynamics of the submarine canyons offshore the Magellan continental shelf. Future detailed studies will enhance our understanding of their dynamics, connectivity, biogeography and provide insights for management and conservation.

A shotgun metagenomic baseline of eukaryotic diversity in the Aveiro Canyon (S1-PC-38)

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Submarine canyons are recognized as hotspots of biodiversity, playing a pivotal role in biogeochemical cycles and in supporting marine food webs. The Aveiro Canyon, located on the northern Portuguese continental margin, is characterized by a wide amphitheatre-shaped morphology, and while it remains largely unexplored, Local Ecological Knowledge suggests it may host diverse deep-sea pelagic and benthic communities. The aim of this study was to characterize the vertical diversity of marine eukaryotes in the Aveiro canyon. Water-column samples were collected at four discrete depths, spanning photic (50 and 180 m), mesopelagic (840 m, under the influence of the Mediterranean Outflow Water [MOW]) and bathypelagic layers (1750 m). At each depth, three replicate 20 L samples were filtered through 0.22 µm membranes to capture environmental DNA and preserved at -80 °C. Simultaneously, environmental parameters including temperature, salinity, oxygen, turbidity and chlorophyll a were measured using CTD casts. DNA was extracted using the Qiagen PowerSoil Pro kit and submitted to Illumina high-depth shotgun metagenomic sequencing (approximately 40-50 Gb per sample). Raw reads were quality filtered with fastp and assembled with MEGAHIT. Using MIDORI2 database as a reference, Metaxa2 was used to extract COI sequences (a golden standard for metazoan profiling) from the assembled metagenomes and subsequently perform the taxonomic affiliation. This study provides high-resolution insights into how eukaryotic communities are structured by vertical gradients and water-mass identity, specifically testing whether the MOW acts as a distinct ecological corridor or compartment. Furthermore, functional annotation of genes involved in carbon, nitrogen, and sulfur cycling elucidates the contribution of these organisms to deep-sea nutrient transformations. Overall, these findings provide an essential ecological baseline for the Aveiro Canyon, showing how

ocean conditions and depth influence the distribution of eukaryotic life in these transition zones of the Atlantic.

Building a curated COI reference library for marine fish parasites: insights from commercially important species in the Northeast Atlantic (S1-PC-39)

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Parasitism is a fundamental yet often overlooked component of marine biodiversity, underpinning key ecological processes such as food web dynamics, host population regulation and ecosystem functioning. Understanding the diversity of parasitic communities in marine systems is, therefore, essential for ecological research and fisheries management. Fish parasites represent one of the most diverse and taxonomically challenging groups. DNA barcoding based on the mitochondrial cytochrome c oxidase subunit I (COI) gene is widely used for species identification and biodiversity assessment across marine organisms, but COI reference data are still limited and unevenly distributed among parasitic taxa. Here, we develop a curated COI reference library for the metazoan parasite fauna of three commercially important fish species: European hake (*Merluccius merluccius*), black scabbardfish (*Aphanopus carbo*), and pouting (*Trisopterus luscus*). Parasites were collected from fish caught at fishing grounds in Portugal, Ireland, and France, and COI barcodes were generated. Complementarily, COI sequences were compiled from GenBank for all parasite species within the families known to be associated with these hosts, applying quality filters to retain sequences of representative length and marine origin. Newly generated and database-derived sequences were combined to build a comprehensive reference dataset, and their

congruence and reliability were evaluated. The resulting reference library includes more than 2,600 sequences representing over 190 species from 19 families across four phyla: Acanthocephala (34 species; 2 families), Arthropoda (108 species; 7 families), Platyhelminthes (22 species; 8 families), and Nematoda (31 species; 2 families). These sequences were assigned to 228 Barcode Index Numbers (BINs), with over 90% representing concordant BINs or singletons. Approximately 10% of the sequences included in the reference library were newly generated. These new sequences constitute the first available COI records for about half of the 13 morphospecies identified. This library fills key gaps in reference data for parasites of the European hake, the black scabbardfish and the pouting. Creating comprehensive and curated reference libraries enhances our understanding of fish parasite diversity and provides a robust resource for monitoring marine biodiversity and fisheries stocks using molecular tools.

Advancing knowledge of mesophotic and deep-sea sponges of the Mozambique shelf using video imagery and integrative taxonomy (S1-PC-40)

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Sponges (Phylum Porifera) are key components of both shallow and deep-sea benthic ecosystems. They contribute to numerous ecosystem functions, from habitat provision to nutrient cycling, particularly in areas where they occur in high density or biomass. Despite their ecological importance, the diversity and distribution of sponge communities remain understudied in many parts of the planet, including in the western Indian Ocean. In this study, we investigate the diversity and distribution of sponge species and habitats along the Mozambique shelf and slope, using a multidisciplinary approach that combines high-resolution underwater video imagery with integrative taxonomy. Data and samples were collected during three research expeditions aboard the RV Dr. Fridtjof Nansen (2018, 2023, 2025). Video transects using both VAMS and ROV systems covered depths from 30 to 2000 meters. In total, 135 transects were performed generating an extensive underwater video dataset of 122 hours. Sponge observations are currently being annotated using BIIGLE and validated via taxonomic analysis of the 170 specimens

that were collected. Species identified so far include demosponges (e.g. *Leiodermatium* sp, *Macandrewia* sp., *Ciocalypa* sp.), and hexactinellids (e.g. *Monorhaphis chuni*). Morphological identifications will be further supported by molecular phylogenetics. The results will advance baseline knowledge of mesophotic and deep-sea sponge communities on the Mozambique shelf and demonstrate the value of combining marine imaging with integrative taxonomy in understudied regions. Generated data and knowledge will be shared with national authorities to support the implementation of existing management and conservation policies of the marine environment in the country.

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Genetic Composition of *Mytilus* Mussels Along the Portuguese Coast: Assessing Biodiversity Patterns and Hybridisation Risk (S1-PC-41)

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Mytilus spp. play a key ecological and economic role in European coastal ecosystems, contributing to habitat structuring, filtration processes and aquaculture production. In recent years, most published studies reporting the presence of *M. galloprovincialis* in Portuguese waters; however, other studies from the same areas have reported the occurrence of *M. edulis*, while more conservative approaches refer only to the genus *Mytilus* spp. This discrepancy is due to the difficulty of distinguishing these species morphologically. The aim of this study is to determine the composition of *Mytilus* populations along the Portuguese coast using a rapid efficient genetic marker and evaluate the potential presence of hybrids. One hundred and twenty mussels were collected between December 2025 and March 2026 from eight locations spanning northern, central and southern Portugal, including Viana do Castelo, Porto, Aveiro, Peniche, Lagos and Olhão. Sampling sites encompassed a wide range of environmental contexts, including exposed rocky shores, estuarine channels, marinas, port infrastructures and areas adjacent to aquaculture facilities, thus representing habitats with distinct hydrodynamic regimes and varying levels of human activity. These areas are recognised gateways for the introduction of non-native mussel lineages through biofouling, ballast water discharge or the transport of larvae associated with imported

bivalves. Genomic DNA extraction has been performed in the laboratory for each mussel, and PCR amplifications were performed to identify *Mytilus* spp. using the Glu-5 marker and to analyse the allelic variation of the Glu-5 gene. Analysed individuals were identified as *M. galloprovincialis*, with no evidence of *M. edulis* or *M. trossulus* and the percentage of mussels detected with both alleles (*M. edulis* and *galloprovincialis*) falls within the expected range for a pure *M. galloprovincialis* population. These preliminary results suggest a genetic homogeneity of *Mytilus* populations across the sampled regions. Nonetheless, the continuous exposure of Portuguese coastal systems to maritime traffic and aquaculture-related introductions highlights the need for ongoing monitoring to detect potential future incursions of non-native or hybrid lineages.

Transmissible Cancer Lineages in Iberian Cockles: Assessing Regional Distribution, Coexistence and Organ Tropism (S1-PC-42)

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Transmissible cancers are rare neoplasias in which malignant cells act as infectious agents, spreading between individuals as clonal lineages. In marine bivalves, these diseases are known as bivalve transmissible neoplasias (BTNs). They can become widespread in natural populations and are associated with reduced physiological performance, impaired reproduction and increased mortality. In the common cockle *Cerastoderma edule*, two independent lineages (CedBTN1 and CedBTN2) have been identified, with distinct genetic signatures and potentially different ecological dynamics. Understanding their distribution, coexistence and tissue tropism is essential for evaluating disease impacts and transmission pathways. This study assesses the occurrence of both CedBTN lineages in cockles from three regions of the Iberian Peninsula, Baiona (Spain), Aveiro and the Algarve (Portugal), to determine lineage distribution, coinfection patterns and tissue infiltration across organs for each lineage. Cockles were screened for disseminated neoplasia via haemolymph cytodiagnosis, confirmed by histology, and positive individuals were analysed molecularly. Over 350 cockles were collected per location. Organs were dissected, DNA was extracted, and lineage-specific TaqMan qPCR assays targeting diagnostic specific-lineage structural variants were applied to discriminate between CedBTN1-2. Assay performance was quantified using plasmids with the target sequences. Both CedBTN were detected in all regions, revealing widespread occurrence and frequent coinfection. In Baiona, BTN prevalence reached 6%, where organ-level data were available, both

lineages occurred across all tissues with frequent coinfection. In the Ria de Aveiro, BTN prevalence reached 17%, including 9% CedBTN1, 4% CedBTN2, and 4% coinfections, supporting active transmission. In the Algarve BTN prevalence reached 6%, molecular screening confirmed the coexistence of both lineages, extending evidence of coinfection to southern Iberia. This study reports, for the first time, CedBTN2 in Portuguese cockle populations. Quantitative analyses of infected individuals revealed that both lineages were predominantly detected in specific organs, with the highest infection prevalence observed in the gill and digestive gland, indicating tissue-specific patterns of infiltration within the host. Overall, results demonstrate a widespread distribution of CedBTN, frequent coinfection, and suggest shared transmission dynamics across regions.

Histological Analysis of *Halocynthia papillosa* from the Eastern Adriatic: A Baseline for Bioindicator Research (S1-PC-44)

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Halocynthia papillosa (Linnaeus, 1767) is a solitary ascidian species widely distributed in the Mediterranean Sea, including the Adriatic Sea and the eastern Atlantic. Inhabiting rocky and coralligenous substrates, it is a sessile benthic suspension feeder that contributes to pelagic - benthic coupling, nutrient cycling and energy transfer. Due to its ecological relevance and sensitivity to environmental conditions, it has potential as a species for marine environmental monitoring. Specimens of *H. papillosa* were collected in the central Adriatic Sea during autumn and winter by SCUBA diving at depths of 10 - 20 m in an area under anthropogenic influence. Tissue samples were prepared as cross-sections and stained with haematoxylin-eosin (H&E). Microscopic analysis revealed well-defined organisation of the tunic and internal structures. Histological observations provided initial insights into tissue integrity and reproductive status, establishing baseline data for this species in the eastern Adriatic. These results provide a foundation for future studies on seasonal variability and environmental responses, highlighting the potential application of *H. papillosa* as a bioindicator species. By providing a histological baseline, this work contributes to the development of monitoring tools for marine ecosystem health.

Habitat-dependent variation in the relative abundance and growth of juvenile gilthead seabream (*Sparus aurata*) in two Adriatic nursery habitats (S1-PC-45)

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This study investigated the abundance, distribution, and growth of juvenile *Sparus aurata* in two nursery habitats of the central eastern Adriatic Sea: Pantan Lagoon and the Jadro estuary. Mean water temperature was similar at both sites (around 19 °C), whereas salinity showed greater variability in Pantan, particularly in surface layers. Dissolved oxygen concentrations were slightly higher in the Jadro estuary. Juvenile individuals inhabit these nursery grounds mainly in March, with peak abundance in May, and most of them migrate out during the summer. Summer samples showed a wider size range, including larger individuals, whereas autumn and winter were characterized by lower abundance but generally larger fish. Length-frequency analysis revealed that Pantan was dominated by smaller individuals (2–5 cm) that were approximately 136 days old, whereas Jadro contained a higher proportion of intermediate-sized fish (3–6 cm) that were approximately 146 days old. Larger individuals (>10 cm) were rare at both sites. These patterns suggest gradual ontogenetic shifts and emigration of juveniles from nursery habitats during the colder part of the year. In both nurseries, growth rates were higher in May and June (mean: 0.537 µm/day) than in April, one month after settlement, when specimens grew at approximately 0.369 µm/day. Daily otolith increment width showed a positive trend with age in days, further supporting accelerated growth over time. A positive linear relationship between age and total length was observed at both sites (Jadro: $LT = -3.11 + 0.0544 \times \text{Age}$, $R^2 = 0.75$; Pantan: $LT = -4.37 + 0.0575 \times \text{Age}$, $R^2 = 0.82$), indicating slightly faster growth in Pantan. Fish length was strongly correlated with otolith length ($R^2 = 0.934$) and width ($R^2 = 0.959$), while fish weight also increased with otolith mass ($R^2 = 0.634$). Overall, the results confirm the ecological importance of both Pantan Lagoon and the Jadro estuary as nursery habitats for juvenile *S. aurata*, while also revealing site-specific differences in environmental variability, size structure, and growth dynamics. These findings emphasize that nursery habitats with distinct ecological characteristics play a crucial role in shaping juvenile survival, growth, and recruitment success.

Hydromorphological change and juvenile fish decline in a Mediterranean Estuary-Lagoon nursery habitat (S1-PC-46)

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The Pantan estuary-lagoon system (eastern Adriatic) was assessed through an integrated analysis of hydromorphology, suspended matter dynamics and changes in juvenile fish communities over time. Comparison for 1968–2025, especially 2002–2025, shows that the inner and upstream parts of the system remained largely stable. The course of the Rika stayed confined within its channel, while the channel network continued to redistribute water efficiently during increased precipitation. Climatic analysis for 2018–2025 showed no increase in mean wind speed or strong wind events, and precipitation, vegetation, and land use within the reserve remained broadly stable. These findings indicate no major long-term changes in freshwater inflow, discharge, or the balance between fresh and salt water in the inner system. Suspended matter dynamics showed clear seasonality and short-term peaks linked to rainfall, wind-induced sediment resuspension, riverine input, and intense meteorological events, but no long-term trend of increasing concentrations. In contrast, the lagoon–sea transition zone showed the strongest changes. The fishpond slightly decreased in area, reducing the buffering capacity of the freshwater–seawater mixing zone. Sandbars retained a similar total area but became morphologically degraded, retreating landward, losing elevation and coherence, narrowing at their ends, and becoming perforated and curved. Reduced vegetation further increased their vulnerability. These changes weakened their function as a barrier regulating exchange with the sea, increased marine influence and wave erosion, and contributed to shoreline regression. These habitat changes are consistent with shifts in juvenile fish assemblages recorded by comparable littoral shore-seine sampling in 2005 and 2025. Species richness declined by 23.5%, mean abundance per haul by 78%, and mean biomass per haul by 67%. The largest declines were recorded for *Pomatoschistus marmoratus*, *Atherina boyeri*, *Liza aurata* and *Gobius niger*. With limited evidence for fishing-driven change, the observed pattern is consistent with increasing marine influence, episodic saltwater intrusion, and shoreline modification, all of which may reduce nursery habitat quality for estuarine-dependent and diadromous juveniles. Restoration priorities include softening embanked shores, improving hydrological connectivity, and re-establishing vegetated littoral habitats, while long-term standardised monitoring remains essential for conservation and management.

Early evidence of shifts in juvenile fish communities: a 2000-2025 comparison of nursery conditions in Pantan (Adriatic Sea) (S1-PC-47)

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A total of 2,830 individuals from 16 families were collected at two stations in the Pantan nursery area over a 25-year period (2000, 2018, and 2025) using a beach seine. Multivariate analyses examined temporal trends in juvenile fish assemblages along the eastern Adriatic coast, focusing on taxonomic, trophic, and fishing-value structure. The ichthyofauna showed significant interannual variation in species composition. In 2000, the assemblage was dominated by *Atherina boyeri* (47.2%) and *Pomatoschistus canestrinii* (35.4%). In 2018, dominance shifted to *Spicara smaris* (19.7%), *Diplodus annularis* (17.1%), and *Symphodus cinereus* (13.2%). In 2025, the community was primarily characterised by *Gobius cobitis* (34.2%) and *Lithognathus mormyrus* (25.5%). Across all years, benthic mesocarnivores and mesocarnivores dominated, while planktivorous and herbivorous species were less represented. Non-commercial species became more prevalent in recent years. Significant differences in abundance among years were detected (Kruskal-Wallis, $\chi^2 = 7.11$, $df = 2$, $p = 0.03$), with post hoc tests indicating a difference between 2000 and 2018 ($p = 0.047$). NMDS ordination based on Bray-Curtis similarity (stress = 0.12) showed clear temporal structuring of assemblages, with distinct clustering by sampling year and increasing dispersion in recent samples, particularly in 2025. These results suggest long-term changes in juvenile fish assemblages in the Pantan nursery area, potentially associated with ongoing coastal anthropogenic pressures such as habitat modification and infrastructure development, alongside other environmental drivers.

Seasonal patterns and catch composition of elasmobranchs in commercial and discarded catches of the gillnet (S1-PC-48)

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This study examined the seasonal catch composition, catch per unit effort (CPUE), and size structure of elasmobranchs caught by the gillnet (GNS, mesh size of 130-160 mm) in 2024, including an assessment of discarded catch. In the commercial catch, mean

elasmobranch CPUE expressed as abundance (N/100 m net) was similar in spring (0.62 ± 0.12) and summer (0.56 ± 0.26), highest in winter (0.89 ± 0.52), and lowest in autumn (0.33 ± 0.20). Biomass-based CPUE (kg/100 m net) followed the same pattern, peaking in winter (2.86 ± 1.39) and reaching its lowest value in autumn (0.69 ± 0.43). However, the winter peak was largely driven by two sampling events in mid to late March, when unusually high catches of *Mustelus mustelus* and *Myliobatis aquila* were recorded. This likely reflects a temporary aggregation rather than a consistent seasonal trend. Smaller sample sizes in winter and autumn should also be considered when interpreting results. A total of 57 commercial samples recorded nine elasmobranch species. The catch was dominated by *Mustelus mustelus* (18 % N) and *Mustelus punctulatus* (12.5 % N), both listed as Vulnerable by the IUCN. Most individuals of both species were adults, with only one *M. mustelus* specimen below 80 cm total length, while all *M. punctulatus* specimens exceeded this size. Other species occurred in much lower numbers, including *Raja clavata*, *Raja miraletus*, *Myliobatis aquila*, *Scyliorhinus stellaris*, *Scyliorhinus canicula*, *Raja asterias*, and *Squalus acanthias*. Discarded catch analysis, based on 30 samples, showed mean elasmobranch CPUE values of 0.60 ± 0.24 N/100 m net and 0.69 ± 0.23 kg/100 m net. Discards were dominated by *Myliobatis aquila* (59.8 % N), followed by *Torpedo marmorata* (11.3% N). The frequent occurrence of threatened species in both commercial and discarded catches highlights the need for continued monitoring and further research to support conservation and management.

Changes in structural and functional biodiversity of meiofaunal and nematode communities under ocean acidification at Mediterranean CO₂ vents (S1-PC-49)

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Ocean acidification (OA) represents one of the major threats to marine biodiversity, yet its effects on the structural and functional organization of benthic communities and their implications for ecosystem functioning remain comparatively less explored, particularly in natural systems. Shallow CO₂ vents represent valuable natural laboratories to investigate long-term ecological responses to acidification under realistic environmental conditions. In this work, meiofaunal and nematode communities were

investigated across two seasons, along a natural pH gradient at shallow CO₂ vent systems around Vulcano Island (Mediterranean Sea). The study included two acidified sites and one control site to assess acidification effects on meiofaunal distribution and composition, and on structural (at genus level) and functional diversity of nematodes, with trophic structure and life strategies used as proxies of their functional traits. Results showed high spatial and temporal variability of meiofaunal distribution, reflecting the environmental heterogeneity and instability typical of vent systems. While the taxonomic diversity of meiofauna was mainly influenced by seasonal variability, community composition differed significantly between acidified and control conditions, particularly in the surface sediment layer. The study of Nematodes, the dominant taxon across all stations, showed lower diversity and higher dominance of a few genera at acidified sites, indicating structurally simplified communities. Functional analyses further revealed a higher contribution of opportunistic life strategies under acidified conditions, suggesting stressful environmental conditions. Trophic structure also shifted towards generalist feeding strategies, with reduced contribution of predatory nematodes and lower trophic diversity, indicating potential simplification of benthic food webs. Overall, these findings suggest that OA can reorganize meiobenthic biodiversity by selecting stress-tolerant taxa and altering functional community structure, with potential consequences for trophic interactions and ecosystem functioning.

Population genomics of the spinytail skate *Bathyraja spinicauda* in the North Atlantic Ocean (S1-PC-50)

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Many elasmobranchs have K-selected life history traits, such as slow growth, late maturity and low reproductivity, making them vulnerable to climate change and overfishing, with implications for marine biodiversity. Deep-sea skates are an understudied group within the elasmobranch family. Although they have historically been less accessible to most fisheries, fisheries are expanding into deeper and less accessible areas, endangering skates further. The spinytail skate *Bathyraja spinicauda* is near threatened with a suspected population reduction of 20-29% over the last 70 years. Sufficient knowledge of potential population structures is necessary for conservation and management measures, particularly given the role of skates in ecosystem functioning in deep-sea environments. Single-nucleotide polymorphisms (SNPs) were used to give an insight into the population structure of *Bathyraja spinicauda*. Individuals were sampled

along the coast of Norway and Greenland between 2010 and 2023 through bottom trawling research cruises. Bayesian clustering and DAPC analysis of 4303 SNPs from 30 individuals revealed evidence for two distinct genetic clusters, separating skates sampled from Greenland from those sampled along the Norwegian coast. There seemed to be some substructuring between skates sampled on the Norwegian Slope and the Barents Sea shelf as well. Future research should include skates from the Faroe Islands to broaden our understanding of the population structure across the whole North Atlantic.

Abundance and distribution of the alien slipper limpet *Crepidatella dilatata* in the Atlantic coast of Iberian Peninsula two decades after its first record (S1-PC-52)

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The slipper limpet *Crepidatella dilatata* (Gastropoda: Calyptraeidae), native to the Pacific coast of South America and the Atlantic coast of Argentina, was first reported outside its native range in 2005 in Ría de Aldán, a small coastal embayment in Galicia (NW Iberian Peninsula). Within four years, it expanded approximately 40 km from its initial record, and within a decade it was recorded in other regions of the Iberian Peninsula, including Asturias (northern Spain) and the Ebro Delta (NE Spain). Most previous records have been primarily qualitative, while quantitative, spatially replicated data on its abundance and population structure remain scarce, limiting our understanding of its invasion dynamics. Here, two decades after its first detection in NW Spain, the abundance, distribution, and population structure of *C. dilatata* in the area of initial invasion were examined. The species was widespread across the intertidal zone of most surveyed shores, occurring on both natural and artificial substrates, with a clear preference for sheltered habitats and being absent from river mouths and wave-exposed areas. In the Ría de Pontevedra, we tested the influence of orientation (north vs. south) and position (internal, middle, and external) on the abundance, biomass, and population structure. Total abundance and biomass were significantly lower in the southern internal zone, whereas no significant effects of orientation or position were detected on the relative abundance of egg masses or sexual categories. Size-class distribution varied significantly among areas and orientations, indicating continuous recruitment. Additionally, we reported the presence of *C. dilatata* in central and northern Portugal, occurring on both soft and hard intertidal substrates. Population abundance and structure did not differ significantly between substrate types, although larger individuals

were more frequent in soft-bottom habitats. Although Portuguese populations showed lower abundance and smaller sizes compared to Galician populations, our findings confirm the successful establishment and ongoing expansion of the species along the Atlantic coast of the Iberian Peninsula. Furthermore, our results highlight the ability of *C. dilatata* to colonise diverse intertidal substrates, providing key insights for its monitoring and management in the studied area.

An Atlas of Atlantic sponge biodiversity and biogeographic patterns. (S1-PC-53)

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The Atlantic Ocean hosts highly diverse benthic ecosystems across broad environmental and biogeographic gradients, yet the large-scale distribution patterns of many key taxa remain insufficiently resolved. One such key taxon is Sponges from both shallow- and deep-sea benthic ecosystems. They provide structural habitat to other organisms and drive biogeochemical nutrient cycling. Despite their importance, comprehensive baseline knowledge of their diversity, distribution and community structure is lacking, particularly at greater depth. This is mainly due to limited practical monitoring tools that target sponges and the absence of a comprehensive species inventory. This knowledge gap prevents the adoption of adequate measures at a scale relevant for conservation. In this study, we aim to investigate the large-scale patterns and trends in sponge species and habitat diversity across the Atlantic Ocean. We hypothesise that sponge diversity is predictable across the Atlantic's latitudinal and bathymetric ranges. To test this, we assembled and curated the most taxonomically and spatially comprehensive sponge occurrence dataset to date by mining biodiversity data from public biodiversity portals (e.g. OBIS, GBIF and the World Porifera Database), alongside additional literature-based records. Using this comprehensive inventory, we calculate species richness and taxonomic distinctness metrics, identify regional data gaps, and assess sponge habitat connectivity. We also develop new distribution models at different spatial scales through biogeographical multivariate data analysis, incorporating latitude, longitude, depth, and relevant environmental variables, further testing the applicability of the Marine Ecoregions of the World (MEOW) and the Global Open Ocean and Deep

Seabed (GOODS) biogeographic classification systems. The findings will advance our understanding of ocean-wide sponge biodiversity structure and provide a baseline to support evidence-based marine biodiversity conservation and sustainable management, in line with the EU Biodiversity Strategy 2030 and the 30x30 global ocean protection target.

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Kelp forests as blue carbon contributors along the central Portuguese coast (S1-PC-54)

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Blue Carbon refers to the organic carbon sequestered and stored by coastal and marine ecosystems. While coastal vegetated habitats such as saltmarshes and seagrasses are widely recognised for their blue carbon capacity, non-accreting systems like kelp forests have historically received less attention, despite their high productivity and significant potential for carbon export to long-term oceanic sinks. Kelp forests represent extensive habitats with high biomass production and detritus export. However, following a marked decline along the Portuguese coast over the last decade, these ecosystems are now largely restricted to northern and central regions. In addition there is a lack of detailed spatial information for marine Natura 2000 sites. To address these gaps, this study quantifies blue carbon storage and sequestration potential in subtidal kelp forests along central west coast of Portugal focusing on the Peniche-Stª Cruz Special Area of Conservation (PTCON0056). The dominant species *Laminaria ochroleuca* and *Saccorhiza polyschides* were assessed using 583 underwater video point surveys conducted across a 40 km stretch of coastline. Mapping of the study area (~5476

ha) identified suitable rocky substrate, of which kelp forests occupy around 2576 ha (~47%). Combining spatial mapping with in situ measurements obtained through scientific diving (abundance validation, biomass, and growth), alongside carbon content analyses, preliminary estimates indicate that carbon storage values are comparable to those reported for northern Portugal. Although total annual carbon sequestration is lower than the 3717 Mg C year⁻¹ estimated for saltmarshes and seagrasses in mainland Portugal kelp forests exhibit comparable or higher sequestration rates when normalised by area. These findings highlight the significant contribution of kelp forests to regional carbon dynamics and support their inclusion in blue carbon frameworks. Expanding in-situ assessments, combined with regional modelling, will improve blue carbon estimates and support the development of national-scale blue carbon assessments. Given their potential role in climate mitigation, conservation and long-term monitoring efforts should be prioritised to protect and enhance the blue carbon capacity of kelp forests and associated habitats.

Tracking the spread of the invasive kelp *Undaria pinnatifida* across Atlantic Iberia (S1-PC-55)

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The spread of non-indigenous species represents a growing threat to marine ecosystems, particularly in regions with high biodiversity and strong socioeconomic dependence on coastal resources. We assessed the distribution, abundance and recent expansion of the invasive kelp *Undaria pinnatifida* along the Atlantic coast of the Iberian Peninsula. In 2024, a standardized field survey was conducted at 59 locations across Portugal and Spain. These observations were complemented with historical records and validated occurrences from citizen science platforms to evaluate temporal changes in distribution. Results indicate a marked increase in the species' presence in Portugal since its first record, currently occurring at 16 sites compared to only two reported in 2007, while remaining well established in the Galician rías. Despite its expansion, *U.*

pinnatifida co-occurs with native kelp species and does not dominate local macroalgal assemblages at most locations. The species was not detected in southern Iberia or in the Bay of Biscay, suggesting that environmental constraints and biotic interactions may be limiting its broader spread. Ongoing environmental change, particularly shifts in temperature regimes and coastal upwelling dynamics, together with human-mediated dispersal through maritime activities, may nevertheless facilitate future range expansion. Continuous monitoring is therefore essential to detect early colonization events and track distribution shifts. This study highlights the value of integrating systematic field surveys with citizen science data to improve the spatial and temporal resolution of non-indigenous species monitoring. Our results provide an updated regional assessment of *U. pinnatifida* and contribute to understanding the current limits and future risks associated with its spread along the Atlantic Iberian coast.

Current and Future Distribution of Portuguese Deep Sea VMEs (S1-PC-56)

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The deep sea is the largest biome on Earth, vastly unexplored, and the consequences of climate change not fully grasped. Many of the deep-sea ecosystems are considered Vulnerable Marine Ecosystems (VMEs). Many are made of habitat-building cold-water corals and deep-sea sponges, sensitive to climate change as these species tend to be stenothermic, with calcareous skeletons and sessile. These are keystone taxa whose decline cascades through local communities. We modelled habitat suitability (HS) for three species: *Desmophyllum pertusum*, *Dendrophyllia cornigera* and *Pheronema carpeni*, across the Northeast Atlantic coast of the Iberian Peninsula and Macaronesia, at 115 m resolution for present and future conditions (SSP5-8.5: 2040–2050 and 2090–2100). Occurrence records were compiled from GBIF and the ICES VME database. Environmental predictors matched to observations included seabed temperature minimum, maximum and range (previous 365 days to observation), seabed salinity, seabed currents, bathymetry and slope, derived from Copernicus Marine Service layers, EMODnet and GMRT. We implemented ensembles of MaxEnt models: shuffled-occurrence ensembles for *D. pertusum* (ample records) and ensembles of small models for *P. carpeni* and *D. cornigera* (occurrences < 50). HS maps were produced for present and projected periods. Results show *D. pertusum* within a narrow bathymetric band along the Portuguese west coast that broadens southward and around seamounts; *P. carpeni* is largely sympatric with *D. pertusum* showing high HS in surrounding areas; *D. cornigera* occurs shallower and is the only species showing an

overall increase in mean HS under future warming. *D. cornigera*'s broader temperature tolerance (~7–17°C) and eurybathic distribution likely underpin its relative advantage under warming, whereas *P. carpenteri* and *D. pertusum* are more stenobathic and projected to decline. All three species are predicted to shift poleward, with *D. pertusum* unlikely to find future habitats as suitable as present. These high-resolution projections identify potential climatic refugia and inform spatial prioritization for Marine Protected Areas and restoration actions under the EU Nature Restoration Law, to safeguard deep-sea habitat-forming species.

Development and changes in the microbial composition during seagrass decay at the southern German Baltic Sea coast (S1-PC-57)

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Seagrass *Zostera marina* can reach high populations and cover up to 80 % of the shallow waters in the western Baltic Sea. There are high amounts of beach wrack landings that consist mainly of seagrass at the southern Baltic Sea and around the island of Poel. Therefore, a strict beach management is executed during tourist season. To get an insight into the natural decay process and in order to find an alternative to beach management, litterbags were filled with seagrass leaves in this experiment and put into a grid and sunk in the shallow waters of the Baltic Sea at the beach "Schwarzer Busch" at the island of Poel to evaluate decay rates, the adhesive microbial community and its changes over time. In two experiments, starting in summer 2020 and winter 2021, the decay of ± 10 g of freshly picked seagrass leaves from the local coast were investigated over a total runtime of 210 days in each experiment. It could be shown that the decomposition rate depends on the starting point, with a higher decay rate in summer; here, the seagrass leaves were completely disintegrated between 140 and 210 days. When the experiment was started in winter, after 210 days there were still minor residues left. The microbial community was evaluated by scratching off the biofilm with a polyester swab from the rotting seagrass leaves at each sampling; this swab was further processed and the biofilm pelleted. DNA was extracted from the pellets with amplicons and the respective DNA content was measured with a Qubit fluorometer before sending it for a Next Generation Sequencing to a professional lab. Prokaryotic and eukaryotic communities were analyzed. In the summer decay experiment attempt there were higher amounts of planctomycetes, confirming their important role in decay processes. Also, the Sva0996 marine group of bacteria increased, these bacteria are able to utilize organic matter. Alpha- and Gamma Proteobacteria were dominant in both experiments. Navicula were

mainly during the cold periods of the experiments present with a higher abundance in winter. *Diplonema* (biflagellated unicellular protists) were only present during winter. Light availability, temperature and oxic or anoxic conditions have an influence on the microbial community and their respective development. Natural decay without beach management is no option for beaches used for tourism as the decay rate is too slow.

Light matters: evaluating trap design and illumination for sampling larval assemblages in kelp forests (S1-PC-58)

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Kelp forests are key subtidal habitats that support diverse marine communities and function as important nursery areas, yet their role in sustaining larval assemblages remains poorly understood, particularly in temperate regions near their distribution limits, such as in the Iberian Peninsula. Understanding early life stages ecology is critical for assessing population connectivity and ecosystem functioning, yet remains limited by the lack of efficient, standardised, and non-destructive sampling methods suitable for complex subtidal environments. Underwater light traps are useful tools for sampling larval stages of fish and invertebrates in these benthic habitats. Yet their application in benthic coastal habitats is limited, particularly in regions characterised by moderate to high turbidity, such as the Atlantic European continental coast. This study provides a preliminary evaluation of light traps for sampling larval assemblages in kelp forests, focusing on their efficiency in capturing decapod larvae and ichthyoplankton. A pilot study was conducted during the summer season in kelp forests dominated by *Laminaria ochroleuca* off the coast of Peniche (central Portugal), at depths of 14–17 m. Two light trap configurations, constructed from PVC, acrylic, and 500 µm collection chambers were used: (i) a smaller quadrafoil light trap integrating disposable chemical green light sticks, and (ii) a larger barrel-shaped trap equipped with a custom programmable LED illumination system with a timed relay; both with similar light periods (10h). Traps were deployed during evening dives and retrieved the following morning over three consecutive nights. LED-equipped traps consistently captured higher

abundances and a broader range of larval taxa, including fish and decapod larvae, whereas chemical light traps sampled exclusively invertebrate zooplankton. Accordingly, LED-based light traps are recommended for similar coastal environments, with light intensity and configuration adapted to target taxa and sampling objectives. The integration of programmable timers and dimmers is further advised to optimise sampling periods, minimise unnecessary bycatch, and maximise battery autonomy and LED longevity. This study also provided valuable insights into practical and operational constraints, highlighting the influence of light intensity and visibility range, deployment logistics, and equipment durability in turbid, kelp-dominated environments.

Distribution Patterns and Abundance of *Mesothuria intestinalis* and *Penilpidia ludwigi* in the Ionian Sea (S1-PC-59)

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Recent deep-sea exploration and sampling efforts have improved our understanding of biodiversity and ecological dynamics. However, Mediterranean soft-bottom communities remain understudied compared to hard-bottom ones, partly due to the misconception that they host simpler communities. This gap is particularly evident for echinoderms, which are still poorly investigated. The present study contributes to fill the gap by documenting the abundance and distribution of two deep-sea holothurians from muddy plains of the Ionian Sea. *Mesothuria intestinalis* is a cosmopolitan limnivorant species with a broad bathymetric range, whereas *Penilpidia ludwigi* is an endemic deep-sea echinoderm of the Mediterranean known for its swimming behavior. Data were collected during a 2022 ROV survey across an offshore area of 115 km². 2625 frames were extracted for taxonomic identification and counting, with spatial and temporal patterns assessed using georeferenced data. A total of 480 *M. intestinalis* and 613 *P. ludwigi* individuals were identified, along with other echinoderms, tube-welling anemones and fishes. Both species were concentrated between 800 and 1200 m depth. Spatial analysis revealed two main aggregations located in the northeast and one in the southwest of the study area, but with different degrees of clustering. *P. ludwigi* showed a patchy and locally

dense distribution, with 3 dives concentrating the highest numbers of individuals, whereas *M. intestinalis* was more homogeneously distributed across dives. A significant positive relationship was found between *M. intestinalis* abundance and fecal pellet counts, supporting their use as proxy for holothurian density. Although no statistically significant temporal pattern emerged, *P. ludwigi* tended to show higher activity and greater number of observed individuals during nighttime dives, suggesting a potential diel behavioral component. This tendency was not evident for *M. intestinalis*, whose observations remained relatively constant across diel phases. These results highlight a species-specific distribution of the two species, likely reflecting environmental preferences. The higher aggregation and possible nocturnal activity of *P. ludwigi* further suggest distinct ecological strategies between the two species. This study also provides the first record of *P. ludwigi* in the Ionian Sea, expanding its known distribution and emphasizing the value of large-scale ROV surveys for studying deep-sea fauna.

Interacting effects of foraminifera bioturbation and microphytobenthos on sediment erodibility of cohesive sediments (S1-PC-60)

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Biotic processes are widely acknowledged to have a strong impact on sediment stability. Microphytobenthos (MPB) has been reported to have an important stabilising effect on cohesive sediment, while fauna can have stabilising or destabilising effects depending on the biological traits of the species in question. The interaction between MPB and faunal bioturbation makes the processes even more complex in terms of impact on sediment erodibility. Depending on biological traits, interactions between benthic fauna and MPB may either enhance MPB biomass, and thus sediment stability or, conversely, induce biofilm disruption and indirectly promote sediment destabilisation and surface erosion. Despite growing evidence that meiofauna, and particularly benthic foraminifera, contribute significantly to sediment dynamics through active bioturbation, the impact of their activities on sediment erodibility has not yet been studied. In this context, we have experimentally investigated the interacting effects between two

foraminiferal taxa (*Ammonia* spp. and *Haynesina germanica*) with distinct biological traits, and MPB (i.e., two MPB conditions, “With MPB” and “Without MPB”) on the sediment erodibility of cohesive sediments. Our results showed that both benthic foraminifera did not influence the critical shear velocity required to initiate sediment erosion, but they did affect the erosion rate. *Ammonia* spp., a surficial biodiffusor, had different effects on sediment stability depending on quantity of MPB present in the sediment. In the presence of MPB, sediment flux increased, whereas in its absence, sediment flux decreased. Conversely, in the presence of *Haynesina germanica*, a gallery-biodiffusor, the erosion rate was lower than in the control core. In summary, this study demonstrates that the contribution of benthic foraminifera to sediment erosion varies among species and is closely linked to their biological traits. Furthermore, the effect of a given taxon may also vary depending on the concentration of MPB in the sediment.

Satellite-based resources for monitoring marine ecosystems in the Northeastern Atlantic: the CoastNet geoportal (S1-PC-61)

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Satellite Earth Observation has become a fundamental component of modern marine research, providing continuous and synoptic observations of ecosystem dynamics across regional to basin scales. However, the practical use of satellite data in ecological studies and environmental monitoring remains constrained by the complexity of data processing and the difficulty of accessing harmonised, analysis-ready products. The CoastNet research infrastructure addresses these challenges through an operational geoportal that provides open access to a suite of satellite-derived products covering the Northeastern Atlantic Ocean, including the full Portuguese Exclusive Economic Zone (EEZ) and continental shelf. The platform integrates multiple variables derived from operational satellite missions, including sea surface temperature, sea surface salinity, and chlorophyll-a concentration. In addition to these core environmental variables, CoastNet delivers value-added products such as anomalies and ecosystem indicators generated in near-real-time. These include indicators of marine heat waves, phytoplankton community dynamics, and coastal upwelling, enabling the detection and monitoring of

extreme events and ecosystem variability across both coastal and offshore environments. As such, the CoastNet geoportal supports a wide range of applications, from fundamental ecological research to long-term ecosystem monitoring, facilitating the broader use of satellite observations for understanding ocean and coastal ecosystem responses to climate change.

Session 2 - Global Change and Multiple Stressors in Ocean Health

The influence of ocean warming on vermetid reef meiofaunal communities: a field colonization experiment (S2-PC-01)

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Vermetid reefs are ecologically important biogenic structures along Mediterranean rocky coastlines, where they play a key role in shaping intertidal benthic communities. Temperature rise and the match of thermal extremes and prolonged desiccation events, documented along these bioconstructions, may affect the distribution and community structure of the associated meiofaunal assemblage. Here, we investigated how simulated ocean warming influences the meiofaunal community associated with the vermetid reef through a field colonization experiment. In June 2022, we deployed 30 geopolymer discs with a topographic complexity along a vermetid reef on the north-western coast of Sicily. Temperature conditions were manipulated by placing white (Ta) and black (T+) PVC frames around the discs. Both treatments (Ta and T+) and the control discs (CTRL; without frames) were replicated ten times along the reef. To assess the ability of meiofaunal organisms to colonize substrates under different temperature conditions, five discs for each treatment (n=15) were collected in July and in October 2022. The meiofauna associated with each disc was then extracted and identified. The temperatures recorded on the T+ discs during the diurnal low-tide periods reached maximum values approximately 3°C higher than those measured on the Ta and CTRL discs. Meiofaunal abundances were significantly higher on Ta discs, with evident differences in community composition among treatments driven by changes in the abundance of the main taxa (i.e., Copepoda, Ostracoda, and Nematoda). Our results suggest that ocean warming may

adversely affect meiofaunal communities inhabiting vermetid reefs, leading to shifts in their abundance and community structure. Such alterations could, in turn, have cascading consequences for the broader biodiversity supported by these valuable bioconstructions, ultimately compromising their ecological functioning and resilience in intertidal ecosystems.

Multi-biomarker assessment of ecotoxicological stress across Moroccan coastal ecosystems: spatial patterns and pollution hotspots (S2-PC-02)

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Coastal ecosystems are increasingly exposed to multiple anthropogenic stressors, including chemical pollution, agricultural runoff, and tourism-related pressures, which threaten marine biodiversity and fisheries sustainability. Effective biomonitoring tools are therefore essential to link environmental quality with ecosystem health and support marine resource management. This study aimed to assess the ecotoxicological status of Moroccan coastal ecosystems using a multi-biomarker approach in bivalves as sentinel species. Seasonal sampling was conducted over a three-year period (2022–2024) across multiple sites (31 sites) distributed along the Mediterranean and Atlantic coasts, as well as coastal lagoons. Four biochemical biomarkers were analyzed: acetylcholinesterase (AChE), glutathione S-transferase (GST), catalase (CAT), and metallothioneins (MTs), reflecting neurotoxicity, detoxification processes, oxidative stress, and metal exposure. Biomarker responses revealed significant spatial variability in contamination patterns. Mediterranean sites exhibited lower AChE activity (13.33–19.28 nmol·min⁻¹·mg⁻¹ protein) and higher GST activity, suggesting increased exposure to neurotoxic and organic contaminants. Atlantic sites showed significant variation, with hotspots characterized by elevated MT levels (up to 105.04 µg·g⁻¹) and AChE inhibition (16.94 nmol·min⁻¹·mg⁻¹ protein), indicating mixed contamination sources. Coastal lagoons displayed contrasting biomarker responses, potentially linked to seasonal tourism pressure. Overall, the multi-biomarker approach proved to be an effective early-warning tool for detecting sublethal effects of environmental contamination. These findings provide valuable insights for marine biosurveillance programs and support effective management strategies aimed at preserving ecosystem health and seafood safety.

Tracing Metal Stress in Green Sea Turtles: Gene Expression Markers in Skin versus Blood (S2-PC-03)

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Marine turtles are globally distributed and exhibit complex life cycles spanning multiple ecosystems. Their longevity and feeding ecology make them prone to accumulating persistent pollutants, such as metals and metalloids, in their tissues. São Tomé (ST) Island hosts important nesting and foraging grounds for four of the seven sea turtle species, including a genetically distinct population of green turtles (*Chelonia mydas*), which contributes significantly to the regional genetic pool. To date, no study has directly compared metal-associated gene expression in blood and skin within a consistent analytical framework (i.e. same individuals, sampling time, markers, and contaminants). Building on our previous findings in blood, this work investigates metal-responsive gene activity in skin samples from sea turtles using the same set of molecular markers. The main objectives of this study were: 1) to investigate whether gene expression patterns in skin tissue can serve as indicators of metal exposure and oxidative stress in nesting green sea turtles; and 2) to assess whether skin transcriptional profiles provide complementary information to blood-based markers potentially capturing skin-specific gene responses. To achieve these goals, nesting females were sampled immediately after oviposition at well-characterised nesting sites. Skin biopsies were collected from the trailing edge of the left hind flipper, preserved in RNAlater, and stored at –80°C until RNA extraction and gene expression analysis by quantitative real-time PCR (qPCR). The metal concentrations were previously quantified in total blood. Gene expression analysis was performed targeting genes encoding core reactive oxygen species (ROS) scavenging enzymes (*sod*, *cat*), markers involved in metal binding and regulation (*mt*, *fer*, *mtf1*), and components of glutathione- and thioredoxin-based redox systems (*gr*, *gclc*, *gst*, *tdx*, *txrd*, *seip*). Results showed significant correlations between expression of some genes and metal

contaminant levels, pinpointing some candidate biomarkers of interest for future biomonitoring campaigns. By comparing gene expression responses across matrices, these findings highlight the potential of skin-based transcriptional responses as a valuable complement to blood biomarkers for assessing metal exposure and its physiological effects in marine turtles and support future integrated biomonitoring approaches.

CHILL project - Coastal environments in the spotlight: integrating impacts of psychoactive drugs in coastal urban ecosystems under light pollution (S2-PC-04)

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Urbanization in coastal regions is increasingly impacting these vulnerable ecosystems. In Portugal, these areas are particularly favored for human settlement. In this context, psychoactive drugs have emerged as pharmaceuticals of emerging concern due to their widespread use among the population. They are frequently detected in the aquatic environment as a result of improper disposal and inefficient wastewater treatment. In parallel, the use of illicit substances has also been increasing. These substances act on the central nervous system, altering brain function, yet their impacts on coastal ecosystems remain poorly understood. As biologically active compounds, psychoactive drugs are likely to interact with specific physiological pathways even at trace levels, potentially affecting vital functions of non-target biota, compromising their ecological and economic roles. Furthermore, seafood consumption plays a central part in the diet of Portuguese population, being deeply rooted in cultural heritage. At the same time, it is an important route of exposure to various contaminants, including pharmaceuticals. Thus, assessing potential risks to human health is also critical. In addition, light pollution is a pressing threat to coastal health, exposing organisms to artificial light at night (ALAN) during periods when darkness should prevail. These disruptions to natural light-dark cycles can impact circadian rhythms and thus the regulation of various physiological processes, behavior and community interactions. This is particularly relevant in the context of co-exposure with psychoactive drugs. Building on this framework, CHILL project will shed light on the impact of psychoactive drugs in coastal ecosystems alongside the environmentally relevant scenario of light pollution. CHILL includes environmental monitoring campaigns along the Portuguese coastline and will evaluate whether their environmental concentrations pose a threat to coastal life and to human consumers. In addition, it will investigate how combined exposure to these stressors affect different

levels of biological organization from subcellular to community levels, by studying model organisms and employing advanced techniques and methodologies. Evaluating this complex interplay will not only expand scientific knowledge about the challenges faced by coastal habitats but also to raise awareness about the urgent need to safeguard urban coastal ecosystems and provide scientific support for policy makers.

Habitat degradation risk in European deep seas (S2-PC-05)

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Deep-sea habitats provide a wealth of resources and essential ecosystem services such as carbon sequestration and nutrient cycling. Despite their distance from human populations, they are increasingly exposed to pressures such as fishing, oil and gas extraction, seabed mining, waste disposal, and climate change, which cause severe and often irreversible degradation of these fragile, slow-growing ecosystems. Various global and regional frameworks now offer criteria, standards, and practical guidance for assessing and restoring degraded habitats, though most attention remains focused on coastal and terrestrial ecosystems. In this study we identify and provide information that helps prioritize degraded areas for restoration in European seas below 200 m depth. To that aim we first define “degradation” and European deep-sea habitats based on existing definitions and classifications. We considered five deep-sea habitats: cold-water coral (CWC) reefs and gardens, deep-sea sponge aggregations, deep-sea soft sediments, hydrothermal vents and cold seeps. We evaluated degradation risk by mapping the distribution of these deep-sea habitats and overlaying spatial data on human activities such as fishing, oil and gas extraction, shipping, and waste disposal. Using a cumulative impact assessment framework, we combined habitat occurrence, pressure intensity, and habitat sensitivity scores to identify areas at greatest risk of degradation. Most European deep-sea areas show low to moderate risk of degradation, but hotspots of potential degradation occur along the upper continental slope of the Northeast Atlantic and across the Mediterranean, where soft sediments and CWCs are especially vulnerable. Smothering, habitat alteration, and pollution dominate pressure contributions, while hydrothermal vents show comparatively lower current risk but remain highly vulnerable to emerging mining activities. Soft-sediment habitats emerged as the most degraded and at risk, particularly in the Mediterranean Sea, reflecting both their wide distribution and vulnerability to trawling, though corals and sponges remain crucial for biodiversity and equally sensitive to disturbance. Bottom trawling is the most damaging and widespread

activity, while other pressures such as mining, oil and gas, climate change, and marine debris pose growing but poorly quantified threats.

Exploring the Influence of Nitrogen Availability on the Toxicological Profile of *Gymnodinium catenatum* (S2-PC-06)

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Gymnodinium catenatum is a marine dinoflagellate responsible for harmful algal blooms (HABs) that pose significant ecological and economic threats through the production of potent toxins such as saxitoxins. Understanding how environmental factors, particularly nutrient enrichment from eutrophication, influence both growth dynamics and toxin production in these species is crucial for predicting and managing bloom events under changing ocean conditions. This study investigated the response of *G. catenatum* cultures to different nitrogen concentrations to evaluate the relationship between nutrient stress and cellular metabolism, including toxin biosynthesis and fatty acid composition. The study employed an integrated approach combining ecotoxicological bioassays using *Artemia* to evaluate cell lysate toxicity, molecular analysis of saxitoxin genes (SxtA), and metabolic profiling of fatty acids to evaluate the cellular responses. Results demonstrate that nitrogen concentration significantly affects both growth dynamics and cellular metabolism in *G. catenatum*. Different nitrogen conditions altered growth patterns, with corresponding changes in toxin production potential. Notably, fatty acid analysis revealed specific correlations between certain fatty acid profiles and toxin production levels, suggesting linked metabolic pathways between lipid metabolism and saxitoxin biosynthesis. These findings advance our understanding of eutrophication stress in dinoflagellates and highlight the potential for fatty acid biomarkers in bloom monitoring strategies.

Response of Portuguese oyster *Crassostrea angulata* to variations in environmental conditions (S2-PC-07)

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Due to climate change global ocean temperatures are expected to rise, leading to changes in salinity and alterations in the timing and magnitude of phytoplankton blooms. Estuaries are among the most vulnerable systems to these changes. In the Sado estuary, oyster aquaculture represents an important socio-economic activity, hence it is key to understand how climate change may affect oyster production. The objective of this study is to understand how alterations in physicochemical (salinity and temperature) and biological parameters (phytoplankton blooms) will affect the behavior of the Portuguese oyster, *Crassostrea angulata*. To this end, extreme water temperature (increase of 5°C up to 30°C, over 17 hours and maintained for 6 hours) and salinity (increase of 12 PSU over 1.5 hours up to 45 PSU and maintained for 4.5 hours) conditions were simulated. In addition, oysters were also exposed to blooms of *Gymnodinium catenatum* (toxic dinoflagellate, the main source of PSP toxin (paralytic shellfish poisoning) on the Portuguese coast) and *Skeletonema marinoi* (non-toxic diatom, isolated from the Sado estuary) for 2.5 hours. Behavior was evaluated through the analysis of valve opening and closing using electromagnetic sensors. Increased temperature did not alter the closing pattern of the oysters. After 2-3 hours under elevated salinity levels, the oysters closed their valves until the end of the experiment. On the other hand, when exposed to phytoplankton blooms, oysters remained open throughout the experiment. These results suggest that oysters may be resilient to warming events and phytoplankton blooms, while actively avoiding hypersaline water conditions.

Benthic Ecosystems as Reservoirs of Plastic-Associated Bacteria: A Culture-Based Study from the Maldives (S2-PC-08)

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Plastic pollution represents a major threat to marine ecosystems, particularly in biodiversity hotspots such as the Maldives, where coral reefs and seagrass meadows sustain essential ecological functions. Filter-feeding and sessile organisms, including sponges, ascidians and soft corals, are particularly exposed to suspended particles and may act as biological concentrators of microplastics, promoting the establishment of specialized microbial communities associated with plastic particles within host tissues. This study explores benthic invertebrates (i.e. ascidians, sponges and soft corals) and surrounding sediments from Faafu Atoll (Maldives) as potential sources of bacteria with plastic-related functional traits. Sampling was conducted at two sites characterized by contrasting levels of anthropogenic influence to assess how environmental pressure may shape the occurrence of plastic-associated microbiota. A culture-dependent approach was employed to isolate bacteria from both environmental matrices and host-associated microbiomes through direct isolation and enrichment cultures. Samples (sediment elutriates and animal homogenates) were directly seeded on Marine agar and on a minimal medium supplemented with 1% (w/v) polyethylene (PE) powder as the sole carbon source, and incubated at 30 °C for 10 days. In parallel, enrichment cultures were prepared by incubating sediment and biological materials in minimal medium amended with 1% (w/v) PE powder at 30 °C for 30 days under constant agitation, and subsequently plated on Marine Agar and minimal medium containing PE, under the same condition as direct isolation. Bacterial isolates were screened for traits relevant to marine bioremediation, including tolerance to heavy metals and ability to grow in the presence of hydrocarbon-like substances, as well as potential involvement in plastic degradation processes, particularly relevant in marine environments where plastics co-occur with other pollutants. Notably, growth observed on minimal media supplemented with plastic suggests the presence of microbial communities adapted to colonise or potentially degrade plastic materials. Our findings support the hypothesis that benthic ecosystems can host microbial communities involved in plastic-related processes, serving as ecological hotspots and potential sources of novel microbial resources for sustainable bioremediation strategies.

First evidence of anthropogenic particles (APs) in longnose skate (*Dipturus oxyrinchus*) in the Southern Sicily (S2-PC-09)

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Microplastics (MP) pollution is a growing threat to marine biodiversity worldwide. Although MP ingestion is well documented in many marine taxa, it remains poorly understood in bathyal species inhabiting the deep sea—below 200 m—the largest and still largely unexplored ecosystem on the planet, where species are far less studied than their shelf-dwelling counterparts. This study provides the first evidence of anthropogenic particles (APs) ingestion in longnose skate (*Dipturus oxyrinchus*) specimens from the Southern Sicily (GSA16). Twenty-five individuals were collected during two sampling campaigns conducted in November 2021 and July 2024 in the central Mediterranean. Total length (TL, 19.5–124 cm), disc width (DW, 12.5–71.5 cm), and total weight (TW, 18.2–4350 g) were recorded for each individual. Gastrointestinal tracts (GITs) were subjected to chemical digestion and the suspected microparticles were identified by Raman spectroscopy. The frequency of occurrence of APs was 36%, with an average of 0.6 items per specimen, showing an increase from 28.6% in 2021 to 45.5% in 2024. Microfibers were the dominant shape (75%), followed by fragments and films (12.5% each). Blue and black were the most common colours (25% each), followed by light blue and transparent particles accounting for 12.5% each. The polymer analysis revealed the presence of polypropylene (PP, 66.7%), polyester (PES, 22.2%) and cotton (11.1%). The occurrence of both synthetic and natural fibres highlights the complexity of pollutant sources in the study area. The Southern Sicily is strongly affected by several anthropogenic activities including commercial, industrial, mariculture operations, oil refineries and offshore platforms. Moreover, it represents one of the most important fishing areas in the Mediterranean Sea, hosting one of the largest fishing fleet. These combined pressures have contributed to high levels of marine litter, potentially enhancing the introduction and dispersion of APs. These findings highlight the susceptibility of bathyal elasmobranchs to APs ingestion, raising concerns about potential effects on feeding ecology, health, and population sustainability, particularly in benthic species such as *D. oxyrinchus*. This baseline assessment underscores the importance of

monitoring APs in bathyal species and the need for conservation strategies to mitigate anthropogenic impacts on Mediterranean marine biodiversity.

Monitoring Aquatic Ecosystem Health and Mitigating Plastic Pollution in European Rivers and Estuaries. (S2-PC-10)

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Plastic pollution is ubiquitous across freshwater, estuarine, coastal and marine habitats, with land-based inputs, urban runoff, wastewater, boating activities and hydrodynamic patterns shaping ecosystem condition. As mitigation technologies are developed and deployed, they must be evaluated not only for efficiency but also for environmental sustainability and potential ecological risk. Within the Horizon Europe INSPIRE project, a Water Framework Directive (WFD)-guided Environmental Impact Assessment (EIA) examines the biotic and abiotic conditions before and after the implementation of Prevention and/or Collection solutions trialled across six European river basins, Scheldt, Rhine, Po, Douro, Kamniška Bistrica, and Danube. Here, we present the Douro estuary use case, which establishes the pre-installation baseline for a WnW EcoPlex Microplastic Remover being installed at a marina point source associated with boat maintenance and washing activities in Porto, Portugal. Six seasonal field sampling campaigns were carried out from 2023 to 2026 integrating physicochemical, sedimentological and biological elements, including water masses characterization, water quality, sediments, benthic macroinvertebrates, and microplastics (MPs) in surface waters and sediments. Preliminary results show measurable MP contamination in both water and sediments, with mean abundances of 9.55 MPs m⁻³ in surface waters and 1,77 MPs kg⁻¹ in sediments, dominated by fibres and fragments. Benthic assemblages showed spatial and seasonal variation, including higher diversity upstream and poorer winter ecological status. These baseline data provide benchmarks for future changes at local and broader scales. Across INSPIRE, the cumulative EIA enables comparison across water body types, intervention modes, and operational settings, generating context-specific recommendations for technology deployment in European waters. By linking plastic mitigation to WFD-aligned ecosystem assessment, this work provides field-based evidence for environmentally sustainable intervention strategies in European rivers, estuaries, and coastal waters, contributing to the EU Mission “Restore our Ocean and Waters” target of reducing MPs released into the environment by 30% by 2030.

Metabolic and oxidative stress biomarkers reflect site-specific responses of intertidal gobies to a warming gradient (S2-PC-11)

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Coastal ecosystems are increasingly shaped by multiple stressors, yet population-specific physiological responses remain poorly resolved. We examined thermal sensitivity and metabolic strategies in three populations of the intertidal goby *Pomatoschistus microps* (Ria de Aveiro, Tróia, and Ria Formosa) along the Portuguese coast. Fish were exposed for 15 days to 15, 20, 25, and 30 °C, and oxidative stress was determined from the analysis of total antioxidant capacity (TAC) and lipid peroxidation (LPO) in gills. Changes to energy metabolism were determined from the activities of liver cytochrome c oxidase (COX), lactate dehydrogenase (LDH), and citrate synthase (CS). Oxidative stress responses were consistently site-specific but thermally unresponsive: both TAC and LPO were lower in fish from Tróia, with no significant temperature or interaction effects, indicating limited plasticity in gill redox balance. In contrast, metabolic enzymes showed population-dependent thermal sensitivity. COX increased with temperature in fish from Tróia, revealing enhanced aerobic responsiveness in this population, and also varied among sites, particularly above 25 °C. The activity of LDH differed only among sites, with higher activity in fish from Tróia, suggesting intrinsic differences in anaerobic capacity between populations, whereas CS displayed significant site-by-temperature interactions and high inter-individual variability, indicating heterogeneous metabolic adjustments. Together, these patterns reveal a decoupling between oxidative costs and metabolic responses under warming, with Tróia fish exhibiting a distinct physiological profile characterized by lower oxidative damage and elevated metabolic capacity. Such divergence likely reflects local acclimatization or adaptation to complex environmental regimes beyond temperature alone, such as fluctuations in salinity, dissolved oxygen and

pH. Our findings highlight that population-specific biomarker responses reveal distinct patterns of thermal sensitivity throughout species distribution ranges, underscoring the need to integrate multiple stressors, traits and populations when assessing resilience to global change.

Mussels as Sentinels of Coastal Pollution: Linking Microbial Load, Biochemistry, and Anthropogenic Pressure (S2-PC-12)

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Mussels, as sessile filter-feeding organisms, are widely recognized as effective bioindicators of environmental contamination. *Mytilus edulis*, the most prevalent mussel species along the Portuguese coast, was therefore selected in this study to assess the coastal water quality of Peniche, Portugal. Water and mussel samples were collected from three selected sites – the Peniche Marina, a site locally known as “Fosso” situated in the city center, and the area surrounding the wastewater treatment plant (WWTP) – during four sampling periods (July, September, November, and December 2020). Mussel samples were analyzed for microbiological load (total microorganism counts, detection of *Escherichia coli*, and sulfite-reducing clostridia spores), biochemical composition (protein, lipid, ash, and carbohydrate contents, as well as fatty acid profiles), and the presence of microplastic particles. Water samples were evaluated for physicochemical parameters, including pH, dissolved oxygen, temperature, chlorophyll *a*, and concentrations of nitrates, nitrites, ammonia, and phosphates. Samples obtained from the WWTP exhibited high microbiological loads, indicating suboptimal environmental conditions for mussel development, which were associated with reduced growth. Additionally, mussels from this site showed significantly higher levels of monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA), as well as protein content, and lower levels of saturated fatty acids (SFA) compared to those collected from the Marina and Fosso. Microplastics were detected in all analyzed samples, with concentrations ranging from 2 to 16 items per gram. Nevertheless, further research is required to characterize the composition of the detected particles and to identify potential sources of polymer contamination. The results demonstrated that filter-feeding organisms underwent microbiological and biochemical alterations in response to environmental pollution, reinforcing the suitability of *M. edulis* as an environmental bioindicator. Future studies should extend monitoring periods, include additional sites with varying anthropogenic pressure, and apply Fourier-transform infrared spectroscopy

(FTIR) to confirm the identity of particulate matter, particularly microplastics, thereby improving the robustness of environmental assessments.

Short-term responses of estuarine mesozooplankton to maintenance dredging activities (S2-PC-13)

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Maintenance dredging is a common practice in estuaries to ensure navigability and support port operations, but it also represents a widespread anthropogenic disturbance. Its effects on planktonic communities, however, remain poorly understood, particularly for mesozooplankton, a key component linking primary producers and higher trophic levels. This study evaluated the short-term responses of mesozooplankton communities and environmental variables to a maintenance dredging operation in the Guadalquivir estuary. Sampling was conducted in two sites with contrasting salinity conditions (polyhaline and mesohaline), during three phases: pre-, during and post-dredging. During dredging, significant reductions in pH and chlorophyll-a concentrations were detected. While pH values returned to baseline after the operation, suggesting a short-lived disturbance, chlorophyll-a levels remained suppressed into the post-dredging phase. Other environmental variables such as salinity, turbidity and nutrients remained relatively stable and not noticeably altered by the dredging activity. Biological descriptors showed contrasting spatial responses. In the polyhaline zone (Salinas), species richness and community structure were significantly altered during dredging and did not fully return to pre-disturbance conditions. This shift was characterized by the decline of taxa such as *Oncaea curta* and *Acartia clausi*, alongside a persistent change in dominance from *Oithona* sp. to *Sagitta* sp. In contrast, the mesohaline community (Puntalete) remained remarkably stable, dominated by *Acartia tonsa* throughout all phases with negligible compositional changes. Overall, these results indicate that the effects of maintenance dredging on mesozooplankton are short-term and primarily expressed through transient shifts in community structure rather than broad changes in environmental conditions. The contrasting responses observed between sites emphasize the role of local ecological

context in modulating disturbance effects, and underline the need for site-specific assessments when evaluating dredging impacts in estuarine ecosystems.

Industrial thermal effluents drive compositional shifts in epibiont assemblages associated with the invasive pearl oyster *Pinctada radiata* in the Mediterranean Sea (S2-PC-14)

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Localised thermal anomalies generated by hot-water industrial effluents can create fine-scale temperature gradients that alter benthic communities. Assessing their effects on benthic species is crucial for understanding coastal ecosystem dynamics and informing management strategies under warming scenarios. To investigate these effects, the invasive pearl oyster *Pinctada radiata* (Leach, 1814), hosting a rich epibiont assemblage, was sampled in Marsaxlokk Bay (Malta) across three sites characterized by increasing temperature conditions: a control site (26.3 °C), an intermediate site (27.1 °C), and a thermally impacted site (28.5 °C) influenced by power plant discharge. Six individuals per site were collected at 4 m depth. Statistical analyses revealed significant differences in community composition among sites (PERMANOVA, $p = 0.001$). Along the thermal gradient, green, brown and red macroalgae showed a marked decline from control to the thermally impacted site ($p = 0.002$). In contrast, calcareous encrusting organisms, including polychaetes and bryozoans, exhibited variable responses, with higher colonisation levels at the impacted site compared to the control site ($p = 0.029$). These patterns are consistent with previous studies showing that warming stressors can alter biofouling communities in a species-specific manner, often leading to the decline of the algal assemblage, one of the most thermally sensitive benthic groups, followed by shifts in the abundance and composition of other *taxa*. Calcareous species may nevertheless persist depending on ecological context and biotic interactions, particularly in the presence of biogenic substrates that support settlement and community stability. Overall, these findings indicate that the thermal gradient drives ecological reorganisation, promoting shifts in community structure rather than a uniform loss of sensitive *taxa*.

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Can kelp bounce back from a heatwave under ocean acidification? (S2-PC-15)

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Marine heatwaves (MHW) – short-term extreme temperature events – are becoming more frequent, intense, and persistent due to climate change. Simultaneously, ocean acidification (OA) is changing global marine carbonate chemistry. Their combined effects can impair physiological processes, reduce growth rates, and increase mortality in habitat-forming species. *Laminaria ochroleuca* is a canopy-forming kelp at its southern distribution limits along the Portuguese coast, and is particularly vulnerable to thermal stress. There is limited understanding of how these kelp populations respond to the interactive effects of MHWs and OA, especially their capacity for physiological recovery. Answering these questions helps us better understand this ecosystem's resilience and guide aquaculture decision-making and management. Experiments were conducted in flow-through mesocosm tanks (5 tanks per treatment) using a factorial design that included normal and elevated CO₂ (1000 ppm), a simulated heatwave (peak 23°C) and a control. Sampling occurred at four time points (T0–T3) across acclimation, peak stress, and recovery. Photosynthetic performance was assessed via photosynthesis-irradiance (PI) curves, fitted using generalised nonlinear least squares and Holm-corrected pairwise comparisons. At the peak of the heatwave (T2), algae submitted to the MHW and MHW*high-CO₂ treatments increased their maximum photosynthetic capacity (P_{max}), suggesting a stimulatory or compensatory photosynthetic response to the heatwave simulation. This effect persisted into the recovery phase (T3), although with lower magnitude. In contrast, high CO₂ alone induced an inconsistent response: P_{max} was similar to control at T2, but lower at T1 and T3. By the end of the recovery phase, P_{max} differed in all treatments, with values above control in the MHW and MHW*high-CO₂ treatments, and below control in the high-CO₂ treatment. The photosynthetic efficiency (α) was similar across all treatments. This indicates that the stressors primarily affect photosynthetic capacity rather than efficiency. These results suggest that *L. ochroleuca* populations at their southern range limit can adjust photosynthesis in response to short-term heatwave and acidification stress. Different recovery trends across treatments suggest that the type of stressor – not just its intensity – should be considered when projecting kelp resilience under future climate scenarios.

Contribution to the study of trace metal contamination in the mussel *Mytilus galloprovincialis* (Lamarck, 1819) on the Oran coast (Western Algeria) (S2-PC-16)

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The existence of populations, urbanizations, ports, and industrial units on the Oran coast is essential due to their primary roles in the national and international economy; herefore, it seemed important to us to study the level of contamination in the main sites of the Oran coast. This study examined the seasonal and spatial variations of four trace metals: zinc (Zn), cadmium (Cd), copper (Cu), and lead (Pb), in the soft tissues of the mussel "*Mytilus galloprovincialis*" (Lamarck, 1819), collected from six coastal sites along the western oast of Algeria. This ecologically rich and diverse region is characterized by high population density and significant human activity. Mussel samples were collected between October 2023 and June 2024. Analysis of variance (ANOVA) revealed significant seasonal variation for Zn and Cd ($F = 8.45$, $P < 0.001$ and $F = 6.78$, $P = 0.0024$, respectively), particularly in spring and summer. Principal component analysis (PCA) showed strong associations between Zn, Cu, Pb, and BOD5, and between Cd and temperature, while hierarchical clustering (HCA) distinctly grouped sampling sites by season, notably highlighting summer/autumn samples. The correlation matrix revealed significant relationships between Zn and Cu, Zn and Cd, and physicochemical parameters and metal concentrations, including a strong inverse correlation between Cd and Pb with dissolved oxygen. These results offer important insights for responding to marine pollution incidents and developing advanced technologies to ensure monitoring and environmental management strategies in the Algerian west coast region.

Physiological response of *Cliona celata* Grant, 1826 (Porifera: Clionaida) to short-term aerial exposure (S2-PC-17)

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Cliona celata, commonly known as the yellow boring sponge, is a widespread species along the shallow East Atlanto-Mediterranean region, and part of a complex of cryptic

species. The species is known to be a major bioeroder of carbonated substrates, including coralligenous habitats, molluscs shells and human-made structures, making it a key habitat modifier and playing a major role in the carbonate cycling and benthic community structure, in the areas where it occurs. Furthermore, *C. celata* is also known to provide habitat to a wide array of taxa. Thus, given its importance in coastal rocky ecosystems, *C. celata* response to a wide array of environmental conditions (e.g., temperature, pH or salinity) has been tested over the years to better characterize its role and ecology on said ecosystems. However, its tolerance to short-term aerial exposure remains poorly understood, despite the fact that individuals inhabiting the intertidal may occasionally be exposed to air during very low tides, such as in the northern Portuguese coasts. Understanding this response is important for clarifying the ecological limits of the species in naturally variable coastal habitats. This study evaluated, for the first time, the response of *C. celata* to different durations of air exposure under controlled conditions. Specimens were assigned to five treatments: T0 (control, no exposure), T1 (5 min), T2 (10 min), T3 (20 min), and T4 (40 min). Following exposure, sponges were returned to aquarium conditions and their respiration was measured for 1h 30min in respiration chambers as a proxy for physiological stress and metabolic performance. Visible signs of stress and survival were also assessed through visual signals (e.g., loss of colour). Preliminary observations suggest that *C. celata* can tolerate short-term emergence, although responses may vary with exposure duration. These results provide the first insights into the resilience of this species to aerial exposure, and point towards *C. celata* being able to withstand relatively prolonged periods of emergence. This information can contribute to a better understanding of the species' persistence in shallow coastal habitats and support the development of improved handling and *ex situ* maintenance protocols, with potential relevance for future conservation and restoration-oriented applications.

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Reduced thermal performance of kelp recruits under an upwelling-limited climate change scenario (S2-PC-18)

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Marine forests are key components of temperate coastal ecosystems, increasingly threatened by climate change. In many coastal systems, such as the Iberian Peninsula, projected declines in upwelling coincide with rising sea surface temperatures, exacerbating stress for kelp populations. While most studies focus on field-collected adult or late-stage juvenile sporophytes, early developmental stages may be more sensitive to environmental stress, with consequences for recruitment and persistence. Nonetheless, the combined effects of these stressors are poorly studied. We experimentally tested the interactive effects of temperature and nutrient availability on the thermal performance of laboratory-grown F₁ early-stage juveniles (recruits) of three North Atlantic kelps: *Saccharina latissima*, *Laminaria hyperborea*, and *Laminaria ochroleuca*, under controlled mesocosm conditions. Ten temperature levels and two nutrient regimes simulated present-day and forecasted warmer, reduced-upwelling scenarios. Nutrient limitation reduced the maximum quantum yield of photosystem II (Fv/Fm) by up to 36% and relative growth rate by 100%, with *S. latissima* most affected. Thermal maxima and mortality thresholds were generally lower than values reported for later-stage sporophytes, particularly in *L. ochroleuca* and *S. latissima*. Species-specific responses followed their biogeographic affinities, with the warm-affinity species *L. ochroleuca* showing higher thermal tolerance than the cold-affinity species *S. latissima*, while *L. hyperborea* displayed intermediate responses. Our results show that early life stages of kelps are highly vulnerable to concurrent warming and nutrient limitation, revealing a demographic bottleneck that may drive community shifts. Incorporating early ontogeny is then crucial for accurate climate vulnerability assessments.

Ocean warming drives dramatic shifts in the fluxes of key greenhouse gases from the matte of *Posidonia oceanica* (S2-PC-19)

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Meadows of *Posidonia oceanica*, an endemic Mediterranean seagrass species, are among the most efficient long-term marine carbon sinks. A notable factor in their storage ability is the meadows' unique matte structure: the accumulation of dead rhizomes and organic debris that can lock carbon away for millennia. Beyond carbon (CO₂) sequestration, seagrass meadows are also significant sites of methane (CH₄) and dimethylsulphide (DMS) cycling—CH₄ being a potent greenhouse gas, and DMS contributing to sulphur aerosol formation, cloud condensation, and thus a net cooling effect on climate. The increasing frequency and intensity of extreme ocean temperature events threaten the structural integrity of the matte and the ecosystem's overall functional capacity, with potentially severe consequences for carbon storage and the cycling of CH₄ and DMS. This study aimed to characterise how thermally induced disruption of the *P. oceanica* matte affects the cycling of these climatically relevant compounds—CO₂, CH₄, and DMS. A mesocosm experiment was performed with *P. oceanica* shoots on three substrate types: no substrate (mimicking shoots exposed to seawater due to matte erosion or degradation), pebbles (mimicking meadows growing on coarse substrate), and matte. After acclimation and a ramp-up phase, half of the cores were subjected to an artificial heatwave (32 °C for seven days); the remaining half were maintained at ambient seawater temperature (26 °C). Gas fluxes were measured via incubations at the end of the heatwave period, and leaf biomass was collected to quantify DMSP content—the primary precursor to DMS and a potential indirect source of CH₄ via microbial demethylation. The heatwave strongly affected the gas flux balance of matte-bearing cores: leaf DMSP content declined under thermal stress, accompanied by disrupted DMS production and a significant increase in CH₄ efflux. These results suggest a shift away from DMSP-to-DMS cleavage toward alternative microbial degradation routes that favour CH₄ production, resulting in a partial CH₄ offset of the system's capacity as a net CO₂ sink. In conclusion, predicted ocean warming will impact both DMS and CH₄ cycling within the *Posidonia*–matte system, underscoring the vulnerability of this ecosystem's climate-regulating functions under projected warming scenarios.

Short-term effects of heavy metal exposure on *Cylindrotheca closterium* cultures (S2-PC-20)

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Heavy metal pollution is a significant environmental problem worldwide, posing serious risks to both human health and ecosystems. Although heavy metals occur naturally in trace amounts in marine and freshwater environments, human activities such as mining and industrial processes have dramatically increased their concentrations in aquatic systems. Unicellular algae are widely used as bioindicators of environmental quality because of their cosmopolitan distribution, short life cycles, and rapid responses to natural and anthropogenic stressors. In this study, we investigated the tolerance of the benthic diatom *Cylindrotheca closterium* to selected metals (zinc, cadmium, arsenic, and lead at final concentrations of 0.5, 1, and 5 mg/L) under controlled laboratory conditions in Guillard's F/2 medium for 96 hours. All cultures were assessed in triplicate. Flasks containing microalgal cultures grown in the absence of heavy metals served as controls. Cell abundance was monitored daily by fixing 1 mL of culture with Lugol's solution (final concentration approximately 2%) and counting cells in a Sedgewick-Rafter chamber under a ZEISS Axiovert 200 microscope at 20× magnification. Taxonomic shifts in the associated bacterial communities during growth in the presence of heavy metals were investigated and compared to the controls by a metabarcoding approach, through next-generation target sequencing. In parallel, the production of biosurfactants, bioactive molecules with potential metal-chelating properties, was evaluated. Preliminary results suggest a general tolerance of *C. closterium* to the tested metals, with the strongest inhibitory effects observed at the highest concentrations of zinc and cadmium. Overall, this study supports the use of diatoms and their associated bacterial community as sensitive sentinels of contaminant stress in coastal ecosystems and highlights the value of integrating multiple approaches. In addition, identifying bioactive molecules involved in heavy metal stress responses may open promising perspectives for biotechnological applications and bioremediation.

Integrating Clinical and Microbiological Findings from a Rescued Loggerhead Sea Turtle (*Caretta caretta*) into Coastal Biodiversity Monitoring (S2-PC-21)

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An adult female loggerhead sea turtle (*Caretta caretta*), estimated to be 10–15 years old, was rescued from coastal waters in the Manfredonia area after exhibiting severe postural imbalance and impaired motor coordination. Clinical assessment suggested neurological impairment consistent with blunt force trauma of anthropogenic origin. Health evaluation included coprological and microbiological analyses conducted under expert supervision. Results revealed the presence of gastrointestinal parasites and bacterial pathogens, including *Escherichia coli*, *Salmonella*, *Proteus* spp., and *Shigella* spp., potentially associated with environmental contamination linked to aquaculture and other coastal human activities. This case highlights the cumulative effects of anthropogenic injury and microbial exposure on marine megafauna and underscores the importance of integrating rescue-based clinical and microbiological data into ecological biodiversity monitoring frameworks. Such integrated surveillance is essential for assessing ecosystem health and informing conservation strategies in human-impacted coastal environments.

Spatial and seasonal distribution of PFAS in water, suspended particulate matter, and biota from the Douro and Tagus estuaries (Portugal) (S2-PC-23)

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Per- and polyfluoroalkyl substances (PFAS) are persistent contaminants commonly found in aquatic environments, mainly due to continuous human inputs. This study evaluated the occurrence, distribution, and composition of PFAS in water, suspended particulate matter (SPM), and biota from the Douro and Tagus estuaries (Portugal), considering spatial and seasonal variability. PFAS were detected in all environmental matrices, with higher concentrations generally observed in the Douro estuary, particularly at sites D4 and D5 (up to 25.07 ng/l), and a clear seasonal pattern with higher levels in winter. In contrast, the Tagus estuary showed lower overall concentrations (0.06–10.18 ng/l), although a pronounced peak was observed at T3 during summer (25.67 ng/l). long-chain PFCA, particularly PFOA, dominated in water, while PFOS showed a stronger association with SPM, reflecting its higher affinity for the particulate phase, with higher partitioning coefficients (logKd). In biota, PFAS concentrations were generally low but showed clear spatial and seasonal variability. In the Douro estuary, macroalgae (*Fucus*) consistently exhibited low concentrations (0.03–0.75 ng/g ww), whereas higher levels were observed in the bivalve *Scrobicularia plana* (0.20–1.85 ng/g ww), with increased values in spring and autumn. In the Tagus estuary, greater variability was observed, with higher concentrations in macroalgae *Gracilaria* (0.47–1.51 ng/g ww), particularly at T4 during summer, while macroalgae *Fucus* and *Ulva* showed consistently low levels. Among fauna, *S. plana* (0.10–0.98 ng/g ww) showed higher concentrations than the crustacean *Carcinus maenas* (0.05–0.39 ng/g ww), especially at T4. Ecological risk was mainly associated with PFOS in both estuaries, with more frequent and higher risk levels observed in the Douro, while the Tagus showed mostly low to moderate risk with occasional peaks. Overall, these results emphasize the need for continued monitoring of PFAS in estuarine systems influenced by human activities, as well as the importance of expanding knowledge to other Portuguese aquatic environments.

Impact of aerosols on chlorophyll a distribution in the Arabian Sea using multi satellite observations (S2-PC-24)

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Atmospheric aerosols can influence marine primary productivity through both nutrient deposition and radiative effects, yet their role in monsoon-driven systems such as the Arabian Sea remains complex and spatially variable. This study investigates the relationship between aerosol loading and chlorophyll-a (Chl-a) variability using multi-satellite observations from 2003 to 2024. Satellite-derived Chl-a, aerosol optical thickness (AOT), and environmental variables including sea surface temperature, winds, salinity, and radiation were analyzed at basin and regional scales. Results reveal a moderate positive correlation between Chl-a and AOT ($r = 0.48$), while the relationship with dust optical thickness is weaker ($r = 0.20$), suggesting that co-variability is largely driven by shared physical processes rather than direct fertilization effects. Strong positive correlations are observed in the western Arabian Sea, where monsoon winds simultaneously enhance upwelling and aerosol transport, whereas weak or negative correlations dominate in the northeastern region and the Arabian Gulf due to stratification and light limitation. Seasonal and lagged analyses confirm that coupling strength depends on the alignment between aerosol presence and oceanic processes. Interannual variability further highlights non-stationary behavior linked to climate extremes. Overall, the results demonstrate that aerosol effects are secondary in regions where physical forcing dominates, emphasizing the need for region-specific and multivariate approaches to better understand atmosphere–ocean interactions and their impact on marine productivity.

Microplastics in *Callinectes sapidus* and *C. bocourti* (Crustacea: Portunidae) gills from the RAMSAR wetland Ciénaga Grande de Santa Marta, Colombia (S2-PC-25)

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The Ciénaga Grande de Santa Marta (CGSM), a RAMSAR wetland and biosphere reserve in the Colombian Caribbean, is a highly productive estuarine system that supports local livelihoods and artisanal crab fisheries. However, it is increasingly affected by human pressures such as hydrological alterations, hypersalinization, and plastic pollution. Microplastics have been detected in sediments and fauna, raising concerns about their transfer through trophic networks. This study evaluated, for the first time, the presence of microplastics in two swimming crab species (*Callinectes sapidus* and *C. bocourti*) from the CGSM. Thirty individuals (14 blue, 16 red swimming crabs) were collected from two sites using traps at two sites in the CGSM between April and May 2019. Water samples were taken for physicochemical analysis. In the laboratory, specimens were measured,

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weighed, and sexed. They were then anesthetized, frozen, sacrificed and dissected, their gills extracted and rinsed with a hypersaline solution to separate particles, and analyzed through standardized laboratory methods for microplastic detection under a stereomicroscope. Microplastics were identified, classified as fibers, fragments or films, and quantified, alongside environmental and morphometric data. All specimens contained microplastics (300–1000 μm), with fibers being the dominant type. a total of 571 particles were recorded, with higher abundance in *c. bocourti* (364) than in *c. sapidus* (207), though without significant differences between species. males showed slightly higher particle loads (9-14) than females (6-10). No correlations were found between microplastic abundance and environmental (physicochemical parameters) or biological variables (morphometric variables such as size and weight). These findings reveal widespread microplastic contamination in CGSM swimming crabs, likely linked to pollution accumulation in mangrove areas. The predominance of small fibers in gills suggests limited removal by grooming and highlights potential ecological and health implications

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Joint disciplinary and cross-sectoral efforts to enhance Norway lobster protection, promote stock recovery, and ensure sustainable fisheries within an ecosystem-based management framework (S3-PC-01)

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The Norway lobster (*Nephrops norvegicus*) is a key marine fishery resource in Europe, both as a valuable commercial species and as an indicator of healthy benthic ecosystems. In Spanish Mediterranean waters, Norway lobster stocks have shown notable vulnerability and decline after decades of intensive fishing, while ongoing ocean warming is progressively altering its distribution and availability to fisheries, likely through changes in habitat suitability. This situation has led to the implementation of new demersal network of no-take marine protected areas (MPAs), where bottom trawling is banned. Here, we synthesise recent results of Norway lobster monitoring efforts and present a proactive, collaborative framework between science, technology and governance aimed at developing a roadmap for its sustainable management in European waters. This framework integrates historical knowledge (incl. long-term fisheries and scientific records on Norway lobster population dynamics) with current innovative approaches of in situ monitoring and ecological modelling. We summarise insights from monthly fishery surveys, and evaluate the benefits of MPAs across multiple Essential Biodiversity

Variables and fisheries indicators. These include metrics at the individual, population, and ecosystem levels, derived from combining landings, and acoustic and imagery monitoring. Building on this empirical foundation, modelling approaches (incl. connectivity and spatial prioritisation) were used to explore optimisation scenarios for MPA networks. Results suggest that while existing MPAs already deliver positive outcomes for Norway lobster and the wider benthic-demersal community, their configuration could be further improved to enhance ecological benefits, although these may vary over time under ongoing seawater warming trends. Overall, this roadmap represents a successful case study of knowledge transfer from science to policy in the framework of Marine Spatial Planning, while also highlighting remaining challenges for effective integration into governance. This approach has strong potential for application to other species in the Mediterranean Sea, and for being exported to other regions in European waters.

EMODnet Seabed Habitats: EUSeaMap(2025) and Habitat Mapping Products For Policy (S3-PC-02)

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Phase 5 of the EMODnet Seabed Habitats project commenced in September 2023, and will run for four years through to September 2027. The project aims to build on the existing data products and improve EUSeaMap (broad-scale habitat map for all European sea basins, and for the Caribbean) with new and revised input data. In 2025, an updated version of EUSeaMap (2025) was published, including coverage of the Caribbean and Caspian Seas. Habitat mapping outputs from EMODnet, such as EUSeaMap, are critical in allowing the EU to achieve the aims set out in its biodiversity strategy. As part of the EU Green Deal, the EU Biodiversity Strategy for 2030 set out ambitious protection and restoration targets. This resulted in adoption of the Nature Restoration Regulation in 2024 which represents a commitment to legally protect 30% of the sea area in the union by 2030. This is linked with other EU legislation such as the Marine Strategy Framework Directive, Marine Spatial Planning Directive, and the Birds & Habitats Directive. The Nature Restoration Regulation aims to restore a broad range of degraded ecosystems, habitats and species across the EU land and seas. This will require identification of Favourable Reference Areas (FRA) and prioritisation of habitats and areas to be restored.

Through ongoing engagement with member state actors, it is hoped EMODnet Seabed Habitats can contribute to restoration measures and their feasibility at different scales. As part of this, information needs and data gaps can be identified. Practical approaches can be evolved to fill knowledge gaps, while considering general marine data limitations. All deliverables are freely available via the EMODnet Central Portal which provides a standardised, centralised and free access point for all spatial information on seabed habitats in Europe: <https://emodnet.ec.europa.eu/en>.

The EMFAF Irish Shelf & Upper Slope Habitat Assessment (SeaShelf) —Mapping To Inform Policy (S3-PC-03)

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The EMFAF Irish Shelf & Upper Slope Habitat Assessment (SeaShelf) project aims to collect the scientific evidence base needed to reconcile sustainable fisheries objectives with nature conservation objectives. To achieve this, there is a requirement to extend our benthic habitat mapping knowledge across the shelf and upper slope, taking a systematic and scientific approach to survey design and data gathering. The SeaShelf project will extend benthic habitat mapping knowledge beyond Irish coastal waters and offshore reef habitat, identify VME habitats (Vulnerable Marine Ecosystem), improve MSFD assessments on seabed integrity (GES D6), support Marine Spatial Planning, underpin future MPA designations and nature restoration efforts, enable Offshore Renewable Energy development, and underpin Strategic Environmental Assessments. The project commenced in 2024 and will run until 2027. It is the current iteration of mapping work to inform policy carried out by the INFOMAR programme and builds upon the previous projects such as SeaRover. Its outputs include acquisition of imagery (ROV, stills), sediment and biological sampling, and geophysical survey. Assessments carried out to date include; 'Best Available Habitat Mapping Data and Habitat Suitability Models', 'Development of Mapping and Monitoring Methodologies', and 'Prioritisation Approach for Regional Habitat Mapping'. These will augment the products developed as part of The EMFF funded SeaRover Synthesis programme. This work developed policy tools that have facilitated an EEZ scale offshore reef habitat mapping assessment. Developing a strategic and scientific approach to benthic habitat assessment, while considering current and future pressures including bottom fishing and offshore renewable energy, will increase our understanding of sectoral impact. Moreover, it will improve our site monitoring capacity and knowledge, and will improve our ability to assess change, and manage our resources accordingly.

Marine restoration actions beyond corals: laying the groundwork for future deep-sea sponge restoration actions (S3-PC-04)

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Human pressure has greatly contributed to the degradation of deep-water habitats to a point where the abundance of benthic megafauna has declined dramatically. Given that natural recovery of earth's ecosystems may take centuries, it is of key importance to actively initiate or expedite recovery and revert degradation. However, while on land there is ample experience regarding restoration actions, in aquatic habitats, and particularly the deep-sea marine realm, we are still in an early testing phase, with many uncertainties regarding both the best methodologies and the relevant spatial scales. Furthermore, marine restoration has so far been heavily skewed towards algae and coral and anthozoan dominated communities, with barely any attention paid to other habitat-forming benthic taxa such as sponges, whose restoration potential remains largely unknown. In this context, several pioneering projects across Europe (e.g. Life ECOREST, REDRESS, SpongeREST) are laying the groundwork regarding sponges current distribution, survival to by-catch and recovery potential to inform future conservation and restoration actions. Here we highlight the main key findings of such endeavours, those being: (i) a sound understanding of the basic ecological and physiological traits of habitat-forming sponges is still missing; (ii) sponges appear to be more resilient than previously thought to stressors such as air exposure, which opens the possibility of utilizing by-catch sponges in restoration actions; (iii) *ex-situ* maintenance and propagation might not be feasible for all species, but offers promising results for certain groups (e.g. Tetractinellida or Suberitida); (iv) substrate fixation represents a bottleneck for successful sponge transplantation. These findings represent a significant step toward integrating sponges into marine restoration agendas and highlights the feasibility of their inclusion in future management strategies for continental shelf and slope ecosystems.

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Recreational boating impacts in a marine protected area in the northern Adriatic (S3-PC-05)

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Recreational boating is a significant source of anthropogenic pressure in coastal marine ecosystems. This study evaluates its ecological impacts in the marine protected area of the Debeli Rtič Landscape Park (northern Adriatic, Slovenia), focusing on anchoring-induced seabed disturbance, damage to *Pinna nobilis* shells, and the distribution of marine litter across different protection regimes. Field surveys were conducted at four sites with varying levels of protection using underwater visual transects and video analysis. Seabed damage, *P. nobilis* shell density and condition (lying, broken, destroyed), and litter presence were quantified and analysed in relation to protection level. A total of 370 *P. nobilis* shells were recorded, with no living individuals observed except for a single juvenile. Impacted areas exhibited significantly higher levels of shell displacement and damage, as well as more frequent seabed disturbances, indicating strong anthropogenic influence. These areas also contained higher amounts of marine litter, further contributing to habitat degradation. Statistical analyses revealed positive correlations between seabed damage, shell degradation, and litter presence, and negative correlations with shell density. Anchoring was identified as the main driver of damage, significantly affecting seagrass meadows and associated benthic microhabitats. The highest levels of impact were recorded in less strictly protected areas, while no anchoring-related damage was observed in the strictly protected zone. These findings demonstrate that stricter protection and targeted management measures can effectively reduce boating-related impacts; however, current protection remains only partially effective and requires improved enforcement and clearer spatial delineation. Anchoring restrictions, particularly when supported by visible boundary markers, play a key role in reducing ecological pressure, highlighting the importance of effective management strategies for maintaining ecosystem resilience.

Marine and Coastal Tourism in Island Systems: Research Trends, Impacts and Knowledge Gaps (S3-PC-06)

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Islands host unique marine biodiversity and cultural heritage, yet the rapid growth of marine and coastal tourism in these ecosystems often generates environmental pressures and socio-economic disparities. With a projected 3.3% annual increase in marine tourism by 2030, understanding its associated environmental impacts is fundamental for effective conservation and management of island ecosystems. This study presents a systematic literature review, following PRISMA guidelines to assess the current state of research on marine and coastal tourism in island contexts. The review aims to: (1) classify types of marine and coastal tourism; (2) identify and categorize associated impacts; and (3) highlight knowledge gaps to support decision-making and future management. A total of 874 publications indexed in Scopus and Web of Science were screened, resulting in 286 peer-reviewed articles selected for analysis. Our data reveals a dramatic surge in academic interest, with publications expanding between the 1990-2009 and 2010-2026 periods. We observed a geographically concentration of the results in Indonesia (24%); Spain (10%); USA (7%) and Croatia (6%) which also corresponds to the most frequently studied areas: the Pacific area is the most studied area (30%) followed by the Atlantic (27%); the Indian (27%); and the Mediterranean (8%). Polar and Southern Ocean island systems remain largely underrepresented. Results enlighten impacts on biodiversity; ecosystem health; governance; pollution; socio-economic context and water quality. By identifying these patterns, this review underscores the need for standardized methodologies to assess the growing and diverse impacts of marine and coastal tourism on island ecosystems. As islands face rapid tourism growth, uneven research coverage, environmental and socio-economic impacts, such frameworks are essential to move from *ad-hoc* observations to evidence-based management that safeguards these marine environments.

Phytoplankton-Based Assessment of Ecological Status in a Mediterranean Brackish Lagoon (Škocjanski zatok, Slovenia) (S3-PC-07)

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Monitoring of ecological quality under the Water Framework Directive (EC/2000/60) was extended to transitional waters in 2024, including a brackish lagoon within the Nature Reserve Škocjanski zatok. Phytoplankton biomass, abundance, and community structure were analysed, and ecological status was assessed using the Multimetric Phytoplankton Index (MPI), which is currently being adapted to local conditions. To support this process, phytoplankton was sampled monthly over two years at up to three sites along a gradient of marine influence. Marked spatial differences in phytoplankton community composition reflected decreasing marine influence across the lagoon, while seasonal dynamics of biomass (chlorophyll-a) and abundance varied strongly between years. In 2024, chlorophyll-a concentrations showed a wider range than typically observed in marine environments (0.22–19.26 $\mu\text{g L}^{-1}$) and exhibited atypical seasonal dynamics. In 2024, diatoms dominated at the least marine-influenced site (SKO2), whereas prasinophytes, cryptophytes, and dinoflagellates alternated dominance at sites with greater marine influence (SKO1, SKO5). Ecological status was classified as very good at SKO1 and good at SKO2 and SKO5, with the lowest values consistently associated with Hulburt's dominance index at SKO5, indicating episodic dominance of few taxa. In 2025, temporal patterns of phytoplankton biomass and abundance were closely aligned, with coinciding peaks and maximum abundances reaching approximately $20 \times 10^6 \text{ cells L}^{-1}$ at SKO5. In 2025, cryptophytes dominated most of the time at both stations sampled in 2025 (SKO1 and SKO5). EQR values of individual MPI metrics differed by one class between sites, with contrasting metric responses; however, Hulburt's dominance index again indicated the lowest status at SKO5. Despite this variability, both sites achieved good ecological status. Overall, phytoplankton-based assessment reveals pronounced spatial and interannual variability, yet consistently indicates good ecological status. The lagoon's anthropogenic origin, combined with hydrological regulation via sluice gates, modifies connectivity, enhances sedimentation, and contributes to more extreme environmental conditions, representing a key driver of observed ecological patterns.

Nursery Function and Storm Resilience of a Restored Saltmarsh: a Before–After Control–Impact Study in the Mondego Estuary (Portugal) (S3-PC-08)

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Saltmarsh restoration is increasingly promoted as a nature-based approach to enhance sediment accretion and protect coasts from sea-level rise. However, its effects on estuarine fish nursery functions can be uncertain, particularly when hydromorphological changes alter habitat connectivity. We evaluated a restored saltmarsh in the Mondego Estuary (Portugal) using a before–after control–impact (BACI) design. This involved comparing a control basin with a nearby restoration basin (modified with a wooden palisade at the inlet to reduce water flow and increase internal residence time), and transplanting *Spartina maritima* and *Bolboschoenus maritimus* into the basin. Fish were sampled at ebbing tide using fyke nets at basin entrances; individuals were identified, counted, and measured before release. Baseline sampling revealed the highest taxonomic richness (nine taxa) and abundance, with assemblages dominated by Mugilidae (notably *Liza aurata*) and a strong presence of small size classes, indicating significant juvenile use, including commercially important species such as European seabass (*Dicentrarchus labrax*) and flatfishes (particularly *Platichthys flesus*). Results indicate that immediately after palisade installation, fish richness and abundance declined in the restored basin relative to the control, suggesting a short-term disturbance and/or partial barrier effect. Nevertheless, juveniles of dominant species, particularly *L. aurata*, continued to use both basins, and subsequent campaigns indicate partial recovery and convergence of assemblage structure towards the control site. Additional observations through 2026, following multiple storm events, showed that the restored setup remained intact, confirming its physical durability. These findings suggest that, despite a temporary cost in nursery use, the implemented Nature-based Solutions can maintain medium-term nursery function while enhancing the physical resilience of saltmarsh habitat to sea-level rise.

PAM for MPA monitoring: listening for noise pollution and illegal boat incursions (S3-PC-09)

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Marine Protected Areas (MPAs) are key tools for the conservation of marine ecosystems and biodiversity. Effective management plans are essential to balance conservation goals with the needs of local communities. Anthropogenic noise is increasingly recognized as a significant pollutant and should be incorporated into management planning. Within the Marine Strategy Framework Directive (MSFD), it is specifically addressed through Descriptor 11 for the assessment of Good Environmental Status (GES). Passive Acoustic Monitoring (PAM) provides an effective method for characterizing marine soundscapes and identifying temporal patterns of noise, particularly in ecologically important areas such as MPAs. This study focuses on the Garajau MPA (Madeira), a biodiversity-rich marine park where access is regulated through permits issued by Institute of Forests and Nature Conservation (IFCN). Two autonomous acoustic recorders were deployed: one in a high-use diving area (Garajau) and one in a less visited site (Arena). Data were collected over four months (October 2023–January 2024), with a 10 min on / 10 min off duty cycle and a sampling rate of 48 kHz. Vessel noise was analyzed and classified based on spectral characteristics, while diver presence events were also identified. The analysis revealed temporal patterns of anthropogenic noise at both daily and weekly scales, highlighting periods of increased acoustic pressure on the ecosystem. Acoustic signatures, combined with a propagation loss model, were used to estimate vessel distance from the hydrophones, allowing differentiation between events occurring inside and outside MPA boundaries. Detected vessel events within the MPA were cross-referenced with permit data, providing insights into the proportion of authorized versus potentially illegal activities. Overall, PAM proved to be an effective tool for characterizing the soundscape, quantifying anthropogenic noise, and evaluating management effectiveness. The results support MSFD monitoring objectives and demonstrate the potential of PAM as a decision-support tool for MPA management.

Persistent angelshark *Squatina squatina* presence in the IUCN Cardigan-Caernarfon Bay Important Shark and Ray Area, UK (S3-PC-11)

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Extinction risk in sharks threatens to undermine marine ecosystem function, with socio-ecological ramifications likely to be exacerbated by projected environmental change. Effective management requires regional evidence regarding species movement, connectivity, and critical habitat use. Angelsharks *Squatina squatina* are among the most threatened shark species with several historical populations considered extirpated. Notable persistence in both the Canary Islands and Cardigan Bay, UK, therefore presents important conservation opportunities. Here, using baited remote underwater video stations (BRUVS) together with passive environmental DNA (eDNA) sampling in September 2024 and June 2025, we repeatedly detected *S. squatina* between two Special Areas of Conservation (SAC) in Cardigan Bay - Pen Llyn a'r Sarnau SAC and Cardigan Bay SAC. This not only represents the first incidence of BRUVS data supporting eDNA detection for this species in the wild, but is notable for regional *S. squatina* populations for several reasons; 1) the study site may constitute an important habitat area, 2) there is an opportunity to expand SAC coverage and regulations for protection, and 3) fine-scale habitat use remains a knowledge gap despite recent declaration of the wider IUCN Cardigan-Caernarfon Bay Important Shark and Ray Area. Comparison of BRUVS and eDNA results provides both an ecosystem-wide context to angelshark presence, and direct development of optimal place-based monitoring of population status and structure, thereby aligning with regional management programmes to strengthen conservation benefits for *S. squatina*.

From deep-sea exploration to data reuse: building FAIR workflows for marine imaging data (S3-PC-12)

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The deep ocean is the largest biome on our planet, covering 66% of its surface area. This vast area hosts remarkable diversity, provides climate regulation, food resources and biomaterials, all of which support humankind. Yet less than 0.001% of the deep seafloor has been visually observed. Current observation technologies (e.g., ROVs, AUVs) enable the collection of large volumes of data (video and imagery) and metadata (environmental data) during research expeditions. These data have become crucial for characterising and monitoring benthic marine communities across a wide range of seabed habitats and depths. However, marine imaging technologies frequently generate multi-terabyte datasets that require a robust server infrastructure to support data storage and processing. Here, we present the development of a marine imaging data workflow developed within TwinDEEPS, an EU project which aims to advance exploration and observation capacity and increase “big data” management capabilities at CIIMAR (Portugal). Using an oceanographic expedition to the Gorringe Bank as a case study, the workflow addresses key stages of the data lifecycle, including data management planning, collection, image pre-processing quality control, storage and (meta)data preservation compliant with the FAIR data (Findable, Accessible, Interoperable, Reusable) and Open Science principles. Here, we illustrate how data stewardship and international collaboration promote robust workflows and support institutional capacity building, ensuring marine imaging data remains usable and accessible beyond the lifespan of the projects. We discuss current gaps and practical challenges associated with image collection, pre-processing and long-term storage and reusability when dealing with large datasets. Endorsed by the Ocean Decade, TwinDEEPS is actively contributing to Ocean Decade Challenge 8, supporting interoperability of the data collected, capacity-building development, and free access to ocean data, improving our knowledge of the deep ocean.

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First Assessment of Coastal Social-Ecological Conditions Using the Conservation and Human Use Index (CHUI) Across Ten European Case Studies (S3-PC-13)

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Social-Ecological Systems (SEs) are shaped by complex interactions between natural processes, governance structures, environmental pressures, and human perceptions. To evaluate these multidimensional dynamics in diverse transboundary coastal areas, this study presents the first application of the Conservation & Human Use Index (CHUI) across ten case studies representing contrasting ecological, institutional, and socio-cultural contexts. The CHUI, grounded in the Social-Ecological Systems Framework (SESF), operationalises system performance through 134 standardised indicators spanning four equally weighted dimensions: Resource System, Environment, Governance, and Actors. Indicators were identified by scientific literature, management documents, and cross-stakeholder consultations, enabling qualitative insights to be translated into semi-quantitative metrics through a harmonised scoring protocol. Results reveal marked variation among the identified case studies, reflecting distinct combinations of ecological conditions, exposure to anthropogenic and climatic pressures, governance effectiveness, and the quality of human-nature relations. Overall, the first CHUI assessment results demonstrate the tool's effectiveness as both a diagnostic framework and a comparative platform for identifying leverage points, guiding adaptive governance, and supporting integrated coastal management. It highlights the importance of balancing ecological protection, institutional strength, and socially legitimate processes to enhance resilience across coastal SEs.

Restoring Mediterranean Macroalgal Forests: Improvement of In Situ Cultivation Methods for *Cystoseira s.l.* species (S3-PC-15)

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In the Mediterranean Sea, canopy-forming brown algae of the genus *Cystoseira* sensu lato form dense marine forests on rocky shores. These biodiversity-rich habitats support

high productivity and provide important ecosystem functions, but are declining across the region due to multiple anthropogenic pressures. Because natural recovery is limited by fragmented populations, short dispersal capacity of the species and herbivory, active restoration is often needed. Restoration of canopy-forming brown algal forests often relies on transplantation, which requires the production of large numbers of individuals for outplanting. For active restoration to be feasible at larger scales, cultivation methods must be simple, low-cost, and efficient in terms of time and labor. In this study, we evaluated different in situ and hybrid cultivation approaches for *Gongolaria barbata*. Field trials tested two direct seeding techniques on natural rocky substrate: (i) bags containing fertile apical parts tied horizontally to the rock, and (ii) bottomless containers used to release zygotes onto cleaned surfaces. Both methods performed well under calm sea conditions, but strong hydrodynamic forces could cause failure of the bottomless container technique. The bottomless container method was more time-efficient and enabled seeding of larger areas at once, whereas the tied-bag method resulted in higher recruit density and proved more reliable at exposed sites. Once recruits from both seeding trials were successfully established and protected from herbivory, growth in situ was markedly faster than in mesocosms or land-based systems. The main threats to early recruits in the sea were grazing pressure and extreme weather events. Building on these findings, we tested (iii) a hybrid approach combining ex situ seeding in an open system with transfer to the sea after several months, when seedlings had reached 3–5 cm in length. This method produced the best results, as it combined the benefits of natural seawater conditions with protection from grazing and physical disturbance during the earliest developmental stages. After one year, numerous healthy *G. barbata* individuals with fertile receptacles were growing on a sandstone slab, and the largest thalli exceeded 50 cm in height. Overall, these findings suggest that successful restoration is often best achieved by working with natural processes and favoring simple, robust methods over more complex interventions.

Environmental Monitoring at Sea Under Pressure: Ensuring Ecosystem Safety Amid Methodological Gaps, Data Uncertainty, and Offshore Expansion (S3-PC-16)

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Sustainable offshore development in the Baltic Sea depends on robust, integrated environmental monitoring capable of capturing ecological variability and supporting informed decision-making. As human activities intensify, particularly in a semi-enclosed and sensitive basin such as the Baltic, environmental assessments require not only

multidisciplinary data but also a clear understanding of the operational and methodological limitations that shape those data. This paper examines the practical challenges encountered during multi-season marine monitoring programs, focusing on how these challenges affect ecosystem protection and the reliability of Environmental Impact Assessments (EIA). Ensuring continuity of long-term measurements remains one of the most significant obstacles. Equipment loss, drifting buoys, anchor failure, collisions with undocumented seabed objects, vessel downtime, and highly variable weather conditions often disrupt monitoring campaigns and create data gaps. Such interruptions can reduce the accuracy of baseline characterizations and weaken assessments of seasonal processes critical for ecosystem functioning. Methodological inconsistencies present an additional challenge. Differences in habitat classification criteria, species sensitivity evaluation, or hydrodynamic data interpretation may lead to divergent conclusions about ecological status and potential impacts. These discrepancies complicate cumulative effects assessment — an essential component for safeguarding marine biodiversity under increasing spatial pressures. Efforts to standardize methodologies and synchronize seasonal surveys have shown promise in improving data comparability and reducing uncertainty. However, experience demonstrates that true standardization is still evolving, requiring continued collaboration among scientists, regulators, and offshore operators. Overall, integrated monitoring must balance scientific rigor with operational realities. Recognizing and transparently addressing these limitations is essential to ensure that environmental data genuinely supports the sustainable management and long-term resilience of the Baltic Sea ecosystem.

The impacts of coastal defense systems on *Caretta caretta* nesting sites (S3-PC-17)

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The intensification of coastal erosion in the Mediterranean basin poses critical challenges for the conservation of the sea turtle *Caretta caretta*. This is due to the increasing prevalence of defense works protecting infrastructure and shorelines, which can interfere with the availability of nesting sites. This paper aims to analyze how different types of coastal defenses—from hard structures to soft protection systems—directly influence the various stages leading to reproductive success, starting from the nesting female's emergence onto the beach. This contribution is part of the LIFE Turtlenest project (LIFE21-NAT-IT-LIFE TURTLENEST), which includes among its objectives the development of “Guidelines on management of coastal erosion to sustain nesting habitat suitability.” The analysis highlights that hard coastal defenses (such as seawalls or

revetments), built to protect infrastructure or urbanized backshore areas, act as insurmountable vertical barriers for the species, leading to beach narrowing and physical habitat loss. Similarly, offshore breakwaters act as obstacles for females attempting to reach nesting sites and alter the migration routes of hatchlings trying to reach the open sea after emergence. Even "soft" solutions like beach nourishment, while intended to maintain the shoreline and beach width, can alter the physical parameters of the site if not properly designed. Changes in grain size, slope, and sand compaction can inhibit nest excavation or compromise embryonic development by altering the thermal incubation regime or nest oxygenation. These Guidelines are designed as an operational tool for local administrators, aiming to integrate erosion management with "turtle-friendly" criteria, prioritizing solutions that protect the coastline without compromising the suitability of nesting habitats.

Operationalizing OECMs in Marine Spatial Planning: Evidence from Italy (S3-PC-18)

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Italy hosts ecologically valuable marine and coastal ecosystems that provide essential services and support locally rooted socio-economic activities such as fisheries, tourism, and maritime transport. In this context, expanding Marine Protected Areas (MPAs) can be challenging, as management restrictions may be difficult to reconcile with existing uses. Other Effective area-based Conservation Measures (OECMs) offer a complementary and more realistic instrument, balancing biodiversity conservation with sustainable human activities. According to Decision 14/8 of the Convention on Biological Diversity (CBD), OECMs are areas not formally protected but effectively governed and managed to ensure long-term in situ biodiversity conservation while supporting ecosystem services and local values. The International Union for Conservation of Nature (IUCN) has developed guidance to support countries in identifying OECMs through a site-level process, with all relevant actors engaged in later stages to ensure a participatory approach aligned with the OECM definition. This eventually leads to the identification of sites eligible for reporting in the World Database on Protected Areas (WDPA). Despite this guidance, the practical implementation of OECMs in Europe remains limited and poorly integrated into Marine Spatial Planning (MSP), and Italy has not yet reported any OECMs. In an effort to address this gap, this study aims to identify potential OECMs in Italian seas and explore their integration within the existing conservation network. Regional expert groups are systematically identifying and assessing potential sites using

a Multi-Criteria Decision Analysis (MCDA) tool developed within the MarinePlan (HORIZON-CL6-2021-BIODIV-01-12) project. The tool translates CBD/IUCN frameworks into a structured workflow that guides users through scored questions. Scores are weighted by expert confidence, reflecting the quantity and quality of available evidence. These are aggregated into a composite index (0-100) to support transparent and comparable site prioritization. To our knowledge, this work represents the first national-scale effort to operationalize OECM assessment. It provides a preliminary, science-based screening to start the identification process and highlight areas of conservation relevance and/or critical data gaps. The tool is adaptable across contexts, including both marine and terrestrial environments, providing a scalable solution to accelerate OECM implementation in Europe. By offering a consistent, transparent, and replicable methodology, this approach can strengthen MSP and facilitate the integration of OECMs into existing conservation frameworks such as MPAs and Natura 2000, contributing to EU biodiversity targets, including 30x30.

Applying Social Ecological Systems Frameworks to Insular Marine Ecosystems: Research Trends and Management Implications (S3-PC-19)

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The management of marine ecosystems requires a multi-disciplinary approach to understand the cultural and socio-economic context, the state and dynamics of the habitats and species, as well as the interactions between humans and nature. The social-ecological system (SES) concept, theorized by Berkes and Folke in 1998, integrates humans and nature into a single system and relies on various research fields. Multiple frameworks based on this concept assess elements of the system: social, political, and economic settings, resource units and systems, governance, users, their links and outcomes. Islands are good models for investigating the relationships between the subsystems of the SES, given the importance of the marine ecosystem to their inhabitants' livelihoods, and its fragility under increasing pressures. However, research on insular SES represents only 12.7% of the studies conducted on marine and/or coastal SES. This literature review explores the application of SES-related frameworks in insular marine settings. We extract metadata from 78 peer-reviewed papers from 2 databases

across five categories: 1) general information (date and location of the study), 2) main objective(s), 3) targeted SES element (or relationship), 4) framework applied, and 5) data source (type of literature reviewed and/or stakeholder interviewed). We used descriptive statistics and geographic information system tools to analyse and visualize the trends in the review. Heatmap analysis of the spatial distribution of studies revealed clear research clusters, while several regions, including the North Atlantic, remain underrepresented. Our results showed that most studies focus on one specific element of the SES rather than investigating the ecosystem as a whole, and that fisheries and tourism are the main elements covered. Several SES-related frameworks are presented, with each having its own objectives, advantages, and limitations. Most studies rely on data gathered from stakeholders, but the category interviewed varies depending on the topic and framework. Several papers highlight the different knowledge and perceptions of each category of stakeholders. Our review provides a basis to identify geographical and thematic research gaps in the application of SES frameworks in islands.

AURORA Shiny App – Converting Raw Biodiversity Data into Darwin Core Archives (S3-PC-21)

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Biodiversity monitoring data are often stored in diverse and inconsistent structures, making standardisation, validation, and publication through public databases challenging. Before submitting to global repositories such as GBIF and OBIS, researchers must overcome several technical constraints, including complex event structures, taxonomic ambiguities, and geospatial inaccuracies, to ensure data quality and interoperability. In response to these issues, we developed an online application based on R Shiny that offers a comprehensive and user-friendly workflow for converting unstructured biodiversity data into standardised Darwin Core Archives (DwC-A) ready for publication. Data may be ingested in diverse tabular formats, allowing users to convert raw datasets into tidy structures. An interactive Graphical User Interface supports the mapping of user-defined fields to Darwin Core terms, joining manual selection with automated suggestions. The tool automates the data cleaning process, performing key tasks including validation of required terms, date standardisation (ISO 8601), duplicate detection, and validation and transformation of coordinates to the WGS84. Integrated API calls to the WoRMS and

GBIF Backbone Taxonomies ensure taxonomic validation, enabling users to select the most suitable reference system, depending on whether their datasets are marine or terrestrial. The workflow allows the conversion of flat tables into key Darwin Core tables, generating Event, Occurrence, and Extended Measurement or Fact (eMoF) tables, followed by a quality-control module assessing data completeness and flagging missing key fields. The final output of the workflow consists of standards-compliant Darwin Core tables, paired with structured metadata, allowing for a DwC-A to be built and published in accordance with FAIR (Findable, Accessible, Interoperable, and Reusable) principles. By consolidating these labor-intensive tasks into an integrated and intuitive interface, this application significantly mitigates the technical challenges that hinder biodiversity data mobilisation and global sharing. Accessible to the public through a web browser, the application requires only an internet connection to be used.

Optimizing light intensity and quality for *Laminaria ochroleuca* (Laminariales, Phaeophyta) cultivation to support kelp forest restoration along the Portuguese coast (S3-PC-22)

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Kelp forests are foundational components of temperate marine ecosystems, supporting high biodiversity and providing valuable ecosystem services. However, these habitats are increasingly threatened by anthropogenic pressures and climatic change, highlighting the need for efficient and cost-effective reforestation strategies. Improving early developmental stages in nursery conditions is critical to enhance the success and scalability of kelp reforestation efforts. This study aimed to optimise light quality and intensity to enhance sporophyte development and growth of *Laminaria ochroleuca*, accelerating the nursery phase for restoration applications. Established gametophyte cultures were subjected to an initial 17-day induction phase under either blue light (460 nm) or red-light (630 nm), at $15 \mu\text{mol m}^{-2} \text{s}^{-1}$ and 14°C . Following induction, cultures were homogenised and seeded onto polyester lines ($\varnothing$ 2mm) wrapped around cylindric spools using two spraying methods: an electrical spray-painter and a manual sprayer. Seeded spool lines were then distributed across four cultivation tanks. Cultures initially induced under red light were subsequently exposed to blue light for 20 days (increasing from 15 to $25 \mu\text{mol m}^{-2} \text{s}^{-1}$), followed by white light (increasing from 40 to $60 \mu\text{mol m}^{-2} \text{s}^{-1}$). In contrast, cultures induced under blue light were maintained under white light throughout the experimental period, following similar light intensity increments. Photoperiod was set

at 12:12 h. After two weeks, blue light induced cultures showed significantly higher substrate coverage (72.8 %) compared to red-light treatments (18.2 %), as well as greater sporophyte size (3.17 mm vs 0.80 mm). After 30 days, this trend persisted, with higher coverage (92.05 % vs 78.69 %) and sporophyte length (6.17 mm vs 2.65 mm) in blue-light induced cultures. Spraying method and culture age had no significant effect. These results demonstrate that an initial blue light induction phase significantly enhances early development and growth of *L. ochroleuca* sporophytes. Implementing this step on nursery protocols can shorten production cycles, reduce maintenance costs, and improve the efficiency and scalability of future kelp forest reforestation efforts along the Portuguese coast.

CoastNet infrastructure: an environmental quality data repository to support the management of the Portuguese coastal area. (S3-PC-23)

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The CoastNet – Portuguese Coastal Monitoring Network is a research infrastructure designed to improve the understanding of Portuguese coastal ecosystems' functioning through the development of a coastal monitoring system. CoastNet provides continuous records of different physicochemical parameters measured in transitional systems such as the Mondego, Tagus and Mira estuaries using fixed stations equipped with multiparameter probes since 2019. These stations register data on key physicochemical parameters, including chlorophyll a, temperature, salinity, pH, turbidity and dissolved oxygen, collected every 15 minutes, providing a robust dataset for assessing environmental variability and impacts of climate change, offering an important tool for coastal management. CoastNet offers both near real-time data and quality-controlled data series. Near real-time data are updated every 6 hours and made immediately available, supporting short-term analyses. In contrast, validated datasets are released approximately every three months, presenting data processed for quality control, ideal for long-term studies. All data are accessible through the CoastNet geoportal, which enables visualization and download in CSV format. In addition to *in situ* measurements, the geoportal integrates historical datasets covering biological communities and

environmental parameters, allowing comparisons across temporal and spatial scales. The infrastructure is expected to expand to additional coastal systems, further enhancing its role as a comprehensive tool for environmental monitoring, research and informed decision-making in coastal management.

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Impact of marine heatwave on the condition and quality of *Magallana gigas* (Thunberg, 1793) oysters (S4-PC-01)

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In the current scenario of climate change, it is expected a reduction in bivalve production. While oyster aquaculture can play an important role in mitigating the negative impacts of climate change, oysters' growth and nutritional value can still be affected by temperature variations near thermal thresholds in both short- and long-term. In this study, we hypothesised that extreme weather events, such as marine heatwaves (MHW), would reduce oysters' quality and market value. To evaluate such an effect, *Magallana gigas* juveniles were exposed to a MHW of up to 6 °C above ambient temperature. The impact of MHW was evaluated on oyster condition index (CI) and soft body texture profile. After acclimation, juvenile oysters (5.11 ± 0.04 g) were exposed to a simulation of a twenty-day MHW. During the simulated MHW, the oysters were subject to a temperature increase of 6 °C (18 °C to 24 °C) for five days, followed by a ten-day plateau of high temperature (24 °C) and a temperature decrease of 6 °C for five days (24 °C to 18 °C). During the trial, oysters were fed with a mixture of microalgae in a proportion of 10% of the oysters' average dry weight. Changes in oysters' weight, condition (CI and AFNOR index, I_{AFNOR}) and soft body texture (hardness, resilience, cohesiveness, springness, adhesiveness, gumminess and chewiness) were monitored before, during and after exposure to the MHW and compared with a control group maintained at ambient temperature (18 °C). Despite the increasing trend in body weight, the condition of oysters under MHW conditions decreased significantly ($p = 0.001$). This decrease in body condition was particularly evident by the end of the heatwave simulation, when oysters subject to MHW presented an I_{AFNOR} of 11.9 ± 1.7 , significantly ($p < 0.001$) lower

than the control group ($I_{AFNOR} = 16.7 \pm 1.4$). Regarding the texture profile, MHW conditions affected oysters' soft body resilience (the sample recovery from deformation), gumminess (the energy required to masticate the sample) and chewiness (how much work is required to chew the sample). These results indicate that the heat stress conditions caused by an MHW have a significant impact on juvenile condition and overall quality of the soft body. Increasing environmental temperatures and consequent thermal stress lead to a higher metabolic demand, reducing the energy available for growth and energy storage. This will reduce the overall physiologic condition of oysters, growth rates, and the opportunity to store energy. Moreover, the changes observed in the textural properties of oysters' soft body suggest underlying changes in tissue structure (e.g. changes in structural protein content or cellular membrane phospholipid content) induced by thermal stress. Future steps will replicate this preliminary study in commercial-size oysters, adding histologic and structural analysis of mantle tissue, as well as quantitative analysis of protein content, lipidic profile and other energy reserves.

Otolith Contour Analysis to Discriminate Between Wild and Farmed European Sea Bass (*Dicentrarchus labrax*) (S4-PC-03)

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The European seabass (*Dicentrarchus labrax*) represents a cornerstone of European marine fisheries and aquaculture. However, the rapid growth of the aquaculture sector has increased the prevalence of escape events, leading to potential ecological impacts, stock overestimation, and market mislabeling. Given the socioeconomic importance of the species, developing robust traceability tools is critical for economic transparency and fisheries management. In this study, we evaluated the efficacy of otolith contour analysis as a diagnostic tool for origin classification. A total of 73 seabass (44 wild and 29 farmed) were sampled from Lagos, Southern Portugal. The contours of the left sagittae otoliths were analyzed using both Elliptical Fourier Descriptors (EFD) and Wavelet Transformations (WT) within the R package *ShapeR*. The extracted coefficients were subsequently subjected to multivariate statistical analyses, and reclassification accuracy was assessed using jackknife cross-validation. Significant differences in otolith shape were detected between wild and farmed fish, with EFD achieving correct reclassification

rates of 93% and 86% for wild and farmed otoliths, respectively, whereas WT yielded rates of 89% and 72%. These morphometric variations likely reflect the accelerated growth rates and high-density rearing conditions of farmed fish compared to wild conspecifics. Our findings support the use of EFD-based otolith contour analysis as a powerful, cost-effective tool for discriminating between wild and farmed *D. labrax*, enhancing fisheries inspection and the monitoring of aquaculture escapees.

Improving Norway lobster management through functional unit delimitation in the northwestern Mediterranean Sea (S4-PC-04)

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The Norway lobster (*Nephrops norvegicus*) is a commercially important benthic crustacean distributed across the northeast Atlantic Ocean and the Mediterranean Sea, where it has historically been subjected to strong fishing pressure. In the Mediterranean Sea, the species is currently classified as overfished, with management advice recommending substantial catch reductions. However, stock assessment and management are conducted at the scale of geographical subareas (GSAs) which may not reflect the species' underlying population structure. In contrast, in the northeast Atlantic Ocean Norway lobster is assessed and managed at the scale of functional units, defined by the species' spatial distribution in discrete patches of muddy substrate. While this approach has proven effective in the Atlantic Ocean, its applicability to the Mediterranean context remains largely unexplored. In this study, we used a Lagrangian particle transport model to simulate ten years of Norway lobster larval release and settlement within the northwestern Mediterranean Sea, in order to understand connectivity patterns and identify potential stock delimitation boundaries for the species in the area. Using effective connectivity between release and settlement locations, we identified spatial clusters that may represent biologically meaningful units for the species, analogous to functional units in the Atlantic Ocean. Our results suggest that a finer spatial subdivision of GSAs 5, 6 and 7 into connectivity-informed units could provide a more realistic representation of stock structure and support improved assessment and fisheries management for Norway lobster in the area. Together with previous studies in the Adriatic Sea, these results offer a starting point for a Mediterranean Sea wide re-

evaluation of Norway lobster management into biologically-informed functional units that could help improve the status of the stock and its assessment, and in turn support a long-term sustainable and resilient fishery.

Carbon fluxes in suspended shellfish aquaculture: developing an integrated metabolic assessment for bivalves and associated fouling communities (S4-PC-05)

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An accurate assessment of the ecological footprint of shellfish aquaculture requires quantifying carbon fluxes not only from the target species but also from the entire biological system associated with production structures. In suspended longline systems, aquaculture lanterns accumulate diverse fouling communities — dominated by mussels, macroalgae and invertebrates — whose metabolic activity may substantially change local carbon dynamics through photosynthesis, respiration, and biogenic calcification. This study puts forward the development and validation of an integrated incubation system to quantify carbon fluxes across two biological components of offshore bivalve aquaculture: the target species *Venerupis corrugata* (grooved carpet shell) and the fouling community colonising the culture structures. Specimens were incubated in temperature-controlled chambers to develop calcification and respiration protocols and wet-to-dry biomass conversion factors. To analyse the biological community as a whole, we designed and tested a sealed incubation system using a 500 L tank, capable of housing an aquaculture lantern (80 × 42 × 42 cm), integrating simultaneous measurements of dissolved oxygen, total alkalinity, dissolved inorganic carbon, and nutrients. This approach allows independent evaluation of organic (net community production) and inorganic carbon fluxes (calcification), with alkalinity measurements corrected for nutrient dynamics. The system was applied across three light regimes — high irradiance, intermediate irradiance, and darkness — using replicate lanterns to characterise community metabolism under contrasting conditions. Together, these tools establish a replicable measurement system capable of showing ecologically meaningful metabolic signals at the practical scale of aquaculture infrastructure. By measuring all biological components in the system, we obtain a comprehensive picture of the carbon footprint of suspended bivalve aquaculture, with implications on the assessment of ecosystem services and carbon accounting in coastal production systems.

Metabarcoding-based assessment of marine macrozoobenthos in an offshore Integrated Multi-Trophic Aquaculture (IMTA) system in Southern Portugal (S4-PC-06)

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The implementation of DNA metabarcoding for biodiversity assessment has increased significantly in recent years. In this study, we used DNA metabarcoding to characterize benthic macroinvertebrate (BMI) communities and evaluate the bioremediation potential of an offshore Integrated Multi-Trophic Aquaculture (IMTA) system, in southern Portugal. IMTA is an aquaculture framework that promotes sustainability where byproducts and waste from one species serve as nutritional inputs for another. Sediment samples were collected before and after IMTA implementation at 12 sites (~30 m depth), both inside and outside the system, approximately 8 km offshore. Three molecular markers (mitochondrial COI and 16S, and nuclear 18S V4) were targeted to ensure a comprehensive assessment of species diversity. A customized bioinformatic pipeline was used for read-processing and taxonomic assignment. Subsequent analyses included the derivation of biotic indexes, e.g., AMBI, and the assessment of community assemblages. DNA metabarcoding recovered more than 200 BMI species, representing 14 phyla, 27 classes, 63 orders, 133 families, and 180 genera. Around 75% of the species-level diversity was represented by Annelida, Arthropoda, and Mollusca, respectively. Taxonomic distinctiveness was found relatively stable throughout sampling events and sites. Only recovered BMI diversity from second and third sampling were found slightly lower than expected. Even though an increased proportion of more opportunistic and tolerant species to organic enrichment was observed, the presence of sensitive species was stable, resulting in low-but-relevant AMBI index variation throughout the sampling period. Samples were classified as non-disturbed (sampling 1 and 4) and slightly disturbed (sampling 2, 3, and 5), with sensitive taxa dominating most sites. A higher proportion of opportunistic species was observed in five sites, all located within the IMTA cage system.

Temporal Changes and Stability of *Lophius* Nursery Grounds in the Northeastern Atlantic Ocean (S4-PC-07)

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Understanding the spatial and temporal dynamics of nursery habitats is essential for managing commercially important demersal species. This study examines changes in nursery grounds of *Lophius budegassa* and *Lophius piscatorius* in a Northeastern Atlantic region using georeferenced abundance data from IEO-CSIC DESCARSEL and DEMERSALES bottom-trawl surveys (2018–2025). These soft-bottom surveys yielded a robust dataset: 1049 hauls covering 83,411 km². Juvenile abundance (≤ 20 cm TL [1]) was processed biennially and converted into 1-km² density indices. Results show substantial temporal change, with maximum juvenile densities increasing nearly ten-fold. Early biennia exhibited very low values, whereas recent periods displayed markedly higher densities, suggesting shifts in habitat use or availability. After standardizing spatial coverage, a persistence analysis identified stable nursery areas, with the highest persistence occurring off the Galician rías area, particularly during the last four years. A spatio-temporal evolution analysis revealed a strong southward intensification of nursery habitat, alongside a more diffuse increase in the western sector. These patterns suggest that environmental or ecological changes likely influenced juvenile habitat suitability, potentially linked to oceanographic variability, prey distribution, or broader climatic forcing. Observed shifts highlight the need for continued monitoring and integration of environmental information to better understand mechanisms driving nursery-habitat dynamics. Identifying persistent and emerging nursery areas is crucial for ecosystem-based fisheries management, especially for species with complex life histories such as *Lophius*. Future work should incorporate environmental predictors, high-resolution oceanographic models, and longer time series to improve understanding of habitat drivers and support more effective spatial management and sustainable exploitation.

Reference

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Insights into the reproductive biology of the spotted ray *Raja montagui* from the Portuguese coast (S4-PC-09)

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The spotted ray (*Raja montagui*) is a common demersal species and an important component of mixed fisheries along the Portuguese coast. This study provides new insights into the reproductive biology of the species, namely on the size-at-maturity, reproductive season and fecundity. A total of 1411 specimens were analyzed, comprising 875 females and 536 males, collected between 2003 and 2023, from commercial landings in Peniche and Matosinhos, and from IPMA research surveys. Total length (T_L) ranged from 12.7 to 71.1 cm for females and from 21.3 to 69.7 cm for males, with the majority measuring between 50 and 60 cm T_L . The smallest mature female measured 49.6 cm T_L and the largest 70.2 cm T_L , whereas the smallest and largest mature males measured 46.7 cm and 69.7 cm T_L , respectively. The reproductive season was inferred based on fluctuations of the gonadosomatic index (GSI) and the proportion of reproductively active individuals. Results determined that the species reproduces from late winter to early summer, with an egg-laying peak between May and June. Males were capable of reproduce almost all year, with highest proportions of active males observed in April, June and August. The potential fecundity was estimated at 69 follicles female⁻¹ year⁻¹, based on the maximum number of yolked follicles (≥ 7 mm) recorded in mature females. Overall, these findings contribute to a better understanding of the species' life-history traits and strengthen the scientific basis for current management measures, supporting future conservation and management actions for skate species in Portuguese waters. In particular, size-at-maturity estimates indicate that the current Minimum Conservation Reference Size (60 cm T_L) effectively protects reproductively active individuals, allowing a substantial proportion of the population to reproduce before being exposed to fishing pressure. In addition, the estimated reproductive season overlaps with the May-June seasonal fishery closure implemented for all Rajidae species, contributing to the protection of adult individuals, enhancing recruitment, and supporting stock recovery, thereby promoting the long-term sustainability of both fish populations and fisheries.

From the ocean to our table: mercury in fish and seafood (S4-PC-10)

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Fish and seafood consumption is widely recognized for its nutritional value and health benefits; nevertheless, it also represents one of the main pathways for human exposure to the neurotoxic mercury (Hg). Due to the potential adverse human health effects, international agencies have established Reference Doses (RfD) as recommendations concerning Hg intake. In this sense, the project “Can I eat this fish? – Dietary recommendations to reduce the mercury risk exposure” funded by OHMI aims to evaluate fish consumption habits, and potential Hg transfer and associated risks to human health as well as and to develop and share tools with simple and precise language that will contribute to an informed decisions on the consumption of fish/seafood involving not only decision makers and but also the target population. First, food frequency questionnaires were made available online to identify the main fish and seafood species consumed in Portugal. Then, focusing on the obtained list and fish landing data, commercially relevant fish and seafood species were purchased in local markets and supermarkets. Muscle tissues of 18 species were analysed for Hg content using atomic absorption spectrometry. Data were analysed to explore potential relationships between Hg levels, species lifestyle (demersal or pelagic) and trophic levels (omnivorous or carnivorous). Based on estimated weekly intake (EWI) and target hazard quotients (THQ) values, potential health risks were identified associated with regular consumption of the axillary seabream *Pagellus acarne*, the black scabbardfish *Aphanopus carbo*, and the blackbelly rosefish *Helicolenus dactylopterus* that may exceed the tolerable limits defined by EFSA, depending on the amount of fish consumed. These findings highlight the importance of continuous monitoring of contaminants in seafood, as well as raising consumer awareness and establishing recommendations for the safe consumption of certain fish species.

Sustainable Feed for Circular Aquaculture: Microencapsulated Phytase for Reducing Phosphorus Discharge (S4-PC-11)

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The expansion of aquaculture has raised environmental concerns, particularly regarding phosphorus discharge and its role in eutrophication in freshwater systems. This study evaluated the use of nanotechnology-derived microencapsulated phytase as a nutritional strategy to improve phosphorus utilization and reduce nutrient release in aquaculture systems for Nilo tilapia (*Oreochromis niloticus*) production. Experimental diets were formulated to meet species-specific nutritional requirements and tested under controlled conditions using a completely randomized design. Treatments included phytase delivered via coating and extrusion, alongside control diets without enzyme supplementation. Fish were reared in replicated aquaria, and water quality was monitored through high-frequency sampling at multiple time points before and after feeding. Total phosphorus concentrations were determined using standard colorimetric methods. Results showed that phytase supplementation significantly reduced phosphorus release into the water, with reductions up to 40% compared with conventional diets without enzyme inclusion. The coating method preserved enzymatic activity more effectively than extrusion, resulting in improved phosphorus digestibility and enhanced nutrient retention. Additionally, diets supplemented with microencapsulated phytase showed greater nutrient utilization efficiency, thereby reducing environmental loading. These findings highlight the importance of enzyme stabilization technologies in aquafeed processing and reinforce the role of precision nutrition strategies in mitigating environmental externalities in aquaculture. The integration of microencapsulated phytase represents a promising eco-friendly innovation that contributes to sustainable fish production, improved water quality, and the advancement of environmentally responsible and sustainable aquaculture practices.

A Framework for Advancing Sustainable Food Production through Aquaculture and Bioeconomy Startups (S4-PC-12)

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Aquaculture is one of the fastest-growing sustainable food production sectors globally and plays a strategic role in food security and sustainable development. However, its expansion depends on the continuous incorporation of technological innovation, particularly through science-based startups (deep techs) capable of transforming academic knowledge into scalable solutions. Despite this potential, these companies face challenges related to technological maturity, market entry, and a lack of acceleration methodologies tailored to the aquaculture sector's specific needs. In this context, this study presents and validates the Startup Agile Assessment Aquaculture (SAA-Aqua) methodology, an innovative framework that integrates agile approaches with maturity assessment tools to diagnose and manage aquaculture and bioeconomy startups. This methodology is structured into four stages: collection of primary and secondary data through interviews and semi-structured questionnaires; diagnosis based on a Maturity Analysis Matrix, which classifies startups into four levels (Ideation, Validation, Operation, and Scale); development of customized solutions and mentoring processes; and generation of visual reports to support decision-making. The study was conducted over 12 months using a mixed-methods approach, including mapping 50 Brazilian aquaculture startups, 17 of which participated in the pilot application. The results reveal an emerging ecosystem of aquaculture deep techs in Brazil with high innovative potential (score 5), in which human capital—characterized by high levels of education and strong scientific output—stands out as the main asset. However, technical excellence alone does not translate into market readiness, reinforcing the need for integrated frameworks that connect technological development with business maturity. The application of SAA-Aqua demonstrated its effectiveness as an adaptive system with incremental guidance (95%), proving superior to traditional linear models, as evidenced by high participant satisfaction and observed increases in maturity levels (78%). The framework reduces uncertainties associated with the “valley of death”, highlighting that, given the biological and regulatory cycles inherent to the sector, continuous institutional support of at least six months is essential to ensure technological maturation, business sustainability, and the strengthening of technological sovereignty in national and international markets.

Beyond food production: ecosystem services associated with freshwater fish farming (S4-PC-14)

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Freshwater fish farming is traditionally associated with fish provision, while other potential benefits of production systems remain poorly recognized. These benefits can be interpreted from the perspective of ecosystem services, whose investigation in aquaculture has focused predominantly on marine and coastal environments, whereas inland fish farming remains poorly explored. In addition, the available studies employ heterogeneous terminologies and classification approaches, hindering the comparison of results and the incorporation of these services into management and sustainable production strategies. In this context, the present study aimed to conduct a systematic literature review on the ecosystem services associated with freshwater fish farming and to reclassify the identified services based on the Common International Classification of Ecosystem Services (CICES v5.2). The review covered studies published between 2015 and 2025 in the Web of Science database. A total of 18 studies met the inclusion criteria, including five review papers and thirteen original studies. The review papers were used to contextualize the state of the art and identify recurring gaps, whereas the original studies supported the reclassification of ecosystem services. The identified services were categorized according to CICES, allowing different terminologies to be grouped within a standardized and comparable framework. The reclassification resulted in 224 occurrences of ecosystem services distributed across 34 classes. Regulation and maintenance services accounted for the largest proportion of records (44.64%), followed by cultural services (33.93%) and provisioning services (21.43%). The most frequently reported services included habitat maintenance and breeding areas, nutrient retention, hydrological regulation and water quality regulation, as well as recreation, environmental education, and scientific knowledge generation. The results demonstrate that freshwater fish farming should not be understood solely as a food production activity, but rather as a multifunctional socioecological system. The use of CICES proved useful in reducing terminological ambiguities and increasing comparability among studies. By supporting

the identification and standardization of ecosystem services, this approach may also subsidize ecosystem-based management strategies.

Trap-based monitoring of the blue crab, *Callinectes sapidus* in small coastal river in Montenegro (South Adriatic Sea) (S4-PC-15)

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Within the GFCM blue crab research programme, six trap surveys were carried out from February to December 2024 in small Sutorina river, about 9 km long located in Herceg Novi Municipality in north-western Montenegro. The total number of caught blue crabs was 89, of which 27 were females and 62 were males (1:2.3). There was a statistically significant difference between the number of females and males ($\chi^2=13.764$, $P<0.001$) The total CW of all sampled individuals ranged from 64 to 167 mm with a mean value (CW $\pm$ SD) of 130.87 $\pm$ 18.26 mm. The CW of females ranged between 64 and 162 mm (130 $\pm$ 20.82 mm) while the males had range between 93 and 167 mm (131.25 $\pm$ 17.19 mm). Males are outnumbered females in almost all size classes. Among females, 8 were juveniles while 19 were adults. Two males were juveniles and 60 were adults, of which 25 were in maturity stage 2 and 35 males were in maturity stage 3. Bycatch was comprised of European conger, *Conger conger*, species from genus *Gobius* such as *Gobius cobitis* and *Gobius niger*, *Diplodus annularis* and Warty crab, *Eriphia verrucosa*.

Influence of cold stress on pigment composition and physiological parameters in *Cassiopea xamachana* (S4-PC-16)

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Temperature stress has been proven to strongly affect the physiological and metabolic performance of *Cassiopea xamachana*, while its impact on pigment profiles and antioxidant properties in the holobiont remains poorly understood. The objective of this study was to investigate the effects of cold stress on antioxidant formation and pigment concentrations. Medusae were exposed to water at 18 °C, 22 °C, or 26 °C for 14 days. The photosynthetic efficiency (Fv/Fm), bell pulsation rate, and relative growth rate (RGR),

pigment composition, and antioxidant activity (ABTS and TPC) were assessed on day 0, 7, and 14. Fv/Fm values increased in all treatments, ranging from 0.53 ± 0.01 to 0.64 ± 0.04 . Chlorophyll a and peridinin concentrations almost doubled across all temperature treatments over 14 days, indicating enhanced photosynthetic capacity can be triggered. Paired with changes in pigment composition, this indicates that different stressors triggered the formation of antioxidant pigments. RGRs remained negative, with medusae at 18 °C losing, on average, $73.43 \pm 18.43\%$ of wet weight and $24.77 \pm 6.11\%$ of diameter. This confirms that cold stress impairs the physiological performance of *C. xamachana*. ABTS ranged between 82.9 and 98.2 mmol TE 100 g⁻¹ DW, with little to no changes over time. TPC varied between 1.59 ± 0.08 and 2.23 ± 0.31 mg GAE g⁻¹ DW, showing a nonlinear decrease at 22 °C on day 7. It is concluded that chronic cold exposure results in severe stress responses in *C. xamachana*.

Reproductive Dynamics and Energy Reserves in *Spisula solida* (Linnaeus, 1758) from the NW Portuguese Coast: Implications for Fisheries Management (S4-PC-17)

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The white clam *Spisula solida* is the main target species of the artisanal dredge fishery operating along the northwestern coast of Portugal, representing a key resource for the regional economy. This study examines its reproductive cycle during 2019-2020, integrating monthly histological analysis and the Condition Index (CI) as a proxy for somatic condition and energy status. The research was conducted in the Portuguese L3 production zone (Litoral Aveiro), a regulated bivalve harvesting area designated by the Portuguese Institute for Sea and Atmosphere (IPMA). Gonadal development was classified into six maturity stages: sexual resting (Stage 0), early gametogenesis (Stage I), advanced gametogenesis (Stage II), ripe (Stage III), spawning (Stage IV), and post-spawning (Stage V). Overall, the population exhibited a synchronous seasonal reproductive cycle between sexes, driven by seasonal thermal conditions. Gametogenesis (Stages I-II) occurred during autumn-winter at low temperatures, leading to a pronounced spawning peak (Stage IV) in April-May associated with spring warming. This reproductive effort caused a marked depletion of somatic reserves, with CI reaching annual minima in May (4.7 in 2019; 4.9 in 2020), followed by progressive recovery during the summer resting phase (Stage 0). However, inter-annual variations were observed. In June 2019, coinciding with an anomalously cold coastal water regime (the coldest June since 2000), specimens exhibited a precocious increase in gametogenic activity, with combined Stages I-II reaching 62.1%. This temperature oscillation likely acted as a false environmental cue. Occurring immediately after the late-May spawning peak, this

response lacked physiological continuity and was subsequently interrupted. Consequently, in July 2019, the population shifted toward sexual rest (84.6% in Stage 0), while CI increased to a historical maximum of 13.8, indicating rapid recovery of somatic condition. In contrast, the 2020 cycle showed a more linear transition into summer rest, although a secondary spawning event occurred in November-December (Stage IV: 25% and 35% of individuals, respectively). These results highlight the strong coupling between temperature, reproductive timing, and energy allocation in *S. solida*. As the current biological fishery closure in the Portuguese L3 production zone is restricted to May, it does not fully encompass the main spawning period (April-May). We therefore recommend extending the closure period to April-May to better align management with the species' reproductive window and ensure effective protection of the spawning biomass.

Size at First Sexual Maturity of *Spisula solida* (Linnaeus, 1758) from the NW Portuguese Coast: a Biological Benchmark for Fisheries Management (S4-PC-18)

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The size at first sexual maturity is a key biological parameter in fisheries science used to determine when a targeted species begins to contribute to reproduction, with direct implications for population replenishment and recruitment dynamics. It is commonly expressed as L50, corresponding to the length at which 50% of individuals in a population are sexually mature. This information is essential for fisheries management, as it supports the evaluation of whether regulatory measures, particularly the Minimum Conservation Reference Size (MCRS), are appropriate. In general, sustainable management requires that the minimum legal capture size is set at or above L50, ensuring that most individuals have the opportunity to reproduce at least once before entering the fishery. Despite the commercial and ecological importance of the white clam *Spisula solida*, no published study has quantified its L50 to date, highlighting the relevance of the present work, which provides the first estimate for this species. The study was conducted on the northwestern Portuguese coast, where a total of 219 individuals (12–32 mm shell length) were collected in December 2025. Sex and gonadal maturity stages were determined through histological analysis, and individuals were classified as mature when in ripe, spawning, or post-spawning stages. L50 was estimated using logistic regression for males, females, and combined sexes. The results showed very similar values across groups, with L50 around 18 mm shell length (17.8 mm in males, 18.3 mm in females, and 17.9 mm for combined sexes). These values are substantially lower than the Portuguese MCRS of 25 mm shell length, indicating that most individuals can reproduce before reaching the legal capture

size. This suggests that the current regulation is biologically conservative and likely supports reproductive sustainability. Overall, this study provides a quantitative reference for *S. solida* to support future fisheries management and research.

Population structure of the axillary seabream, *Pagellus acarne*, along the mainland Portuguese coast using otolith elemental signatures (S4-PC-19)

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Defining biologically meaningful population units is fundamental for sustainable fisheries management and for safeguarding the long-term persistence of exploited marine resources. The axillary seabream, *Pagellus acarne*, is an important commercial species in Portuguese waters, yet its population structure remains poorly understood. In this study, otolith geochemistry was applied to explore population connectivity, environmental history, and spatial structuring of this species along the Portuguese mainland coast. Adult specimens were collected from three fishing grounds, Matosinhos (north), Peniche (centre) and Portimão (south). From each location, 25 individuals aged 4 years were selected in order to avoid ontogenic variation. Otolith elemental concentrations were quantified for Sr:Ca, Ba:Ca, Mn:Ca, Mg:Ca, Zn:Ca, and Li:Ca using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) to analyse both otolith cores and edges, providing information on early-life and recent environmental histories, respectively. In parallel, whole otoliths were analysed by solution-based ICP-MS (SB-ICP-MS) to obtain integrated chemical signatures over the lifetime of each fish. Geochemical signatures among sampling sites were examined through univariate and multivariate statistical analyses, and classification accuracy was tested using jackknife cross-validation. Core chemistry showed only a moderate capacity to discriminate natal origin, with an overall reclassification success of 56%. Edge signatures were less

informative, yielding a lower classification success of 44%. Nevertheless, whole-otolith chemistry produced the strongest spatial separation, with significant differences between Matosinhos and the other two locations with an overall reclassification success of 63%. This pattern was mainly associated with reduced Sr:Ca, Mn:Ca, and Zn:Ca ratios in the northern area, possibly reflecting local environmental influences such as freshwater input and/or adaptive responses. Overall, the results support the interpretation of a single stock, characterized by high connectivity with possibly some degree of localized differentiation, particularly in the north. Future research should focus on using complementary techniques and a greater sampling area in order to detect large scale population breaks.

SEALNet: Shape-Enhanced Adaptive Learning for Lightweight Underwater Fish Detection and Contour Reconstruction (S4-PC-20)

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Continuous marine observation systems are generating rapidly growing volumes of underwater imagery, creating new opportunities for automated fish monitoring and ecosystem assessment. However, most existing underwater object detection methods focus primarily on category identification and target localization, providing limited information for fisheries management, behavioral analysis, and ecological monitoring. The lack of detailed morphological representation restricts their application in scenarios requiring refined biological observations. To address this limitation, we propose a novel Shape-Enhanced Adaptive Local Network (SEALNet). The proposed framework combines efficient target detection with contour-aware representation learning to generate richer descriptions of fish targets. Specifically, SEALNet first extracts discriminative underwater features through lightweight multi-scale aggregation and adaptive local optimization modules. Based on the enhanced feature representations, a set of biologically meaningful key points is predicted to characterize the spatial structure of fish bodies. Subsequently, a contour reconstruction strategy is employed to infer complete fish outlines by exploiting the geometric relationships among the detected key points. This design enables the framework to move beyond conventional bounding-box detection and provide more detailed shape information for underwater targets. Furthermore, SEALNet incorporates attention-guided feature refinement to improve robustness against common underwater challenges, including illumination degradation, turbidity, background clutter, and partial occlusion. The lightweight architecture significantly

reduces computational overhead while maintaining high detection performance, making it suitable for deployment in resource-constrained marine monitoring systems. Experiments conducted on multiple public underwater fish datasets demonstrate that the proposed framework achieves reliable detection accuracy and effective contour reconstruction across diverse observation conditions. By integrating object localization with shape-aware representation, SEALNet provides a practical solution for intelligent fisheries assessment, marine biodiversity monitoring, and long-term autonomous underwater observation.

Session 5 - Blue Biotech Innovations: From Marine Biodiversity to Bioactive Solutions

LEVANTE: upscaling global seagrass restoration through low-cost robotics (S5-PC-01)

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Seagrass meadows rank among the most valuable coastal ecosystems on Earth, providing services estimated at \$1.9 trillion annually through carbon sequestration, nutrient cycling and fisheries support. Yet they are declining at an accelerating rate: global analysis of 547 sites documents a net loss of 5,602 km² since 1880, with decline rates increasing from 0.9% year⁻¹ before 1940 to 7% year⁻¹ since 1990. Current losses of approximately 110 km² year⁻¹ vastly outstrip restoration gains, which have remained below 200 km² accumulated over decades of effort. Traditional diver-based planting—limited to hundreds of shoots per day—is ecologically and operationally insufficient to close this gap. LEVANTE is a marine technology company developing a low-cost autonomous modular underwater vehicle to automate and upscale seagrass restoration, the Autonomous Seagrass Planter (ASP). Its core rests on four pillars: (i) large-scale ecosystem restoration — by automating planting, the ASP enables high-throughput deployment across restoration polygons with optimised inter-plant spacing and systematic coverage, shifting intervention from artisanal to spatial relevant scales; (ii) blue carbon generation — large, continuous meadow patches re-establish the self-facilitating feedbacks—sediment stabilisation, wave attenuation, turbidity reduction—that underpin long-term carbon sequestration and meadow persistence; (iii) diver-free, data-rich operations — removing human divers reduces operational costs and safety constraints while the autonomous platform continuously generates georeferenced planting and environmental data, opening new research and monitoring lines; and (iv)

multispecies applicability — the modular design is adaptable to the biological and sedimentary requirements in different bioregions. LEVANTE, through our ASP model, represents a necessary paradigm shift in seagrass conservation, directly addressing the ecological, operational and scalability constraints that have limited restoration to marginal impact for decades.

*The views and work presented are those of the authors and do not reflect the official position of the affiliated institutions. This work was performed independently and without the use of institutional resources.

Comparative analysis of genes involved in the metabolism of porphyrinoid pigments in marine annelids (S5-PC-02)

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Porphyrins and related tetrapyrrolic pigments are tetrapyrrolic compounds with many unique functions and biochemical properties. Notoriously, they can bind to metals and form the basis of as haem and chlorophylls. Previous research disclosed a wide variety of porphyrinoids and their metabolites in marine polychaeta whose functions and properties expand beyond gas transport and body colour to repellents, antimicrobials and even cytotoxicity with photodynamic properties, which suggests several biotechnological applications as biocides, antifoulants and photosensitisers in photodynamic therapy. These pigments can be exogenous or endogenous and their distribution and variety, which surpasses that of chordate haemic bile pigments, can vary greatly between species. This study aims to compare genes involved in haem synthesis and breakdown in two polychaetes bearing very distinct colouration: the colourful *Hediste diversicolor* and the bright-green *Eulalia* sp., namely uroporphyrinogen synthase (UROS), uroporphyrinogen decarboxylase (UROD) and ferrochelatase (FECH). Transcriptomic datasets from previous works were mined to identify the full coding sequences, confirm open reading frames and design primers for the enzymes. Target transcripts were amplified by PCR, validated through Sanger sequencing and phylogenetic analyses were performed to confirm orthology. In parallel, morphoanatomical and histological procedures were optimized by fixation in glutaraldehyde and embedding in EPON and LR White resins, enabling localization of pigments in tissues and cellular structures. So far, we obtained success for *H. diversicolor*

UROS and FECH. Phylogenetic analyses placed *H.diversicolor* sequences within well-supported UROS and FECH clades, consistent with the conserved roles in the haem biosynthesis. Optimized histology preserved tissue morphology and pigmentation, allowing clear visualization of pigmented structures across the analysed organs and enabling the integration of pigment distribution with morphoanatomical traits in the proboscis, skin and intestine. The molecular and phylogenetic data support conserved functions of UROS and FECH in marine annelid haem biosynthesis and provide robust markers for organ for organ-specific haem metabolism. Together, these molecular and morphoanatomical tools allowed to disclose the molecular mechanisms involved in the synthesis of porphyrins and tissue pigmentation in *Hediste diversicolor* and *Eulalia* sp.

Biotechnological potential of the lesser weever fish venom (S5-PC-03)

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Marine venoms are complex biochemical mixtures that have evolved in diverse organisms, including fish. Among fish venom components, protein and peptide-based toxins are particularly promising biomolecules for blue biotechnology research and targeted pharmaceutical therapies, due to their potential bioactivity at low concentrations and their interaction with essential cellular components. The lesser weever fish (*Echiichthys vipera*) is a common species along the Portuguese coast, and it inflicts one of the most painful stings of the marine realm by using its opercular and dorsal spines. Despite its commonness, *E. vipera*'s intraspecific variation in venom system structure, functioning and composition are mostly unknown. Some venom components have been previously identified for the species, including trachnine, a two subunit membrane pore-forming toxin, however, many gaps persist in the characterisation of the venom. Histological analyses showed a mushroom-shaped bony structure, surrounded by a retractable layer of skin with two venom glands lined on the interior of both venomous spines – dorsal and opercular – and no differences between sexes. The venom secretion in this species seems to be holocrine. Through liquid chromatography and tandem mass spectrometry we characterised the venom proteome of wild-caught specimens, and compared differences between types of spines (opercular vs. dorsal vs. soft rays) and fish sexes (males vs. females). Some of the identified proteins presented similarities with toxins from other venomous fishes (e.g., in Scorpaenoidei suborder) and

a higher number of toxins was identified in female fish than in male fish (five vs four) and in the opercular spines than the dorsal spines. Specifically, trachnine subunits concentration was higher in the venomous spines compared to the non-venomous soft rays but no differences were observed between sexes. Moreover, we identified three specific domains in the α subunit of trachnine: the Stonustoxin helical domain, a thioredoxin-like domain and a SPRY/B30.2 domain. These domains are associated with membrane pore formation, redox reactions and protein-protein interaction, respectively. Our future focus will be on isolating this and other active proteinaceous compounds from *E. vipera*'s venom through RNAseq to identify their full coding mRNAs and enable their heterologous expression, a crucial asset to unravel toxicity and identify toxin cellular targets, revealing its biotechnological potential.

Histone Deacetylase Inhibition Provides Insights into Chromatin-Level Transcriptional Regulation in Diatoms (S5-PC-04)

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Diatoms are the most diverse group of phytoplankton, producing a wide variety of bioactive molecules with potential applications in cosmetic, nutraceutical and pharmaceutical sectors. The *in vivo* production of such high-value compounds has long been of biotechnological interest, and microalgal epigenetic processes, playing a crucial role in regulating gene expression through alterations of chromatin structure, have been gaining increased attention. Among epigenetic processes, histone acetylation plays a central role in boosting transcriptional activity, yet remains poorly studied in diatoms as only a limited number of microalgal genomes and transcriptomes are currently available. Chemical epigenetic modifiers, such as non-competitive histone deacetylase (HDAC) inhibitors, provide a powerful approach to explore acetylation-driven gene regulation. In this study, cultures of the diatoms *Phaeodactylum tricornutum* and *Cylindrotheca closterium* were grown under control conditions or supplemented with a non-competitive HDAC inhibitor. Total histone acetylation levels following treatment were assessed by Western blotting, while specific genomic loci were assessed for their level of histone acetylation using Native-Chromatin Immunoprecipitation followed by qPCR (N-

ChIP-qPCR). Our results demonstrate that non-competitive HDAC inhibitors are a potent tool for revealing epigenetic gene regulatory networks, which could in turn support future applications in marine biotechnology.

Regeneration biology in aquatic animals: an histological and comparative bioinformatics approach (S5-PC-05)

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Many aquatic eumetazoans show remarkable regenerative abilities. After amputation or autotomy, the formation of new tissue usually occurs without scar formation and potentially with no loss of function. The extent of this capacity is variable, ranging from a specific tissue to whole body regeneration. We hypothesize that comparative transcriptomics and computational approaches involving annotation strategies, analysis of differential gene expression and of pathway can elucidate the key differences in molecular mechanisms driving regeneration in distinct species and why some have partially lost this ability. The present study investigated the transcriptomes of five aquatic species, namely *Hediste diversicolor* and *Platynereis dumerilii* (Annelida), *Hydra vulgaris* (Cnidaria), *Schmidtea mediterranea* (Platyhelminthes) and the zebrafish *Danio rerio*, that include organisms with different regeneration abilities and mechanisms. Emphasis was given to the Wnt signalling pathway, known to regulate essential steps of regeneration, such as pattern formation, cell fate, proliferation or even migration, during blastema patterning and in the case of *H. vulgaris*, the proliferation phase after the establishment of organizers. In all species, transcriptomic patterns related with regeneration were identified, particularly genes linked to the Wnt signalling pathway, reinforcing this pathway as key regulator of regeneration across species. To attempt a confirmation of these molecular signatures at the cellular level, computational information of the regenerative process was phenotypically anchored with morphoanatomic and histopathologic analyses with different staining techniques performed in *H. diversicolor* following amputation experiments. Preliminary results indicated that this marine annelid is capable of posterior regeneration, but anterior regeneration is limited. An early histological analysis shows an increased presence of apoptotic bodies, coelomocytes and also new epidermis formation. Notably, although inflammation was required to the success of this biological process, it appeared that an amplified response was present in

the anterior regeneration. The next steps are to continue the histological characterization and to analyse the convergence or divergence of Wnt signalling pathway, which seems to be conserved throughout most animal lineages. This multi-dimensional approach can shed a light on the regeneration process among Eumetazoa with implications for biomedicine.

Fatty Acid Profiling of Wild, Invasive and Cultivated Macroalgae Species for Blue Biotechnology Applications (S5-PC-06)

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The environmental impacts of conventional plastics, including greenhouse gas emissions, marine pollution, and the persistence of fossil-based polymers, have intensified the search for sustainable bio-based alternatives. Macroalgae represent a promising renewable resource due to their biochemical diversity and potential to provide functional compounds of industrial interest. Within the AlgaeTech project, marine biomass is being explored for the development of biodegradable and bioactive materials for agricultural applications. In this study, the fatty acid profile of nine macroalgae species was assessed, including wild native species (*Laminaria ochroleuca* and *Saccorhiza polyschides*), an invasive species (*Sargassum muticum*), and cultivated species (*Ulva* sp., *Porphyra dioica*, *Gracilaria gracilis*, *Chondrus crispus*, *Fucus vesiculosus*, and *Codium tomentosum*). Fatty acid composition was determined and major saturated, monounsaturated, and polyunsaturated fatty acids were identified. Palmitic acid (C16:0) was among the predominant saturated fatty acids across species, while oleic acid (C18:1n-9 cis) was one of the main monounsaturated fatty acids detected. Several species presented relevant levels of polyunsaturated fatty acids, including alpha-linolenic acid (ALA, C18:3n-3) and eicosapentaenoic acid (EPA, C20:5n-3), highlighting their potential as sources of bioactive lipids. Notably, *P. dioica* exhibited a distinctive fatty acid signature, with an n-6/n-3 ratio below 1, indicating a favorable nutritional and functional profile. Overall, these results demonstrate that wild, invasive, and cultivated macroalgae contain valuable lipid fractions rich in biologically relevant fatty acids. This biochemical characterization supports the potential of macroalgae as sustainable feedstocks for blue biotechnology applications, particularly in the development of functional bio-based products.

Marbiome: Bioprospecting Salt Marsh Hidden Diversity for Biotechnology and Microbiome-Assisted Restoration (S5-PC-07)

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Salt marshes, characterised by their rich biodiversity, are increasingly threatened coastal ecosystems that function as natural filters, retain pollutants, support blue carbon storage, and sustain valuable ecological services. Despite their significance, the microbiota within these ecosystems remain an underexplored source of ecological functions and blue biotechnological innovation. Here, a bioprospecting framework is presented, focused on marine bacteria, fungi and yeasts isolated from salt marshes across abiotic and biotic gradients, specifically targeting rhizosphere sediments as well as root and leaf endospheres of halophytes. Within the marbiome biobank initiative (<https://marbiomebiobank.wixsite.com/home>), microorganisms are sampled from coastal systems, isolated through culturomic approaches, functionally screened via biochemical pipelines, identified using genomic tools, and associated with environmental metadata and culturing conditions. These microorganisms are then archived under cryopreservation as a curated living repository. The screening process emphasises plant growth-promoting and stress-alleviation traits pertinent to both biotechnology and ecosystem recovery, including nutrient solubilization, phytohormone-related activities, siderophore production, ACC-deaminase activity, ammonia production, biocontrol potential, and tolerance to stressful saline conditions. This strategy aims to uncover microbial resources valuable for tailored biostimulant development, sustainable agriculture in saline environments, biocontrol, and broader marine biotechnology. Additionally, it seeks to identify isolates with potential for bioremediation applications, such as contaminant transformation, decomposition of organic pollutants, and plastic degradation. Beyond these applications, selected isolates will support the mRESTART project to develop nature-based solutions using marine biostimulant bacteria to enhance the survival, resistance, and resilience of halophyte vegetation during salt marsh restoration, thereby contributing to the recovery of native flora, associated fauna, and

key ecosystem services. By integrating microbial bioprospection, functional phenotyping, biobanking and microbiome-assisted ecological restoration, this approach establishes a bridge between conservation and innovation, creating a strategic microbial resource for future restoration and remediation actions towards the recovery of degraded coastal ecosystems.

Marine macroalgal-derived compounds and mineral-rich thermal waters: a blue biotechnology-based synergistic strategy for psoriasis-related skin conditions (S5-PC-08)

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Marine natural products represent a rich and sustainable source of bioactive compounds with increasing relevance in dermatological applications. Among these, macroalgae-derived compounds are widely recognized for their anti-inflammatory and skin-protective properties, supporting their incorporation into stable cosmeceutical and pharmaceutical formulations, while mineral-rich thermal waters have long been applied in balneotherapy, demonstrating beneficial effects in skin conditions. The present study explores the combined use of marine macroalgal-derived compounds and thermal waters as a promising synergistic strategy for improving psoriasis-related skin conditions. In order to accomplish this objective, the extraction of total and sulfated polysaccharides from *Bifurcaria bifurcata* and *Asparagopsis armata* was performed, using conventional and green methodologies, with the L-arginine method yielding up to 5.75% in *B. bifurcata*, surpassing the 4.68% obtained with cetylpyridinium chloride (CPC), which also reached 11.96% in *A. armata*. Total polysaccharides obtained from *B. bifurcata* (HCl method) and sulfated polysaccharides from *A. armata* (L-arginine method) showed strong inhibitory effects (100 µg/mL), exhibiting residual hyaluronidase activities of $11.43 \pm 8.44\%$ and $18.47 \pm 5.39\%$, respectively. These values were lower than those observed for the positive control, epigallocatechin gallate (EGCG) ($37.34 \pm 4.28\%$) for the same concentration, confirming the greater inhibitory efficacy of the evaluated macroalgal extracts. Furthermore, to assess the role of thermal waters as functional extraction media and potential modulators of bioactivity, extracts of *B. bifurcata* were obtained using thermal waters (TW) from Vimeiro (carbonate-rich) and Caldas da Rainha (sulfate-rich) as solvents. The highest extraction yield (29.77%) obtained with the 100% aqueous extract (Vimeiro TW), showed at 100 µg/mL a notable hyaluronidase inhibitory capacity (residual activity of $32.34 \pm 4.39\%$). These results suggest that the mineral composition of thermal water could influence the bioactivity of compounds extracted from macroalgae.

Furthermore, the antioxidant activity of the extracts was evaluated independently to avoid overlapping biological effects, at a concentration of 400 µg/mL, both the hydroethanolic extract (70:30, Vimeiro TW:ethanol, v/v) and the aqueous extract (100% Vimeiro TW) demonstrated antioxidant capacity, with DPPH radical reduction values ranging from 30% to 35%. Overall, this work highlights the ocean as a valuable source of bioactive compounds and supports the strategic combination of marine macroalgae and therapeutic thermal waters for developing more effective dermatological applications.

Targeting Psoriatic Inflammation with Seaweed-Derived Bioactives: A Keratinocyte-Based Approach (S5-PC-09)

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The skin, as the largest organ of the human body, plays a crucial role in maintaining internal homeostasis. However, exposure to environmental stressors triggers a cascade of events, including the generation of reactive oxygen species (ROS) and activation of inflammatory signaling pathways, including NF-κB and MAPKs, ultimately promoting chronic inflammation and contributing to the development of skin disorders. Psoriasis is a chronic, non-curable inflammatory disease characterized by dysregulated immune responses and abnormal proliferation of keratinocytes, significantly impairing patients' quality of life. In this context, marine-derived bioactives have gained increasing attention as potential sources of novel therapeutic agents. Moreover, seaweeds are rich in bioactive compounds, including terpenes, polysaccharides, phenolic compounds, etc, with reported antioxidant and anti-inflammatory properties. The present work evaluated the effects of a panel of seaweed-derived compounds, along with fractions and polysaccharides obtained from the brown seaweed *Carpomitra costata*, previously reported to exhibit anti-inflammatory activity, in human keratinocytes (HaCaT cells) at different concentrations (1 and 10 µM for compounds and 100 µg/mL for fractions). Non-cytotoxic concentrations were selected for subsequent evaluation of anti-inflammatory effects. To better mimic psoriatic inflammation, a cytokine-induced model based on a pro-inflammatory cocktail (5Mix) was used to recapitulate key disease features, including altered keratinocyte responses and inflammatory signaling, in HaCaT cells. This model enables the evaluation of the effects of seaweed-derived components on key

inflammatory pathways, highlighting their potential as novel multi-target therapeutic strategies for psoriasis.

Encapsulated invasive seaweed extracts as an alternative to synthetic pesticides in agriculture (S5-PC-10)

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Invasive seaweeds are increasingly disrupting marine environments due to globalization and climate change. However, the same characteristics that make them problematic can also turn them into valuable biotechnological resources. Seaweeds are known to synthesize bioactive compounds with antifungal activities, capable of inhibiting mycelial growth of important fungal phytopathogens in both in vitro and in vivo assays. Specifically, an invasive from the Portuguese coast has shown up to 98% inhibition in the mycelial growth against three key fungi affecting orange fruit production (*Colletotrichum gloeosporioides*, *Penicillium digitatum* and *Phytophthora citrophthora*) in previous studies. Despite this potential, the application of natural extracts in agriculture faces significant challenges, particularly the degradation of bioactive compounds under environmental conditions such as light, temperature, pH and humidity, which complicate their large-scale use. In this context, encapsulation techniques with organic and inorganic polymers offer a promising strategy to enhance stability and improve handling and transportation of seaweed extracts. In this work, an aqueous extract of an invasive seaweed was encapsulated using pyrogenic amorphous silica and maltodextrin:pectin matrices. Particle size distribution, scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy imaging, specific surface area and thermogravimetric analysis were carried out to characterize the formulations. The maltodextrin:pectin formulation demonstrated to maintain (*P. citrophthora*) and significantly improve (*C. gloeosporioides* and *P. digitatum*) the antifungal activity of the extract, demonstrating a successful encapsulation. These results highlight the potential of encapsulated seaweed extracts as sustainable alternatives to synthetic pesticides, promoting more sustainable agricultural practices while contributing to the marine ecosystem restoration.

From the depths of the Ocean to the top of skyscrapers: the DEEP-BioBank as a platform for marine conservation and biotechnological innovation (S5-PC-11)

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Biological collections and biobanks are important repositories of biodiversity that can play a key role in advancing both fundamental research and in developing of biotechnological applications. In the marine realm, however, deep-sea organisms remain underrepresented in such collections despite their ecological importance and potential for innovation. Here, we present the DEEP-BioBank, an integrated platform established in 2025 that comprises a curated collection of over 400 sponges and corals (phyla Porifera and Cnidaria), collected from diverse mesophotic and deep-sea environments - continental shelf and slopes, to offshore seamounts - across the North Atlantic. Hosted at CIIMAR, the DEEP-BioBank is part of the Portuguese Blue Biobank, a network of national marine biological collections that aims to position Portugal in the forefront of knowledge and conservation of marine biodiversity and blue biotechnology. DEEP-BioBank can support a wide range of fundamental research areas from biodiversity assessment to conservation and restoration of marine ecosystems, for instance by providing samples and data for studies to assess genetic diversity and connectivity, mapping species distributions, and investigate ecosystem functioning. It also enables the exploration of bioactive compounds and genetic resources with potential applications in the pharmaceutical and biomedical sectors. Examples include marine natural products with antimicrobial, antiviral and anticancer properties. Furthermore, biomaterials such as biosilica, and their structural and functional properties have promising applications for diverse fields such as tissue engineering and as bio-inspired design in engineering and architecture of, for instance, bridges and skyscrapers. DEEP-BioBank connects deep-sea biodiversity to real-world applications, creating new opportunities for collaboration across research, industry and innovation.

***Rugulopteryx okamurae* derived bioactive hydrogels as collagen analogue systems for dermal applications (S5-PC-12)**

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Animal-derived collagen remains the dominant dermal extracellular matrix (ECM) biomaterial but is constrained by sustainability, variability, and regulatory considerations, motivating marine-derived collagen-analogue alternatives. This work advances a circular concept in which the invasive brown macroalga *Rugulopteryx okamurae* is valorised into bioactive fractions that are integrated into ulvan extracted from *Ulva* spp. to yield dermal-ECM collagen biomimetic hydrogel systems. Solid-liquid extractions generated polarity-strategized *Rugulopteryx* fractions using aqueous, 70:30 ethanol:water, absolute ethanol, cyclohexane, and ethyl acetate. Bioactive potential will focus on antioxidant, antimicrobial and wound healing capacity. Initial antimicrobial screening was conducted against skin microbiota microorganisms: *Cutibacterium acnes*, *Staphylococcus aureus*, *S. epidermidis*, and *S. hominis*. Results showed demonstrating high activity for non-polar and mid-polar extracts, with IC₅₀ values in the ~30-100 µg/mL range against *S. epidermidis*, thus supporting their potential as sustainable alternatives to metal-based antimicrobials frequently used in biomedical hydrogels. Hydrogel formulations using Soxhlet-extracted ulvan and alginate (1% w/v) confirmed robust dual-biopolymer matrix hydration and swelling behaviour in deionised water, indicating feasibility for constructing highly hydrated ECM-like scaffolds capable of hosting hydrophobic and semi-polar bioactives via green crosslinking chemistry. Results show that *R. okamurae* can be used to develop innovative products for skin care industry, transforming an ecological burden into a renewable resource while supporting circular bioeconomy strategies and marine ecosystem management.

Proximate Profiling of *Furcellaria lumbricalis* from the Baltic Sea for Industrial Utilization (S5-PC-13)

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The red macroalga *Furcellaria lumbricalis*, widely distributed along the coasts of Estonia, represents a particularly valuable yet underexploited resource in the Baltic Sea. Unlike many other seaweeds, *Furcellaria lumbricalis* thrives in the Baltic's unique brackish conditions, characterized by low salinity, limited tidal movement, and strong seasonal variability. These environmental constraints shape its biochemical profile, often resulting in distinct polysaccharide compositions—especially its high-quality furcellaran, a hybrid carrageenan with desirable gelling and stabilizing properties for the food, pharmaceutical, and cosmetic industries. Furthermore, its natural abundance, adaptability, and capacity to form extensive benthic mats make it a promising candidate for sustainable harvesting and cultivation. Leveraging this species within blue biotechnology not only supports the diversification of industrial raw materials but also aligns with circular bioeconomy goals, promoting the efficient use of locally available biomass while reducing dependence on imported resources. In this work, *Furcellaria lumbricalis* collected from the coast of Saaremaa (Estonia) was analysed through elemental, thermogravimetric, and calorific assessments, along with the quantification of major biochemical components and phycobiliproteins. *F. lumbricalis* showed a highest calorific value (11.82 MJ/kg) and a volatile content of 64.2%. Elemental analysis revealed 30.9% carbon, 4.8% hydrogen, and 3.2% nitrogen. Protein content, measured through a nitrogen-to-protein conversion factor of 6.25, was 20.2%, while carbohydrates accounted for 46% of the biomass, primarily composed of galactose and glucose. The phycobiliproteins analysis showed high yield (mg/g dry weight) of allophycocyanin (1.40), phycocyanin (1.04), and R-phycoerythrin (5.33). The results point out the potential of *F. lumbricalis*, with high protein and carbohydrate contents, to be used for aquafeed, biofertilizers, and for other high-value applications such as natural pigments and cosmetic ingredients due to its phycobiliprotein content.

Investigation of the *in vitro* and *in silico* anti-inflammatory activity of uraboside C saponin from the Brazilian marine sponge *Ectyoplasia ferox* (S5-PC-14)

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Brazil stands out as the country with the greatest biodiversity on the planet with the second second-longest continuous coastline in the world and has adopted the term “Blue Amazon” to value the existing fauna and flora. Marine sponges depend greatly on the occurrence of specialized metabolites to ensure survival. These sponge metabolites inspired the development of two synthetic derivatives, currently marketed as Cytosar-U® and Halaven®, both approved by the FDA for cancer treatment. Uraboside C demonstrated significant cytotoxic activity against the HCT-116 cell line, as evaluated in a previous study by our research group. In the process of neoplasms, inflammation has a major influence on tumor initiation and growth. Therefore, evaluating protection against the inflammatory cascade is a relevant strategy to enhance cancer treatment. In this context, the objective of this study was to evaluate the potential anti-inflammatory of uraboside C saponin from *Ectyoplasia ferox* *in vitro* and *in silico*. This project is registered in the SisGen under code AB724BB. The specimen of *E. ferox* was collected in the Fernando de Noronha Archipelago, Brazil. Uraboside C was isolated from the butanolic fraction as described. NO and ROS levels were measured in LPS/IFN- γ -stimulated macrophages treated with uraboside C (6.25–100 $\mu\text{g/mL}$) for 48 h using the Griess assay and H2DCFDA fluorescence, respectively. The interaction between uraboside C and iNOS was evaluated by molecular docking using AutoDock Vina. The iNOS structure (PDB: 3EAI) was obtained from the Protein Data Bank. The best binding pose was selected based on interaction profile and binding energy. Nitrite levels were significantly reduced ($P < 0.05$) at concentrations of 100.00, 50.00, and 25.00, suggesting an anti-inflammatory effect through modulation of NO production and possible indirect reduction of COX-2 activation. Uraboside C also decreased ROS production at these same concentrations. The molecular docking studies with iNOS and uraboside C were performed, demonstrating favorable binding energy (–9.09 kcal/mol), despite unfavorable interactions with the GLU371 residue, critical for substrate binding. Additional interactions with other residues of the catalytic site may justify the observed inhibitory potential, corroborating the results of the NO assay. The results highlight the anti-inflammatory potential of uraboside C, which may complement its previously described cytotoxic activity.

Optimizing diatom biomass downstream processing methods to obtain intact biosilica microcapsules (S5-PC-15)

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Diatoms are unicellular microalgae with three-dimensional (3D) silicified cell walls (frustules) that exhibit species-specific architectures, porosity patterns, large surface areas and tunability. These characteristics make diatom biosilica attractive for photonic devices, energy storage and drug delivery systems, driving diatom nanotechnology. Conceptually, diatoms can be exploited as living factories for the production of customized biosilica nanomaterials through the cultivation of specific strains. However, large-scale biosilica production is still limited by the high costs and inefficiencies of the downstream processing stage. Conventional purification methods are energy-intensive, generate hazardous waste and often fail to preserve frustule architecture. This study aimed to develop a rapid, cost-effective and sustainable method for organic matter removal while preserving frustule integrity. *Thalassiosira pseudonana* was cultivated in 5 L photobioreactors and downstream processing was optimized by refining the filtration and centrifugation steps, extraction buffer concentrations and ultrasound treatment. The resulting protocol reduced hands-on processing by over 80%, decreased reagent consumption while increasing processing volume and throughput, and yielded clean microcapsules while preserving their natural 3D structure. This study also demonstrated the feasibility of loading diatom-derived microcapsules with three model bioactives—pyridoxine, inositol and lysine—using a simple vacuum infiltration method comprising three sequential phases: (i) dispersion of microcapsules in a bioactive solution (contact phase); (ii) removal of air and liquid under vacuum (removal phase); and (iii) restoration of atmospheric pressure to promote infiltration and immobilization of compounds within the microcapsule structure (immobilization phase). Successful immobilization of all compounds was confirmed by UV–Vis spectrophotometry. Together, the optimized purification and loading procedures establish a sustainable and scalable platform for producing diatom-derived biosilica microcapsules, contributing to the advancement of diatom nanotechnology and microencapsulation applications.

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Developing diatom-derived microencapsulation devices for oral delivery of bioactives to marine shrimp (S5-PC-16)

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Microencapsulation technologies are increasingly recognized as powerful tools in aquaculture. Microencapsulation *i.e* the entrapment of a target substance within the core of micrometer-sized capsules; offers the means to protect, stabilize, transport and deliver labile substances (e.g. bioactives) to aquatic livestock. With rising demand for novel, eco-friendly and customizable microencapsulation systems for aquaculture applications, we propose to explore diatom microalgae as sources of encapsulating materials owing to a unique set of physico-chemical properties. The diatoms' cell-wall (frustule) consists of a three-dimensional biosilica material, featuring micro- and nanoscale porosity patterns and strain-specific morphological traits (size, shape, and nanoarchitectures). The biomaterial can be obtained by cultivating specific diatom strains in photobioreactors and recovered after downstream biomass processing, offering an alternative to synthetic encapsulation materials. Following a proof-of-concept demonstrating their potential as a microencapsulation system, a key challenge remains: the efficient administration of these microcapsules to aquaculture species, particularly via passive oral uptake. This study aimed to evaluate administration strategies in farmed marine shrimp. To address this, biosilica microcapsules extracted from *Thalassiosira pseudonana* (CCAP 1085/12) were functionalized with a fluorescent marker (Rhodamine B) for *in vivo* tracking and administered to *Palaemon varians* through three presentation strategies: (i) dispersed in seawater, (ii) substrate-associated, and (iii) incorporated into feed pellets. Uptake efficiency and ingestion dynamics were assessed using Confocal Fluorescence Microscopy, while bioactive release profiles were analyzed by UV–Vis spectroscopy. Our findings suggest that presentation strategy influences ingestion success. Incorporation into feed pellets significantly increased ingestion rates, likely due to better alignment with shrimp feeding behavior. Substrate-associated microcapsules also exhibited uptake, indicating their potential as an alternative delivery route. Imaging analyses confirmed the presence of microcapsules in the digestive tract and in feces, providing insights into transit and release dynamics. This work paves the way for the development of diatom-based microencapsulated systems designed for shrimp that can be easily administered in aquaculture environments, providing insights into transit and release dynamics.

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An investigation on the pigments in the sea star (Asteroidea) *Astropecten aranciatus* (Linnaeus, 1758) (S5-PC-17)

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Pigments produced and accumulated in echinoderm tissues exhibit diverse physicochemical and bioactive properties that make them prized targets for biotechnology, for instance in applications such as cosmetics, pharmaceuticals and in food as nutraceuticals or safe colorants. Among these compounds, naphthoquinone pigments are particularly significant. These compounds occur almost exclusively in echinoderms, especially sea urchins, and are associated with various bioactivities, including antioxidants, cardioprotective, and potential anticancer effects. Recent studies suggest that sea stars (class Asteroidea) may also contain similar pigments within their tissues. Considering that echinoderms frequently represent a substantial proportion of fisheries bycatch, identifying valuable compounds from these organisms may help valorize biological material that would otherwise be discarded, contributing to more sustainable resource utilization. This study aimed to detect the occurrence of pigments in the sea star *Astropecten aranciacus* (Linnaeus, 1758) using histological methods. Specimens were collected from the fishing area of Sesimbra using trammel nets and identified through integrative taxonomy, combining morphological and molecular characters. Tissue from arms was excised, fixed in Bouin's or Zenker's solutions, embedded in paraffin or epoxy resin, sectioned and stained with a range of histochemical methods. Unstained sections allowed identification of the distribution of native pigments and their autofluorescence. Results revealed that yellow pigments are localized mainly in the skin epithelium. Fluorescence patterns and staining characteristics suggest the presence of carotenoids and naphthoquinones, including spinochromes, although further biochemical analyses are required to confirm pigment composition and bioactivity for future biotechnological applications prospects.

Temporal bioactivity shifts in a brown algae: the case of *Bifurcaria bifurcata* (S5-PC-18)

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Bifurcaria bifurcata is a marine brown seaweed commonly found along the Atlantic coast, with recent studies highlighting its potential as a source of bioactive compounds of interest for pharmaceutical and food applications. Therefore, the main objective of this study was to assess the seasonal variation in the dermatological potential of *B. bifurcata* over the months of October, November, and December, focusing on the antioxidant and anti-enzymatic activities of five extracts obtained using solvents of increasing polarity (water, ethanol:water 50:50, ethanol, ethyl acetate, and cyclohexane) at a 1:10 (w/v) biomass-to-solvent ratio. Antioxidant activity was evaluated using DPPH and FRAP assays, while anti-enzymatic activity was assessed through hyaluronidase inhibition. Additionally, extraction yields for each month were correlated with environmental variables measured at the time of sample collection. Extracts obtained with ethanol, ethyl acetate, and ethanol:water (50:50, v/v) exhibited the highest antioxidant activity in October at 1000 µg/mL. These extracts remained the most active in the following months, showing an increased capacity to scavenge DPPH radicals. FRAP results were consistent with DPPH in terms of the most active extracts; however, December presented the lowest ferric reducing power. Regarding hyaluronidase inhibition, at 100 µg/mL, the ethanol extract was the only one in October to exceed 50% inhibition. In contrast, during November and December, not only did this extract show increased inhibitory activity, but the ethyl acetate and ethanol:water (50:50, v/v) extracts also surpassed 50% inhibition. Strong correlations were observed between extraction yields and environmental parameters such as pH, salinity, and dissolved oxygen (%), while some extracts also showed additional correlations with temperature and chlorophyll *a* concentrations. Overall, the results suggest an increase in hyaluronidase inhibition and DPPH radical scavenging activity from October to December, whereas ferric reducing power exhibited an opposite trend. Furthermore, environmental variations appear to influence extraction yields, with the magnitude of these effects depending on the solvent used. In conclusion, *Bifurcaria bifurcata* shows potential as a source of antioxidant and anti-enzymatic compounds, with bioactivity influenced by seasonal variation and environmental conditions. Solvent polarity and harvest timing were key factors affecting both activity and extraction yields.

Cellulose extraction from the brown algae *Rugulopteryx okamurae* for textile applications (S5-PC-19)

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The global population rising and the acceleration of fast fashion consumption patterns have intensified the demand for textile fibres. To meet this demand, fossil-based fibres, while effective, are a non-renewable and environmental harmful solution. Cotton is a more sustainable alternative, yet its production faces several challenges such as extensive water and chemicals use, environmental contamination, and declining production due to resource limitations. Man-made cellulosic fibres (MMCFs) emerged to substitute cotton, but their high reliance on wood as a primary raw material, also raises environmental concerns, particularly deforestation and associated ecological impacts. To mitigate these impacts, it is essential to diversify MMCFs production by incorporating alternative cellulose sources. Macroalgae, particularly brown algae, may be a promising alternative, due to their high availability, high growth rates, cellulose with high purity and lignin absence, which facilitates the extraction process. *Rugulopteryx okamurae* is an invasive brown algae spreading along southern European coastlines, producing abundant stranded biomass that outcompete native flora, alter benthic habitats, and disturb trophic interactions. As so, its repurpose could both mitigate its ecological impact and foster new bio-based industries. This study demonstrated that *Rugulopteryx okamurae* can be repurposed as a cellulose source using a low environmental impact methodology. Three alkaline treatment processes were investigated: the first treatment comprised varying concentrations of a strong basic solution (Solution 1), the second employed a weak basic solution (Solution 2), and the third treatment used a mixture of both solutions in different concentrations. The use of a weak basic solution alone did not yield a successful extraction. However, when combined with a strong basic solution in a lower concentration, increased the cellulose content by 166.34%, far exceeding the 57.88% increase obtained with the single Solution 1 with a higher concentration. These findings show that the combination of these solutions produces a complementary action that promotes the degradation of different algae cell wall components, thereby yielding a more sustainable extraction process. Accordingly, this study identifies *Rugulopteryx*

okamurae as a viable alternative cellulose source for potential applications in the textile industry.

NEXTMARINE: Unlocking marine extremophile biodiversity for next generation industrial biocatalysts (S5-PC-20)

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Marine ecosystems host an extraordinary diversity of life forms adapted to extreme and fluctuating environmental conditions, such as high salinity, pressure, temperature, and pH. These marine extremophiles represent a largely untapped reservoir of novel enzymes with unique functional properties, offering high potential for sustainable biotechnological applications. However, their systematic exploration and translation into industrial solutions remain limited. The NEXTMARINE project addresses this gap by developing an integrated, interdisciplinary pipeline to discover, characterize, and valorise biocatalysts derived from marine extremophiles. By combining marine biology, microbial ecology, genomics, protein engineering and industrial biotechnology, NEXTMARINE aims to accelerate the identification of robust, efficient and environmentally friendly enzymes for use in sectors such as pharma, food, bio packaging and biomaterials. The project adopts a source-to-application approach, starting from targeted sampling in extreme marine environments, followed by advanced culturing, metagenomic and functional screening strategies. Promising enzymes are subsequently optimized through protein engineering and evaluated under industrially relevant conditions. Throughout the process, NEXTMARINE integrates sustainability, scalability and safety-by-design principles, ensuring alignment with European environmental and innovation policies. Beyond technological development, NEXTMARINE places strong emphasis on data sharing, capacity building and stakeholder engagement. The project contributes to strengthening European leadership in blue biotechnology by fostering collaboration between research institutions, industry partners and innovation networks, while promoting responsible access to marine genetic resources. By unlocking the functional potential of marine extremophile biodiversity, NEXTMARINE aims to deliver innovative biocatalytic solutions that support the transition towards a more sustainable, resilient and bio-based economy, while advancing fundamental knowledge of marine life in extreme environments.

Session 6 - Citizen Science and Participatory Monitoring

Changing seas through the eyes of recreational fishers: a participatory monitoring of marine biodiversity and ecological trends in southern Italian waters (S6-PC-01)

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Recreational fishing is a widespread activity with deep social roots. In Italy, data remains fragmentary and still insufficient to quantify this phenomenon or assess its impact on marine resources. To address these requirements, a monitoring program on marine recreational fishing was developed in compliance with the Marine Strategy Framework Directive (2008/56/EC). Engaging recreational fishers enables data collection across broad spatial and temporal scales while promoting transparent management, transforming fishers from resource users into active protagonists in biodiversity conservation. In this scenario, Citizen Science emerges as a fundamental tool to bridge this knowledge gap and collect additional data. A questionnaire was designed to gather information across the southern coasts of Italy (Sicily, Calabria, Campania and Basilicata) regarding fishers' perceptions of the status of resources and the main problems regarding this recreational activity. Data from this survey highlighted that illegal fishing, coupled with inadequate surveillance and limited access to fishing spots are the most significant issues perceived by the community. Furthermore, the survey included a section on ecological observations, requiring respondents to identify long-term shifts in species abundance and distribution. Preliminary results demonstrated a strong alignment between local ecological knowledge and scientific data. Fishers' reports confirmed that climate change is a primary driver for the spread of thermophilic and alien species. Thermophilic predators such as *Sphyræna viridensis* and *Pomatomus saltatrix* were frequently reported to be increasing in catches in contrast with a significant decline of temperate species like *Dicentrarchus labrax*. Furthermore, the extensive spatial coverage of this study enabled effective monitoring of non-indigenous species across some Italian regions. Sightings of *Pterois miles*, *Lagocephalus sceleratus* and *Sepioteuthis lessoniana* underscored the potential of participatory actions for long-term biodiversity surveillance, proving that fishers' local ecological knowledge is an indispensable asset for tracking marine environmental changes.

Surfcasting tournaments as a framework for assessing recreational fishing pressure and knowledge of elasmobranchs along the Spanish Mediterranean coast (S6-PC-02)

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The e-Elasmobranch project aims to improve knowledge of elasmobranchs (sharks and rays) in the Spanish Levant through the application of emerging technologies, including machine learning tools, while assessing the pressures affecting these species and promoting their conservation. In this context, recreational fishing has been identified as a potential source of impact, although important knowledge gaps remain regarding its actual effects. This study focuses on evaluating such pressure in the south-eastern Iberian Peninsula, using shore-based fishing tournaments as a framework for collecting biological and social data. The study area covers the coastline of Alicante and Murcia, characterized by high habitat diversity and intense fishing and recreational activity. The methodology combines angler surveys with the collection of catch data during nine tournaments held in 2025, integrating information on participant profiles, experience, knowledge of elasmobranchs and fishing results. A total of 258 valid surveys were obtained. Results show a clear predominance of male participants and a pattern of regular but mainly recreational fishing activity. Although a significant proportion of anglers have interacted with elasmobranchs, particularly rays, their knowledge of these species is limited, especially regarding identification and conservation status. Total catches are mainly composed of common small-sized coastal species, with elasmobranchs being rarely recorded. Differences are observed between tournaments, with higher total catch volumes and species diversity in open events compared to social competitions. Overall, results indicate that the direct pressure of recreational fishing on elasmobranchs is low within the analysed context, although there is a clear need to improve angler awareness and education. Furthermore, the study highlights the value of fishing tournaments as a tool for scientific data collection and for integrating citizen science approaches into the management and conservation of marine ecosystems.

Local ecological knowledge of fishers: a case study from the eastern Adriatic Sea (Croatia)
(S6-PC-03)

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In recent decades Adriatic marine ecosystems has faced rapid transformation under the combined pressures of climate change, long-term exploitation and complex socio-economic dynamics. Therefore, in order to better understand the spatial and temporal dynamics, monitor marine species' biodiversity and develop sustainable strategy to managing marine resources, it is crucial to incorporate information obtained directly from fishers, who often possess valuable local ecological knowledge. The significance of this recent interdisciplinary approach has been widely recognized by the scientific community, leading to the introduction of the term FLEK (Fisheries Local Ecological Knowledge). This paper analyzed FLEK of recreational, subsistence, small-scale commercial and large-scale fisheries in Croatia. The aim was to provide information in terms of target and bycatch composition, but also invasive species caught within different fisheries sectors. Furthermore, fishers' perception of targeted individuals' vulnerability and type of fishing activity was compared with the official endangered status and attitudes towards climate change was examined through a questionnaire. The analysis was based on a sample of 550 fishers from Croatia, gathered as a part of the project "Sustainable fishing: social relations, identity and co-management of Adriatic fishery resources", funded by the Croatian Science Foundation. Preliminary results revealed that total catch was strongly structured by fishing gear and operational scale. Recreational, subsistence and small-scale commercial fisheries mainly targeted demersal species, whereas purse seiners specialized on small pelagic taxa and bottom trawlers mixed demersal fish–crustacean organisms. Bycatch assemblages displayed highest taxonomic heterogeneity in trawl fisheries. Our findings show that FLEK is not uniform, but instead arises from repeated, gear-driven ecological interactions.

Citizen Science in Maritime Supply Chain Management: A Participatory Monitoring Framework (S6-PC-04)

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Maritime supply chains play a central role in global trade, yet increasing environmental concerns and regulatory pressures require more transparent and inclusive monitoring approaches. Traditional monitoring systems are often centralized and institution-driven, which can limit responsiveness and stakeholder engagement. This study will explore how citizen science can be integrated into maritime supply chain management as a complementary approach to enhance sustainability, transparency, and decision-making. This study will propose a participatory monitoring framework in which port workers, coastal communities, and other stakeholders contribute observations on environmental conditions and operational challenges in and around port areas. Rather than focusing on technical infrastructure, the study will emphasize digital platforms and collaborative reporting tools that enable structured data collection and communication between stakeholders and supply chain managers. These inputs will support managerial decision-making by offering timely, ground-level insights that are often overlooked in formal systems. From a management perspective, the study will examine how citizen-generated data will be incorporated into supply chain governance, risk management, and sustainability reporting. It will also address key challenges, including data reliability, stakeholder motivation, and integration with existing organizational processes. The framework will highlight the role of digitalization in facilitating participatory approaches, while maintaining data quality through basic validation mechanisms and cross-verification practices. The expected findings may suggest that citizen-driven monitoring can strengthen supply chain resilience, improve environmental accountability, and foster trust between port authorities, businesses, and local communities. This research will contribute to the emerging discourse on digital and sustainable supply chains by positioning citizen science as a practical and scalable tool for participatory governance in maritime contexts. It will also offer actionable insights for policymakers and supply chain managers seeking to adopt more inclusive and adaptive monitoring strategies.

Upskilling ECRs in deep-sea science: Boosting careers through training activities and networking (S6-PC-05)

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Early Career Researchers (ECRs) represent a crucial component of the research landscape and are required to develop a comprehensive set of skills, both technical and soft, to navigate a highly competitive and increasingly multidisciplinary research environment. Besides developing their own research, ECRs are encouraged to invest in their training and actively engage in networking to boost their career development and establish themselves as independent, competitive researchers. This work explores the impact of targeted training activities and networking opportunities in enhancing ECRs' skillset and career progression, using the TwinDEEPS project as a case study. A comprehensive training programme was developed to enhance ECRs technical competencies and transferable skills. The activities included at-sea training in oceanographic expeditions, workshops on diverse technical areas (i.e., habitat modelling, -omics methods and ecosystem monitoring) as well as career development activities such as strategic planning and career design, research cruise leadership and grant writing. The training programme was complemented by networking opportunities, through the active involvement of TwinDEEPS ECRs in international networks (e.g., OYSTER Euromarine, EMB ECOPS) promoting exchange of knowledge and facilitating collaborations worldwide. Participation in the different activities increased the confidence, skillset and professional visibility of ECRs. Additionally, it also represented gains in transferable skills such as communication, leadership and career management. Overall, the example of TwinDEEPS' training programme highlights the effectiveness of structured and targeted training programmes in empowering ECRs and supporting their careers, contributing to a sustainable and competitive career development of the next generation of deep-sea researchers. A similar framework could be applied in other marine research fields, supporting a more connected, cohesive, and empowered ECR community.

Funding: This work was supported by the European Union through the TwinDEEPS project (Horizon Europe, GA 101160298). It was also supported by FCT – Fundação para a Ciência e a Tecnologia, I.P., and the European Commission's Recovery and Resilience Facility, under UID/04423/2025, UID/PRR/04423/2025, and LA/P/0101/2020.

From Fishing Vessels to Data: collaborative Mapping and Monitoring of Deep-Sea Habitats in the NW Portugal (S6-PC-06)

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The deep sea remains one of the least explored marine environments due to high technical and logistical challenges, limiting our understanding of habitat distribution and biodiversity patterns, as well as their current ecological status, particularly relevant in areas exposed to long term anthropogenic pressures such as the Portuguese margin. Within the BioProtect project, the northwestern Portuguese margin was set as a demonstration site to help address some of these gaps through underwater visual surveys and collaboration with local fishers. Participatory activities, including workshops with local fishers' associations, surveys with individual fishers, and further discussions to co-plan future field surveys, aim to expand knowledge of deep-sea habitats in the region. These activities are being used to document fishers' knowledge of the main fishing grounds, identify priority areas for further conducting imaging surveys, but also capture long-term observations of habitat change from their own experience, including areas reported to have been altered over time by bottom-contact fisheries. Fishers are also contributing to the development of the survey approach by helping assess how cost-effective imaging platforms, including the Azor Drift Cam system and mini-ROVs, can be adapted for deployment from their vessels. The information gathered is helping identify priority sites for mapping and monitoring deep-sea habitats, particularly in locations likely to host Vulnerable Marine Ecosystems (VMEs). By combining local knowledge with low-cost imaging tools, this approach aims to support the development of locally informed monitoring and conservations approached along the northwestern Portuguese margin, while offering a replicable model for participatory deep-sea research in other regions.

Seeing through fishers' eyes: revealing the presence of VME indicator species in Portugal (S6-PC-07)

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Marine sponges and cold-water corals are essential components of benthic ecosystems, forming complex habitats that support marine biodiversity and key ecosystem functions. While only a subset of these species are formally recognised as Vulnerable Marine Ecosystems Indicators (VMEIs), establishing a comprehensive baseline of their diversity and distribution is critical, as information on these species is limited. This study presents a stepwise participatory approach for integrating Local Ecological Knowledge (LEK), to study the diversity and distribution of VMEIs along the northern and central Portuguese continental shelf. We conducted semi-structured interviews with 70 professional fishers using a sponge and coral photo catalogue to assess species recognition, spatial and bathymetric distribution, and relative abundance. Fishers recognised 46 morphospecies, including 33 classified as VMEIs (e.g. *Axinella infundibuliformis*, *Dendrophyllia cornigera* and *Neophrissospongia bowerbankii*) occurring between 100-700 m depth. Some of the fishers were engaged in the collection of sponge and coral bycatch during their regular fishing activities. This effort resulted in 345 specimens, representing 24 species, 10 of which were VMEIs. A follow-up workshop with 13 skippers involved reviewing photo catalogue and collected specimens, which allowed to further complement and validate the LEK. Fishers also identified nine areas that they perceive as biodiversity hotspots, thereby also supporting the design of upcoming exploration surveys. This participatory approach generated a valuable dataset on coral and sponge biodiversity and highlighted the important role that LEK can play to support the identification, monitoring and conservation of VMEs. Engaging fishers in the co-production of knowledge can enhance conservation efforts, inform restoration initiatives, and support sustainable management of marine ecosystems, particularly in such data-limited deep-sea environments.

Funding: This research was funded by the BioProtect project (Horizon Europe, GA101157341) and by national funds through FCT - Fundação para a Ciência e a Tecnologia, I.P., and by the European Commission's Recovery and Resilience Facility, within the scope of UID/04423/2025, UID/PRR/04423/2025, and LA/P/0101/2020.

Flash Talk

Presentations



Wednesday, 8th July

Session 1 - Marine Biodiversity & Ecosystem Functioning

Kelp forests as blue carbon contributors along the central Portuguese coast (S1-PC-54)

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Tracking the spread of the invasive kelp *Undaria pinnatifida* across Atlantic Iberia (S1-PC-55)

Mar Humet^{1,2}, Joana Pereira^{1,2,3}, João Nunes^{1,2}, Rocío Nieto-Vilela^{1,2,*}, Ana Sinde-Mano^{1,2}, Fernando P. Lima^{1,2,3}, Cátia Monteiro^{1,2}

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Widespread decline of canopy-forming macroalgae along the Slovenian coastline (northern Adriatic): evidence from an expanded long-term monitoring network (S1-PC-11)

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Current and Future Distribution of Portuguese Deep Sea VMEs (S1-PC-56)

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Development and changes in the microbial composition during seagrass decay at the southern German Baltic Sea coast (S1-PC-57)

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Transmissible Cancer Lineages in Iberian Cockles: Assessing Regional Distribution, Coexistence and Organ Tropism (S1-PC-42)

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Session 2 - Global Change and Multiple Stressors in Ocean Health

Monitoring Aquatic Ecosystem Health and Mitigating Plastic Pollution in European Rivers and Estuaries (S2-PC-10)

Garry F. Kett^{1,2,*}, Luis R. Vieira^{1,2}, Isabel Iglesias¹, Sandra Nogueira², Samuel Santos², Sara C. Antunes², Isabel Sousa-Pinto^{1,2}

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Habitat degradation risk in European deep seas (S2-PC-05)

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Metabolic and oxidative stress biomarkers reflect site-specific responses of intertidal gobies to a warming gradient (S2-PC-11)

Sofia Lopes^{1,2}, Matilde Martins^{1,3}, João Vitorino^{1,2,3}, Cátia Gonçalves^{1,2}, Bianca Allegra Parodi⁴, Anne Guichard⁴, Madalena Missionário⁴, Ricardo Calado⁴, Mário S. Diniz^{1,3}, Pedro M. Costa^{1,2}, Diana Madeira^{4,*}, Carolina Madeira^{1,2}

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Can kelp bounce back from a heatwave under ocean acidification? (S2-PC-15)

Carolina V. Mourato^{1,*}, Giulia Bocelli¹, Rui Santos¹, João Silva¹

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Reduced thermal performance of kelp recruits under an upwelling-limited climate change scenario (S2-PC-18)

Bianca Reis^{1,2,3,*}, João N. Franco³, Cheyenne Oliveira¹, Katerina Economou^{1,4}, Maria F. Sá¹, Isabel Sousa-Pinto^{1,2}, Francisco Arenas¹

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Ocean warming drives dramatic shifts in the fluxes of key greenhouse gases from the mat of *Posidonia oceanica* (S2-PC-19)

Tamara Smith^{1,2,*}, Fabio Blanco Murillo¹, Eileen Kröber³, Francesca Margiotta¹, Antonio Pusceddu⁴, Gabriele Procaccini¹, Fabio Bulleri², Ulisse Cardini¹

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Session 3 - Marine Conservation, Management & Policy

Restoring Mediterranean Macroalgal Forests: Improvement of In Situ Cultivation Methods for *Cystoseira* s.l. species (S3-PC-15)

Ana Lokovšek^{1,*}, Martina Orlando-Bonaca¹, Domen Trkov¹, Tihomir Makovec¹, Milijan Šiško¹, Simone Spinelli¹ & Neža Leban¹

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Nursery Function and Storm Resilience of a Restored Saltmarsh: a Before–After Control–Impact Study in the Mondego Estuary (Portugal) (S3-PC-08)

João M. Neto^{1,2,3,*}, João Fernandes^{1,2,3}, Luís Resende^{1,2,3}, Margarida H. Matias^{2,3}, Carlos Gonçalves^{1,2,3}, Sónia Seixas^{1,2,4}

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EMODnet Seabed Habitats: EUSeaMap(2025) and Habitat Mapping Products For Policy (S3-PC-02)

Fergal McGrath^{1,*}, Ville Karvinen², Jorge Manuel Dos Santos Gonçalves³, Mikkel Skovgaard Andersen⁴

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PAM for MPA monitoring: listening for noise pollution and illegal boat incursions (S3-PC-09)

Dafni Nikisanli^{1,*}, Manuel Vieira¹, M.Clara P. Amorim^{1,2}, Rodrigo Silva^{3,4}, Susanne Schäfer^{3,4}, João G. Monteiro^{3,4}

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Operationalizing OECMs in Marine Spatial Planning: Evidence from Italy (S3-PC-18)

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CoastNet infrastructure: an environmental quality data repository to support the management of the Portuguese coastal area (S3-PC-23)

Rui Cereja^{1,*}, Ana C. Brito^{1,2}, Bernardo R. Quintella^{1,2}, Carlos Alexandre³, Helena Adão³, Joana P. C. Cruz¹, Luciane Favareto¹, Luís Costa⁴, Paola Castellanos⁵, Paula Chainho¹, Susana França¹, José Lino Costa^{1,2}

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Session 6 - Citizen Science and Participatory Monitoring

Changing seas through the eyes of recreational fishers: a participatory monitoring of marine biodiversity and ecological trends in southern Italian waters (S6-PC-01)

Chiara Bacchiani^{1,*}, Marco Lopes¹, Calogero Fontana¹, Emanuele Asciutto^{1,2,3}, Francesco Longo¹, Pietro Battaglia^{1,2}

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From Fishing Vessels to Data: collaborative Mapping and Monitoring of Deep-Sea Habitats in the NW Portugal (S6-PC-06)

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Seeing through fishers' eyes: revealing the presence of VME indicator species in Portugal (S6-PC-07)

Ana Soares^{1,2,*}, Daniel Despujols², Celso Domingos^{1,2}, Andreu Santín², Joana Xavier^{2,3}

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Citizen Science in Maritime Supply Chain Management: A Participatory Monitoring Framework (S6-PC-04)

Muhammad Noman Shafique^{1,*}, Zeeshan Arshad¹, Altaf Akbar^{1,3}, Helena Vieira¹, Ana I. Lillebø², Nina Szczygiel³

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Upskilling ECRs in deep-sea science: Boosting careers through training activities and networking (S6-PC-05)

Inês Gregório^{1,2,*}, Tina Kutti³, Furu Mienis⁴, Joana R. Xavier^{1,5}

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Thursday, 9th July

Session 1 - Marine Biodiversity & Ecosystem Functioning

Sharks of the Gorringe Bank: new records from deep-sea video observations (S1-PC-34)

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Can rubble support reef recovery? Interactive Effects of Rubble Substrate Ecology and Submarine Groundwater Discharge on Coral Recruitment Dynamics (S1-PC-13)

Maria Pla Prah^{1,*}, Steve Doo¹

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Intertidal Biodiversity Mosaics and Thermal Heterogeneity Along the North-Western Iberian Coast (S1-PC-07)

Inês Ferreira^{1,2,3,*}, Fernando P. Lima^{2,3}, Kätlin Jeedas^{2,3}, Ana Sinde-Mano^{2,3}, Cátia Monteiro^{2,3}, Rocío Nieto-Vilela^{2,3}, Mar Humet^{2,3}, João Nunes^{2,3}, Matilde Águas^{2,3}, Rita da Silva^{2,3}

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Light matters: evaluating trap design and illumination for sampling larval assemblages in kelp forests (S1-PC-58)

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Session 2 - Global Change and Multiple Stressors in Ocean Health

Mussels as Sentinels of Coastal Pollution: Linking Microbial Load, Biochemistry, and Anthropogenic Pressure (S2-PC-12)

Luísa Ramalho¹, Marta Neves², Carla Tecelão², Susana Mendes², Paulo Maranhão^{2,*}

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Industrial thermal effluents drive compositional shifts in epibiont assemblages associated with the invasive pearl oyster *Pinctada radiata* in the Mediterranean Sea (S2-PC-14)

Maria Carolina Martone^{1,2,*}, Eugenio Geremia², Alessio Marrone³, Alan Deidun³, Sara Esposito Marroccella^{1,2}, Maria Antonietta Nitopi², Gaetana Napolitano^{1,2}, Luigia Donnarumma^{1,2}

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CHILL project - Coastal environments in the spotlight: integrating impacts of psychoactive drugs in coastal urban ecosystems under light pollution (S2-PC-04)

Maria D. Bordalo^{1,*}, Maria Pavlaki¹, Sílvia F.S. Pires¹, Francesca Coppola¹, Fernando Morgado¹, Gianluca Polese², Hugo C. Vieira¹, Andreia C.M. Rodrigues¹

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Impact of aerosols on chlorophyll-a distribution in the Arabian Sea using multi-satellite observations (S2-PC-24)

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Session 3 - Marine Conservation, Management & Policy

Joint disciplinary and cross-sectoral efforts to enhance Norway lobster protection, promote stock recovery, and ensure sustainable fisheries within an ecosystem-based management framework (S3-PC-01)

Morane Clavel-Henry^{1,*}, Miguel López², Nixon Bahamon², Jacopo Aguzzi², Joan Navarro², Maria Vigo², Damianos Chatzievangelou², Juliana Quevedo², Antoni Sánchez-Márquez², Mireia Mingote², Fabiola Cecchini², Joan B. Company²

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AURORA Shiny App – Converting Raw Biodiversity Data into Darwin Core Archives (S3-PC-21)

Sara M. Araújo^{1,*}, Álvaro Somensi¹, Ana Hilário¹, Heliana Teixeira¹, Sofia Ramalho¹, Eva Ramirez-Llodra², Fábio L. Matos¹

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Session 4 - Sustainable Food Production and Fisheries

SEALNet: Shape-Enhanced Adaptive Learning for Lightweight Underwater Fish Detection and Contour Reconstruction (S4-PC-20)

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Carbon fluxes in suspended shellfish aquaculture: developing an integrated metabolic assessment for bivalves and associated fouling communities (S4-PC-05)

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Sustainable Feed for Circular Aquaculture: Microencapsulated Phytase for Reducing Phosphorus Discharge (S4-PC-11)

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Metabarcoding-based assessment of marine macrozoobenthos in an offshore Integrated Multi-Trophic Aquaculture (IMTA) system in Southern Portugal (S4-PC-06)

Jorge Moutinho^{1,2,*}, M. Pilar Cabezas^{1,2}, André O. Ferreira^{1,2,3}, João Tadeu Fontes^{1,2}, Rafael Torres^{1,2}, Marcos Rubal¹, Sofia Duarte^{1,2}, Pedro Encarnação⁴, Filipe O. Costa^{1,2}

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Impact of marine heatwave on the condition and quality of *Magallana gigas* (Thunberg, 1793) oysters (S4-PC-01)

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Influence of cold stress on pigment composition and physiological parameters in *Cassiopea xamachana* (S4-PC-16)

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Session 5 - Blue Biotech Innovations: From Marine Biodiversity to Bioactive Solutions

Temporal bioactivity shifts in a brown alga: the case of *Bifurcaria bifurcata* (S5-PC-18)

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An investigation on the pigments in the sea star (Asteroidea) *Astropecten aranciacus* (Linnaeus, 1758) (S5-PC-17)

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Cellulose extraction from the brown algae *Rugulopteryx okamurae* for textile applications (S5-PC-19)

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