# BOOK OF ABSTRACTS

8th European Conference on

SCIENTIFIC DIVING

Heraklion, Crete | 22-26 April 2024

# Περιεχόμενα

# WELCOME

Every year, the European Conference on Scientific Diving (ECSD) provides an international platform for the community of European leaders in the field of scientific diving, early-stage researchers and students to present results from their most recent underwater research. Furthermore, the event serves as a platform to learn about and discuss newly developed technologies, safety issues, as well as institutional issues.

The ECSD in its current form was initiated in 2015 by the Marine Board European Scientific Diving Panel (ESDP). The aim was to combine the “International Symposium on Occupational Scientific Diving (ISOSD)” and the international workshop “Research in Shallow Marine Water Systems” into one general annual meeting.

The first ECSD took place in Stuttgart, Germany, in 2015. The following conferences were hosted in Kristineberg, Sweden (2016), Funchal, Madeira/Portugal (2017), Orkney, Scotland/UK (2018), Sopot, Poland (2019), Freiberg, Germany (2021; video conference), respectively and in Roscoff, France (2023).. The 8th edition of the ECSD takes place in Heraklion at the island of Crete, Greece, 22-26 April 2024.

Main topics for the talks and posters may concern **biology/ecology, physical oceanography, biogeochemistry, geosciences, archaeology, technologies, scientific diving (SD) education and training, and SD regulation**.

Marine spatial planning and marine renewable energies may be also new emerging topics when considering the growing demand for sustainable management of the littoral and coastal zones and environmental issues associated with the setting up of MRE technologies.

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# COMMITTEES

**Scientific Conference Organization:**

**Dr. Thanos Dailianis** & **Dr. Maria Salomidi,** Hellenic Centre for Marine Research (HCMR)

**SCIENTIFIC Committee:**

**Dr. Maria Salomidi,** Researcher, Institute of Oceanography, HCMR, Greece

**Dr. Thanos Dailianis,** Researcher, Institute of Marine Biology, Biotechnology & Aquaculture, HCMR, Greece

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**Dr. Martin Sayer,** Managing Director, Tritonia Scientific Ltd., UK

**Dr. Christos Arvanitidis,** Chief Executive Officer, LifeWatch ERIC, Spain

**Prof. Giorgos Tsounis,** Adjunct Professor, Dept. of Biology, California State Univ., USA

**Dr. Theotokis Theodoulou,** Archaeologist PhD, Diver, Ephorate of Underwater Antiquities, Greece

**Prof. Vasilis Gerovasileiou,** Assistant Professor, Dept. of Environment, Ionian Univ., Greece

**Prof. Dr. Dr. MSc Niki Evelpidou,** Dept. of Geology and Geoenvironment, NKUA, Greece

**Prof. Eleni Voultsiadou,** Professor Emeritus, Dept. of Biology, Aristotle Univ. of Thessaloniki, Greece

**Dr. Maria Sini**, Research Fellow, Dept. of Marine Sciences, Univ. of the Aegean, Greece

**Dr. Yiannis Issaris,** Research Associate, Institute of Oceanography, HCMR, Greece

**Dr. Alex Tourtas,** Post Doc Res., Dept. of Cultural Technology and Communication, Univ. of the Aegean, Greece

**Dr. Vasilis Gerakaris,** Research Associate, Institute of Oceanography, HCMR, Greece

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**Dr. Maria Salomidi,** Researcher, Inst. of Oceanography, HCMR, Greece

**Dr. Vasilis Gerakaris,** Research Associate, Inst. of Oceanography, HCMR, Greece

**Dr. Yiannis Issaris,** Research Associate, Inst. of Oceanography, HCMR, Greece

**Dr. Georgios Chatzigeorgiou,** Technician, Inst. of Marine Biology, Biotechnology & Aquaculture, HCMR, Greece

**Eleni Kytinou,** PhD candidate, Inst. of Oceanography, HCMR, Greece

**Grigorios Skouradakis,** PhD candidate, Inst. of Marine Biology, Biotechnology & Aquaculture, HCMR, Greece

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**Scientific Conference Organization:**

Hellenic Centre for Marine Research (HCMR)

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ΕΛΚΕΘΕ

The Conference is supported by the European Scientific Diving Panel (ESDP)

esdpanel.eu

EUROPEAN SCIENTIFIC DIVING PANEL
MARS
The European Network of Marine Research Institutes and Stations

# KEYNOTE SPEAKERS

**Dr. Lorenzo Bramanti** – *Laboratoire d'Ecogéochimie des Environnements Benthiques, LECOB, Observatoire Océanologique de Banyuls sur Mer, Centre National de la Recherche Scientifique (CNRS)-Sorbonne Université, Banyuls sur Mer, France*

***Title: "Under the Pole DEEPLIFE Expeditions: Mesophotic Marine Animal Forests"***

**Pierre-Yves Cousteau –** *Founder and President of Cousteau Divers*

***Title: "Cousteau Divers: Citizen Science for Recreational SCUBA Divers"***

**Dr. Stella Demesticha** – *Associate Professor of Maritime Archaeology, Archaeological Research Unit, University of Cyprus, Cyprus*

***Title: "Shipwreck Archaeology in the eastern Mediterranean: key challenges and perspectives"***

**Prof. Stelios Katsanevakis** – Department of Marine Sciences, University of the Aegean, Greece

***Title: "Ecological status and biodiversity shifts in Mediterranean shallow marine ecosystems: drivers and challenges"***

# SPONSORS

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**Official Air Carrier Sponsor:**

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# USEFUL CONTACTS

| | |
|---|---|
| Heraklion city buses information | 2810 283270 |
| Taxi Heraklion | 2810 361362, 2810 210102, 2814 003084 |
| Ambulance | 166 |
| Fire Department | 199 |
| Police | 100 |
| Medical Center- CRETA INTERCLINIC | 2810 373800 |
| Public Hospital Venizeleio | 2813 408000 |
| University General Hospital of Heraklion "PAGNI" | 2813 402111 |

**Local Conference Secretariat (Crete, Greece):**

**"Diazoma Conferences & Events"** diazoma.net

Tel: 6908 215112, 2810 321494

Email: info@diazoma.net, conferences@diazoma.net, meetings@diazoma.net

# SOCIAL EVENTS

**HERAKLION SIGHTSEEING AND MUSEUM 26th APRIL 2024**

Excursion organized for the **26th of April**. We will meet at the Archaeological Museum of the city for a guided tour with an English-speaking guide.

We will continue with a walking tour of the city of Heraklion. Duration of excursion 09:30-13:30.

The Heraklion Archaeological Museum was founded in 1908 to house the first collections of Cretan antiquities, which were rapidly enhanced. Its cultural riches cover seven millennia, from the Neolithic period (7000 BC) to Roman times (3rd cent. AD). Following the restoration work of the past few years, completed in May 2014, the exhibition is housed in 27 rooms. The collections are now displayed according to modern museological practices and design, in chronological and thematic units accompanied by audiovisual material and introductory texts.

Price: 15.00 euros + 12.00 euros entrance fee.

(The excursion will be realized with a minimum number if 20 participants).

**DIVING EXCURSION 26th APRIL 2024**

The dive site will be Mononaftis, a typical rocky reef site with local biodiversity, located in Agia Pelagia Peninsula. The expected seawater temperature in late April is 18ºC. Maximum depth of the dive will be 20 m, duration of dive: 60 min. An alternative dive site in South Crete is planned if adverse weather conditions are foreseen for the day.

We will accommodate a limited number of participants on a priority basis. Price for participation per person is 30€ (own equipment) or 60€ (with equipment rental) and includes transportation to the dive site.

Price to be paid on site.

**GALA DINNER 24th APRIL 2024**

The gala dinner is included in the conference registration fee. It will take place at the restaurant “NTORE” in the city center of Heraklion. It is a fine rooftop restaurant and bar, with an amazing view of the city center and the port of Heraklion.

# GENERAL INFORMATION

**THE VENUE**

The 8th European Conference on Scientific Diving (ECSD) will take place in the **Cultural – Conference center of Heraklion** and specifically in the conference room called "Experimental Stage".

The Cultural and Conference Center of Heraklion is a modern venue in Crete dedicated to performing arts and scientific meetings. After many years in the making, it made its official debut in 2019. It has been built near some important historical sites of the city of Heraklion, such as the remnants of the Venetian walls and the burial site of the Greek writer and Heraklion native Nikos Kazantzakis. It is also close to Heraklion city center and to many city hotels.

Venue address: Nikolaou Plastira 49, 712 01 Heraklion, Greece
Please visit cccc.gr for more.

**CRETE**

Crete is the most southern region of Greece and Europe, separating the Aegean Sea from the Libyan Sea, it marks a physical boundary between Europe and Africa. It is the largest Greek island and one of the largest in the Mediterranean basin, with a total surface of 8,336 km$^2$, 1,100 km of coastline and approximately 623,000 inhabitants.


The island of Crete boasts a long and turbulent history and a fascinating culture. Cultural influences from other civilizations of the West and the East, as well as the remains of the glorious Minoan civilization (c. 2700-1420 BC), are found across the island. This mix of civilizations has marked contemporary Cretan culture, which is still vibrant and distinctive as it has always been.

The Cretan land encompasses an amazing variety of landscapes and landforms. Crete is renowned for its breathtaking mountain ranges, fertile valleys, the plethora of caves, gorges and plateaus of exceptional beauty as well as for its long sandy beaches and clear blue seas. Historic and cultural attractions, Cretan traditions, traditional settlements, monuments, archaeological sites, social mores,

the local proceedings, the Cretan cuisine, the natural environment, the folkloric richness, remarkable ecosystems and unique landscapes are waiting to be discovered.

If you would like to discover more about Crete visit:

incrediblecrete.gr
cretanbeaches.com

**HERAKLION**

Heraklion is the capital of Crete, the largest urban centre in Crete and the economic centre of the island with approximately 200,000 people. The town of Heraklion is a vibrant small metropolis and combines urban scenery, archaeological and cultural heritage with natural beauty.

The first European civilization, the Minoan civilization, flourished on this land 5000 years ago and can still be experienced today by visiting the ancient palace of Knossos Archaeological Site and the Archeological Museum of Heraklion.

**HOW TO COME TO HERAKLION**

Arriving by plane

You can fly directly to Heraklion International **Airport "Nikos Kazantzakis" (HER).** Heraklion International Airport "Nikos Kazantzakis" is the second busiest airport of Greece during summer period. Charter flights directly connect Heraklion with 43 countries and more than 100 airports around the world. In case there is not a direct flight from your city to Heraklion, the best option is to arrive in Heraklion through Athens. Around 12 flights per day arrive to Heraklion from Athens and the duration of the flight is just 40 minutes.

**You are strongly advised to choose a flight to Heraklion International Airport.** Alternatively, one can land to Chania International Airport and reach Heraklion by bus or car. Please keep in mind that Crete is a big island and **the driving distance between Heraklion and Chania is 142km (around 2,5 hours).**

Once you arrive at the Heraklion airport you can use public transport (buses) or a taxi for your transfer to your hotel or the conference venue. Also, you could rent a car. Bus station, taxi station and many rent- a -car companies are in the airport area.

For more information for local transportation in the city please visit: astiko-irakleiou.gr.

Arriving by ship

The city of Heraklion is connected to Piraeus port (close to Athens) daily. You could use this option but keep in mind that it is a longer trip (9 hours). You could arrive in Athens, use the public transport to reach Piraeus port and travel by ship directly to Heraklion port, which is close to the city center.

For more information and boat tickets booking please visit: minoan.gr and anek.gr.

# PROGRAMME TABLE

## MONDAY 22/04/2024

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| **18.00 - 21.00** | Registrations & Welcome Reception |

## TUESDAY 23/04/2024

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|---|---|
| **8.30 – 9.00** | Registrations |
| **9.00 – 9.30** | **Conference Opening with introductory word from IMBBC Director**<br>**Dr. Constantinos Mylonas** |
| **9.30 – 10.15** | **Keynote Speech by Prof. Stelios Katsanevakis**<br>*"Ecological status and biodiversity shifts in Mediterranean shallow marine ecosystems: drivers and challenges"* |
| **10.15 – 11.30** | **SESSION I: Monitoring & management of marine ecosystems under a changing climate**<br>**Chair: Maria Salomidi** |
| **10.15 – 10.30** | ***OP1: "Scientific diving as a tool to evaluate the effect of Marine Protected Areas in safeguarding kelp forests against herbivores"***<br>Reis Bianca*, Sánchez-Gallego Álvaro, Marques Alexandre, Arenas Francisco, Sousa-Pinto Isabel, Franco, João N |
| **10.30 – 10.45** | ***OP2: "The mega-benthic community of Amvrakikos Gulf in the context of climate change"***<br>Gavriel Eleni*, Spinos Efthimios, Ramfos Alexis |
| **10.45 – 11.00** | ***OP3: "Assessment of biodiversity, pressures and threats in marine caves in a protected area of the South-Eastern Aegean Sea, Greece"***<br>Gerovasileiou Vasilis*, Digenis Markos, Dailianis Thanos |
| **11.00 – 11.15** | ***OP4: "Ecological notes on macrozoobenthic Amphipoda populations, recruited on artificial anti-trawiling barriers, in the North-West Sardinia, by the means of scuba diving"***<br>Trabucco Benedetta*, De Simone Michela, Di Cosmo Anna, Nonnis Ornella, Tomassetti Paolo, Massara Francesca |
| **11.15 – 11.30** | ***OP5: "Ecological evaluation of the rocky reef complex of Chrysi islet, (Eastern Mediterranean) reveals a degraded state of benthic communities and canopy algae"***<br>Skouradakis Grigorios*, Vernadou Emmanouela, Chatzigeorgiou Giorgos, Shealy Errikos, Koulouri Panagiota, Dailianis Thanos |
| **11.30 – 12.00** | **Coffee Break** |
| **12.00 – 13.30** | **SESSION I (cont.): Monitoring & management of marine ecosystems under a changing climate**<br>**Chair: Vasilis Gerovasileiou** |
| **12.00 – 12.15** | ***OP6: "T-MEDNet: a collaborative network to track mass mortality events in the Mediterranean Sea"***<br>Ponti Massimo*, Garrabou Joaquim, Ben Souissi Jamila, Bensoussan Nathaniel, Carlot Jeremy, Cebrian Emma, Cerrano Carlo, Comeau Steeve, Galobart Cristina, Gattuso Jean-Pierre, Gerovasileiou Vasilis, Gómez-Gras Daniel, Katsanevakis Stelios, Ledoux Jean-Baptiste, Millán Agudo Lucia, Montefalcone Monica, Pulido Mantas Torcuato, Ramirez-Calero Sandra, Rilov Gil, Santamaría Jorge, Sini Maria, Tamburello Laura, Teixidó Nuria, Turicchia Eva |
| **12.15 – 12.30** | ***OP7: "SCUBA sampling and acoustic survey coupling in shallow sandy bottoms"***<br>Turicchia Eva*, Abbiati Marco, Mercuri Silvia, Bidini Camilla, Mercorella Alessandra, Del Bianco Fabrizio, Stanghellini Giuseppe, Ponti Massimo |

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| **12.30 – 12.45** | ***OP8: "Developing a standardized approach to record and monitor biodiversity trends on cylindrical artificial structures"***<br>Vernadou Emmanouela*, Skouradakis Grigorios, Dailianis Thanos |
| **12.45 – 13.00** | ***OP9: "Scientific equipment below the Mediterranean Sea surface to monitor epiphytic assemblages of Posidonia oceanica leaves and pollutant concentrations"***<br>Mirleau Pascal*, Sarkis Noelle, Rigal Camille, Amadei Cedric, Amella Hugo, Meglecz Emese, Guillemain Dorian, Angeletti Bernard, Doumenq Pierre, Malleret Laure |
| **13.00 – 13.15** | ***OP10: "Monitoring Coastal Marine Seascapes in the edge of climate change"***<br>Poursanidis Dimitris*, Ragousis Michalis, Digenis Markos, Papadakis Orestis, Papadimitriou Evangelos, Karampi Maria, Sini Maria, Gerovasileiou Vassilis, Katsanevakis Stelios |
| **13.15 – 13.30** | ***OP11: "Lionfish (Pterois miles) in the Mediterranean Sea: available knowledge and updates on the invasion front"***<br>Bottacini Davide*, Pollux Bart, Nijland Reindert, Jansen Patrick, Naguib Marc, Kotrschal Alexander |
| **13.30 – 14.30** | **Lunch Break** |
| **14.30 – 16.00** | **SESSION II: Advancing Science in Aquatic Ecosystems**<br>**Chair: Thanos Dailianis** |
| **14.30 – 14.45** | ***OP12: "A window to the future: field research at unique CO2 vents along the coast of Ischia (Italy)"***<br>Teixido Nuria*, Alliouane Samir, Boada Jordi, Carbonne Chloe, Carlot Jeremy, Chiarore Antonia, Rosanna Guglielmo, Iacono Bruno, Lorenti Maurizio, Valerio Mazzella, Mirasole Alice, Núñez-Pons Laura, Somma Emanuele, Comeau Steeve |
| **14.45 – 15.00** | ***OP13: "Seagrass archives on the search of the environmental history of the Eastern Mediterranean coasts"***<br>Garcia Escudero Catalina Andrea*, Apostolaki E. T. |
| **15.00 – 15.15** | ***OP14: "Efficient Stereo-DOV approaches for investigating mesophotic reef assemblages: the case of a red coral (Corallium rubrum) demography study in the Aegean Sea"***<br>Issaris Yiannis*, Gerakaris Vasilis, Salomidi Maria |
| **15.15 – 15.30** | ***OP15: "Assessment of benthic communities in sea caves of Dugi Otok Island (Adriatic Sea, Croatia)"***<br>Digenis Markos*, Marchio Alfredo, Natsios Fotis, Efthimiou Maria, Dailianis Thanos, Petricioli Donat, Bakran-Petricioli Tatjana, Gerovasileiou Vasilis |
| **15.30 – 15.45** | ***OP16: "Looking for the best fitting plane: BORA as an innovative multi-habitat artificial reef structure for the restoration of Mediterranean coralligenous species"***<br>Roveta Camilla*, Calcinai Barbara, Campanini Claudia, Coppari Martina, Di Camillo Cristina Gioia, Gregorin Chiara, Marrocco Teo, Pulido Mantas Torcuato, Cerrano Carlo |
| **15.45 – 16.00** | ***OP17: "Towards a better understanding of the ecophysiology and impact of quagga mussels in Lake Geneva"***<br>Stephan Jacquet*, Jean-Nicolas Beisel, Viet Tran-Khac, Jonathan Grimond, Leana Revirand, Erwin Reymondet, Jean-Philippe Jenny |
| **16.00 – 16.30** | **Coffee Break** |
| **16.30 – 18.00** | **SESSION II (cont.): Advancing Science in Aquatic Ecosystems**<br>**Chair: Louis Hadjiioannou** |
| **16.30 – 16.45** | ***OP18: "Tracking changes in benthic community composition along the seabird colony impact gradient with a photo-quadrat surveys in the Arctic"***<br>Bałazy Piotr*, Włodarska-Kowalczuk Maria, Chełchowski Maciej, Opalińska Zuzanna, Zmudczyńska-Skarbek Katarzyna |

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| **16.45 – 17.00** | ***OP19: "It does not count who counts: the observer effect in visual surveys of sublittoral rocky reefs is negligible"***<br>Azzola Annalisa*, Oprandi Alice, Mancini Ilaria, Robello Chiara, Morri Carla, Bianchi Carlo Nike, Montefalcone Monica |
| **17.00 – 17.15** | ***OP20: "Development of a quantitative diving survey protocol for assessing food web structure and shifts in shallow rocky reefs"***<br>Kytinou Eleni*, Issaris Yiannis, Sini Maria, Salomidi Maria, Dailianis Thanos, Kokkinis Odysseas, Coll Marta, Katsanevakis Stelios |
| **17.15 – 17.30** | ***OP21: "Functional responses of the Chilean scallop, Argopecten purpuratus (Bivalvia: Pectinidae), to environmental variability along the Chilean coasts: past achievements"***<br>Thouzeau Gerard*, Avendano Miguel, Cantillánez Marcela, Stotz Wolfgang |
| **17.30 – 17.45** | ***OP22: "Using underwater Structure from Motion (SfM) as a blueprint for Marine Nature-Based solutions in Eastern Mediterranean (Cyprus)"***<br>Moraitis Manos*, Georgiou Antroula, Neophytou Maria, Pedrotti Felix |
| **17.45 – 18.00** | ***OP23: "An incubation chamber for water column sampling: experimental trial with marine sponges in an IMTA system"***<br>Aguilo-Arce Joseba*, Trani Roberta, Oddenino Muriel, Ferriol Pere, Longo Caterina |

| WEDNESDAY 24/04/2024 | |
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| **9.00 – 9.45** | **Keynote Speech by Dr. Stella Demesticha**<br>*"Shipwreck Archaeology in the eastern Mediterranean: key challenges and perspectives"* |
| **9.45 – 11.00** | **SESSION III: Maritime Archaeology Session**<br>**Chair: Stephanie Blankshein** |
| **09.45 – 10.00** | ***OP24: "Scientific diving in Greece in the framework of underwater archaeology. The case of Crete"***<br>Theodoulou Theotokis*, Tsimpoukis George, Tourtas Alexandros, Kourkoumelis Dimitris, Foley Brendan |
| **10:00 – 10:15** | ***OP25: "Navigating the Depths of Shallow Water Archaeology"***<br>Blankshein Stephanie*, Pedrotti Felix*, Sturt Fraser |
| **10.15 – 10.30** | ***OP26: "Scientific documentation of Underwater Cultural Heritage in Greece. The case of diveable 20th c. historic wrecks."***<br>Tourtas Alex*, Papadimitriou Kimon, Karadimou Elpida, Theodoulou Theotokis |
| **10.30 – 10.45** | ***OP27: "The archaeology of diving and diving's cultural significance in antiquity"***<br>Mylona Dimitra* |
| **10.45 – 11.00** | ***OP28: "Over a century of activities at the Antikythera shipwreck: Evolution of the applicable underwater research methods and latest scientific achievements"***<br>Sotiriou Alexandros*, Simosi Angeliki, Baumer Lorenz, Manousos Orestes, Ogloblin-Ramirez Isaac |
| **11.00 – 11.30** | **Coffee Break** |
| **11.30 – 12.45** | **SESSION IV Scientific Diving Education/Training Session**<br>**Chair: Gerard Thouzeau** |
| **11.30 – 11.45** | ***OP29: "British Antarctic Survey Diving Operations"***<br>Gilkinson Shea*, Brian Mike |
| **11.45 – 12.00** | ***OP30: "Best practices and other educational materials to prevent scuba diving impact in the Mediterranean Sea"***<br>Di Camillo Cristina*, Turicchia Eva, Quadrini Giada, Roveta Camilla, Storari Annalisa, Scarpa Clarissa, Coppari Martina, Gregorin Chiara, Marrocco Teo, Pulido Mantas Torcuato, Torsani Fabrizio, Cerrano Carlo, Ponti Massimo |
| **12:00 – 12.15** | ***OP31: "ISO standards for scientific diving. Are those standards addressing Occupational Scientific Diving or Citizen Science Diving?"***<br>Norro Alain*, Feral Jean-Pierre |
| **12.15 – 12.30** | ***OP32: "Scientific diving hazards demand specific safety standards"***<br>Seferlis Miltiadis*, Karatzas Nikos, Evelpidou Niki |
| **12.30 – 12.45** | ***OP33: "An academic curriculum targeted at providing skills and knowledge to aspiring scientific divers"***<br>Iossifidis Thomas*, Evelpidou Niki, Karatzas Nikos |
| **12.45 – 13.30** | **Round table discussion on emerging SD standards and diving education (coordinator: Martin Sayer)** |
| **13.30 – 14.30** | **Lunch Break** |
| **14.30 – 16.00** | **POSTER SESSION** |
| **16.00 – 19.00** | Visit to the HCMR facilities and the Cretaquarium |
| **19.00 – 20.30** | Free time |
| **20.30 – 23.00** | Gala Dinner |

| THURSDAY 25/04/2024 | |
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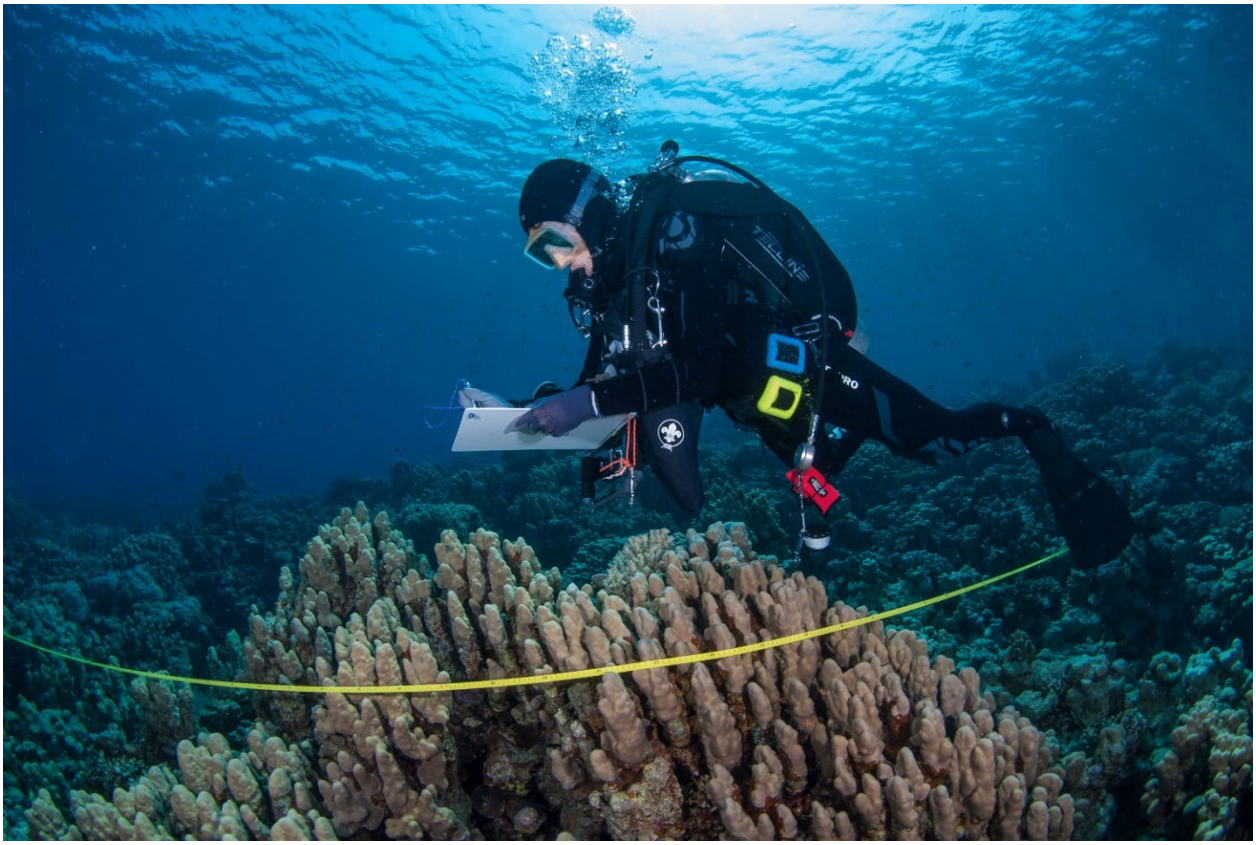
| **9.30 – 10.15** | **Keynote Speech by Pierre-Yves Cousteau**<br>*"Cousteau Divers: Citizen Science for Recreational SCUBA Divers"* |
| **10.15 – 11.00** | **SESSION V: Marine Geosciences**<br>**Chair: Niki Evelpidou** |
| **10.15 – 10.30** | ***OP34: "Where geomorphology and natural hazards meet scientific diving: the case of the submarine landslide at Gialtra, North Euboean Gulf, Greece"***<br>Harris Scott, Saitis Giannis, Evelpidou Niki*, Karkani Anna, Karatzas Nikos, Papanis Prokopis |
| **10.30 – 10.45** | ***OP35: "Exploring Coastal Evolution: Integrating Scientific Diving, Geomorphological research, and Sea Level Changes"***<br>Karkani Anna*, Evelpidou Niki |
| **10.45 – 11.00** | ***OP36: "Importance of scientific diving in 30 years of research in marine lake Zmajevo Oko, Adriatic Sea"***<br>Petricioli Donat*, Bakran-Petricioli Tatjana |
| **11.00 – 11.30** | **Coffee Break** |
| **11.30 – 12.30** | **SESSION VI: Integrating new technologies in underwater research**<br>**Chair: Massimo Ponti** |
| **11.30 – 11.45** | ***OP 37: "I want to break free... of mucilage! SUEX Discovery vacuum pump as an innovative tool for the mucilage removal from benthic coralligenous organisms"***<br>Pulido Mantas Torcuato*, Berardone Simone, Borelli Bruno, Cappa Gian Andrea, Cappanera Valentina, Coppari Martina, Marrocco Teo, Roveta Camilla, Segatto Marco, Di Camillo Cristina Gioia, Cerrano Carlo |
| **11.45 – 12.00** | ***OP38: "ResuS: Handling of lacustrine sediments in barrages – a case study from the RWA Freiberg"***<br>Adamek Judy, Stanulla Richard*, Hartmann Clemens, Scheytt Traugott |
| **12.00 – 12.15** | ***OP39: "Using digital twins to advance our understanding and management of popular dive sites"***<br>Cai Leda*, Pedrotti Felix, Hadjioannou Louis |
| **12.15 – 12.30** | ***OP40: "SCUBA diving as an essential tool for monitoring global ocean temperatures"***<br>Sayer Martin*, Marlowe C, Azzopardi E, Sayer-Mitchell JD |
| **12.30 – 13.30** | **Round Table/Workshop: Diving into Synergy: "Unifying Biological, Geological, and Archaeological Perspectives in Underwater Research" (coordinator: Yiannis Issaris)** |
| **13.30 – 14.30** | **Lunch Break** |
| **14.30 – 15.15** | **Keynote Speech by Dr. Lorenzo Bramanti**<br>*"Under The Pole DEEPLIFE Expeditions: Mesophotic Marine Animal Forests"* |
| **15.15 – 16.30** | Documentary Screening - Under the Pole Expeditions - short discussion |
| **16.30 – 17.00** | Closing of the ECSD8 - Concluding remarks - Awards of the best posters and talks - Announcement of the next ECSD |
| **17.00 – 19.00** | Participants to the dive to be transported to the diving facilities to prepare equipment |
| **FRIDAY 26/04/2024** | |
| **8.30 – 13.30** | Diving excursion (for those registered) |
| **9.30 – 13.30** | Visit to the Archeological Museum of Heraklion (for non-divers) |



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# POSTER SESSION - WEDNESDAY 24/04/2024

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| **P1** | ***"The GFCM research programme on red coral"***<br>Aurelle Didier*, Kreckelbergh Eugenie, GFCM Red Coral expert group |
| **P2** | ***"Evaluating Aquaculture's Impact on Maërl Bed Biodiversity"***<br>Chatzigeorgiou Giorgos*, Rallis Ioannis,Gratsia Eirini,Maidanou Maria,Naletaki Maria, Tsapakis Emmanouil |
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# ABSTRACTS_ORAL PRESENTATIONS

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## Scientific diving as a tool to evaluate the effect of Marine Protected Areas in safeguarding kelp forests against herbivores (OP1)

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Understanding the dynamics of herbivory in marine ecosystems, such as kelp forests, is crucial for determining their potential ecological impacts and providing support for effective conservation, management, and eventual restoration strategies. In this study, we assessed the effects of herbivory on two common kelp species, *Laminaria ochroleuca* and *Sacchorhiza polyschides*, in two distinct subtidal regions in central Portugal: Peniche (39°21'20.88"N; 9°22'52.03"W), a coastal non-protected area with dense kelp forest habitats; and Berlengas archipelago (39°24'55"N; 9°30'34"W), a Marine Protected Area with few kelps. Through *in-situ* tethering experiments we quantified the rates of herbivory at two depth levels (shallow and deep) and two seasons (summer and autumn). Additionally, we assessed faunal composition on the study sites using scientific diving sampling methods such as Underwater Visual Census and Diver-Operated video surveys. Our findings revealed significant differences in herbivory rates (consumed kelp biomass) among the study sites. These were higher in protected areas – Berlengas; compared to non-protected areas - Peniche; and differed between kelp species and season. Furthermore, herbivory rates were also higher at deeper sites. The faunal composition analysis demonstrated contrasting patterns between locations with herbivorous fish abundance being higher in Berlengas and sea urchin abundance higher in the shallow area of Peniche. This suggests that fish are likely a greater threat than sea urchins in the Portuguese kelp forests. These findings highlight the need for improved understanding and management of Marine Protected Areas and conservation approaches that encompass the protection of diverse habitats and ecosystems beyond fish populations alone. Moreover, our study emphasizes the importance of considering multiple factors, such as habitat protection, depth gradients, seasonal variations, and faunal composition, when assessing herbivory rates as a stressor and formulating effective conservation strategies.

# The mega-benthic community of Amvrakikos Gulf in the context of climate change (OP2)

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The study of protected coastal areas is more urgent than ever due to anthropogenic pressures, increasing eutrophication and hypoxic water masses, as well as global warming and acidification due the rising of $CO_2$. The increase of $CO_2$ in the atmosphere has affected the chemical balance of inorganic carbon in seawater, causing rising temperatures and decrease in pH, adversely affecting aquatic organisms and important habitats such as coral reefs. Calcium shell benthic organisms are actively involved in the chemical balance of inorganic carbon, especially when they are in high abundance, but at the same time they are the most sensitive and vulnerable to changes in this balance. Amvrakikos Gulf is a very dynamic eutrophic ecosystem which seems to be degrading the last decades, resulting in an increase in the extent and intensity of hypoxia (<2mg $DO_2$) in the deep layer. In the oxygenated layer (0-20m) the mega-benthic fauna presents rare elements for the Mediterranean environment as it is characterized by the particularly high abundance of a few species with calcareous shells (sea urchins, bivalves, gastropods, barnacles, corals) and the absence of macroalgae, while it remains understudied. The present study focuses on the estimation of the distribution and population characteristics (density, biomass, size distributions), of the mega-benthic target species (*Paracentrotus lividus*, *Pinna nobilis*, *Arca noae, Cladocora caespitosa*, *Hexaplex trunculus* and some Holothuria and Ophiuroid species). A total of 21 line-transects were performed in the period July – October 2023 in the depth range of 0 – 11m depth, covering several areas in the gulf. Different methods were applied for the estimation of the density of each species depending on its abundance and substrate type. Density estimation was performed through in-situ enumeration of individuals or photography in quadrats, followed by enumeration in digital images. Preliminary results indicate very high densities of *P. lividus*, on all hard substrates (up to 350 ind/$m^2$) in the gulf, a significant presence of the murex gastropod *Hexaplex trunculus*, extensive populations of Noah's Ark bivalve *Arca noae* on hard substrates, and a notable presence of the endangered pillow coral *Cladocora caespitosa* in various sizes. Certain areas of the gulf also harbor extremely dense populations of brittle stars and sea anemones, while holothuria were present in almost all substrates and sites in low numbers. *Pinna nobilis* individuals were present in several sites that seem to have survived the mass mortality events between 2016 and 2019 that nearly decimated populations across the entire Mediterranean.

# Assessment of biodiversity, pressures and threats in marine caves in a protected area of the South-Eastern Aegean Sea, Greece (OP3)

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Marine caves are considered biodiversity reservoirs and are protected by the European Union's Habitats Directive (habitat code 8330) and the Barcelona Convention under the Dark Habitats Action Plan. However, they receive multiple pressures and threats due to human activities and climate change. Recent extended surveys within NATURA 2000 sites of Karpathos and Saria Islands (South-eastern Aegean Sea, Greece) have revealed such pressures in numerous sea caves. In spring of 2023, 18 sea caves in this area were surveyed with scientific diving within the project "Study and clean-up activities of marine caves and rapid assessment of pressures/threats, non-indigenous species and protected benthic species", in the framework of the action "Support of the Dodecanese Protected Areas Management Body for the implementation of management measures for protected areas, species and habitats (MIS 5034797)", of the NSRF 2014-2020 Operational Program "Transport Infrastructure, Environment and Sustainable Development". A rapid assessment survey was carried out focusing on benthic biota, non-indigenous species and protected species. In addition, where necessary, litter was collected, and their type and weight were recorded. A rich biodiversity was recorded, consisting of 218 taxa (139 sessile and 79 motile), including 14 protected and 15 non-indigenous species. The number of non-indigenous species observed in each cave ranged from 1 to 9, while most species were found in the semidark parts of the caves. A total number of 4470 litter items were collected, weighing 44 kg in total. The vast majority was artificial polymer materials that had piled up on the internal beach of a semi-submerged cave which is used as a habitat by the endangered Mediterranean monk seal. In addition, partial necrosis or mortality of calcareous red algae and benthic invertebrates was observed in many caves. The above results, coupled with the finding of rare bioconstructions made up by deep-water rock sponges, highlight the urgent need for protecting and monitoring these unique habitats.

# Ecological notes on macrozoobenthic Amphipoda populations, recruited on artificial anti-trawiling barriers, in the North-West Sardinia, by the means of scuba diving (OP4)

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This work is a part of a broader environmental monitoring initiative conducted by the Institute for Environmental Protection and Research (ISPRA) within the SAPEI Project, implemented by Terna S.p.A. with the installation of two marine cables between the Lazio coast and Sardinia. During inspections conducted at various points along the cables, damage attributable to anthropogenic actions, likely illegal bottom trawling activities, was observed. To safeguard the connection, protecting the cables from potential illicit activities while simultaneously promoting the protection of existing ecosystems, tripods, artificial anti-trawling barriers, were introduced. Our work then focuses on observing recruitment on anti-trawling barriers to evaluate the colonization of artificial substrates introduced into the marine environment. In particular, the research involved the identification of amphipod species present in samples collected by the means of scuba diving, from eight selected stations. Samples were collected by scientific divers by direct collection with an air operated suction suppler of a surface enclosed in a 20 x 20 cm square. Amphipods emerge as one of the most diversified and fascinating groups of crustaceans inhabiting marine waters and can serve as a partial descriptor of the community, providing a tool to assess the current state of the ecosystem. The data obtained by the sample analysed confirm findings from similar studies conducted in other coastal areas and highlight the challenges in predicting the processes and timing of colonization by macrobenthic organisms. The data obtained indicate a well-established state of colonization of the anti-trawl barriers, progressing towards a climax stage. The vagile fauna primarily consists of small-sized organisms that inhabit the algal mats. Changes in the abundance and composition of amphipod species over time on the artificial reef provide valuable and essential insights into the ecology of these species and their intra/interspecific relationships. Furthermore, this work has confirmed what has already been demonstrated by similar studies regarding the utility of anti-trawl barriers as artificial habitats, attracting a wide range of organisms, from small invertebrates to fish, and therefore have positive effects on fish repopulation and biodiversity. Tripods were indeed introduced as invasive structures designed to prevent the passage of trawl fishing gear on the seafloor, thus protecting the habitats and species living there. Monitoring activities remain highly relevant because the evolution of the colonizing population needs to be studied and evaluated over time.

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# Ecological evaluation of the rocky reef complex of Chrysi islet, (Eastern Mediterranean) reveals a degraded state of benthic communities and canopy algae (OP5)

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Chrysi is a small island occupying roughly 5 km$^2$ and located 8 nm off the south coast of Crete. Its terrestrial part has a recognized ecological and aesthetic value and is included in the Greek Natura 2000 sites (GR4320003). The extended and gently sloping shallow sublittoral zone around the island up to the depth of 20 m, is characterized by sandy flats, *Posidonia oceanica* meadows and rocky reefs. In late April 2023 the scientific diving team of IMBBC conducted the first coordinated assessment of the ecological state of those rocky reefs by implementing the reef-EBQI index at 8 sites around the island. This index is specifically designed to evaluate algae-dominated Mediterranean rocky reefs, by breaking them down to functional compartments which are nominated a weighting index according to their importance to the ecosystem functioning. Our results indicate an extensive loss of the expected macroalgal canopy of this reef complex, which translates into an extended barren reef system and low abundances of reef-associated ichthyofauna, assigning a poor ecological status for the reef complex of Chrysi. This phenomenon is attributed to a plethora of Lessepsian species that have established in the area, imposing a detrimental effect on the coastal ecosystem. These alien thermophilic species are either very efficient grazers, like the rabbitfish *Siganus rivulatus* and the sea urchin *Diadema setosum* whose dominant presence has led to the overgrazing of the macroalgal canopy, or apex predators like the lionfish *Pterois miles* and the silver-cheeked toadfish *Lagocephalus sceleratus* which are dominating over the Mediterranean ichthyofauna unchallenged by native predators. The findings of this baseline study are in line with a general diminishing trend in Eastern Mediterranean rocky reef systems, calling for urgent management actions towards habitat monitoring and restoration.

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# T-MEDNet: a collaborative network to track mass mortality events in the Mediterranean Sea (OP6)

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The Mediterranean region is a climate change hotspot. According to the United Nations Environment Program - Mediterranean Action Plan (UNEP/MAP), the region is warming at a rate of 20% faster than the global average, with repeated periods of drought and heatwaves alternating with intense rains and storms. While land and very shallow coastal habitats are well monitored by environmental agencies in some Mediterranean countries, the ability to observe and understand the phenomena occurring in deeper coastal waters remains very limited. Since the first observations of mass mortality events (MMEs) linked to marine heatwaves (MHWs) occurred in 1999, the establishment of T-MEDNet, a collaborative observation network, has been pivotal in tracking anthropogenic climate change impacts on marine coastal ecosystems. To address the lack of high-resolution temperature series in Mediterranean coastal habitats, T-MEDNet adopted a standardized protocol based on underwater temperature data loggers, gradually engaging researchers from various institutions and countries. Presently, the network boasts over 33 teams of scientific divers from 11 Mediterranean countries acquiring temperature data and conducting regular monitoring on MMEs. This enables detailed analyses of the relationship between MHWs and MMEs, enhancing our understanding of the consequences of climate change on benthic communities. Thanks to the collaborative research efforts, T-MEDNet compiled the most comprehensive database on MMEs. They mainly affected species dwelling between 0 and 40 m. The number of species affected has increased over the last two decades, involving more than 90 species belonging to 10 phyla. Cnidaria, Porifera and Bryozoa account for the largest number of the impacted species. This knowledge is critical for developing strategies to enhance the resilience of native biodiversity, ecosystem functioning and services. Yet, the network's maintenance and expansion into unmonitored areas demand an escalating and continued collaborative effort.

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# SCUBA sampling and acoustic survey coupling in shallow sandy bottoms (OP7)

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Coastal shallow sandy bottoms are subject to various anthropogenic disturbances, including coastal urban development and the construction of coastal defence structures. These increase habitat fragmentation and loss, and decrease biodiversity, negatively affecting ecosystem functions and services. For this reason, they are in need of well-informed ecosystem-based management. However, since these habitats are characterised by high dynamism and shallow depth, they are challenging to investigate and regularly monitor using research vessel-based instruments and samplers.

The sandy coasts of the Emilia-Romagna region (NW Adriatic Sea) represent an ideal area for developing integrated monitoring approaches for shallow bottoms, the aim of the present study. They feature a variety of urbanisation, including bathing facilities, coastal defence structures, as well as river estuaries and small protected areas. For this purpose, 3 study sites with different levels of naturalness, tourist use, protection, and coastal defence interventions were selected in this region. For each site, sampling of sediment and macrobenthic organisms was manually performed by scientific divers on random points, spread to cover the entire area of interest. Geophysical data were acquired along a grid of routes via acoustic instruments on board the OpenSWAP, a fully autonomous surface vehicle designed and equipped for shallow waters. Its ability to follow the planned routes with great precision (<30 cm) allows accurate replication over a long time. To make the data acquired with different methods and resolutions comparable, all measured variables (e.g., depth, sediment features, species abundances) were interpolated within the areas of interest using the geostatistics Kriging method, obtaining the corresponding grid maps. Depth and sediment features are considered among the main drivers in structuring the benthic communities of these seabeds. However, the presence of both artificial structures and river mouths can strongly affect the species local distribution. Linear spatial correlations between species abundances, diversity indices, and environmental variables were used to highlight these effects, and the resulting residuals were mapped and analysed. Residuals distribution maps can be regarded as species distribution anomalies related to natural sedimentological and ecological processes and alterations induced by anthropogenic disturbances. Quantifying these anomalies allows us to better understand the effects of anthropogenic disturbances and interventions in these areas of tourist interest, thus forming the basis for integrated coastal management and the conservation of coastal habitats. This correlative spatial data analysis approach allows the integration of data collected by scuba divers and other sources. Although tested in sandy bottoms, it could be effective in other coastal habitats like seagrass meadows and rocky bottoms.

# Developing a standardized approach to record and monitor biodiversity trends on cylindrical artificial structures (OP8)

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A variety of underwater constructions have cylindrical shape, like pipelines, cable lines, and the submerged foundations of bridges, piers and jetties. These constructions are usually established over sandy or muddy substrates, offering new available surfaces for the colonization by algae and sessile invertebrate species, creating complex aggregations. In the above context, they also often serve as stepping stones for the spreading of non-indigenous sessile species, along coastlines with intermittent extents of rocky and soft bottoms. Despite their importance, especially at the local level, a specialized protocol for recording biodiversity on cylindrical structures is lacking so far. The aim of this study was to develop a standardized biodiversity monitoring approach and apply it on the outflow pipelines of Cretaquarium, a public aquarium located east of Heraklion city in Crete. A hoop with fixed and equidistant points was applied at predefined intervals, thus creating a sampling point matrix along the length of each pipeline. Next, the species found on each of these points of the hoop were identified and recorded *in situ* at the lowest possible taxonomic level. Thereby, the biodiversity and the relative abundances of the species of this artificial ecosystem were described. This method will be used alongside other approaches, to systematically monitor temporal biodiversity trends in the particular coastal area, which is affected by climate change-induced habitat shift, along with expectedly increasing anthropogenic disturbance due to ongoing touristic development.

# Scientific equipment below the Mediterranean Sea surface to monitor epiphytic assemblages of Posidonia oceanica leaves and pollutant concentrations (OP9)

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The Mediterranean Sea is exposed to multiple stressors including chemical pollution and water temperature elevation that likely affect marine biodiversity. As key engineer species of Mediterranean coasts, the seagrass *Posidonia oceanica* holds an important biodiversity of both benthic and pelagic species. The leaves of *P. oceanica* are regularly colonized by epiphytic organisms, forming assemblages of varying composition according to surrounding environmental conditions. Our study aims to better understand how pollutants of seashore ecosystem influence these epiphytic assemblages. To this end, we equipped 17 seagrass sites next to Marseille, Toulon and Calvi, we achieved regular diving to collect environmental data and Posidonia samples from 2017. We measured morphometric characteristics of leaf blades and scraped leaf surface epiphytes. We used ICP-MS to quantify trace metals in three matrices: leaves, epiphytes and local suspended matter depots. We characterized epiphytic assemblages using a metabarcoding approach targeting COI and 16S rDNA universal genetic markers. The variation of alpha and beta diversity was studied across sites, seasons and years. Univariate and multivariate analyses were applied to identify correlations between environmental conditions and epiphyte biodiversity. We observed different contamination levels between sites and matrices. Our approach provides a first basis to understand the links between contaminants and epiphytic biodiversity. Environmental monitoring of selected *P. oceanica* meadows is planned on a longer period to detect the effects of climate change and extend contaminant detection to other problematic contaminants, such as persistent organic pollutants (POP). Usage of epiphytes as indicators of global change and chemical contamination might be proposed in future risk assessment programs.

# Monitoring Coastal Marine Seascapes in the edge of climate change (OP10)

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Monitoring coastal seascapes is paramount for assessing the impacts of the climate crisis and human-induced pressures on various marine ecosystems. Such studies serve as the foundation for proposing conservation actions that mitigate pressures and enhance ecosystem resilience. One notable region under scrutiny is the Samaria National Park, among the oldest coastal areas within the Natura 2000 network in Greece, situated in the southwest part of Crete Island. Executing a comprehensive three-year monitoring project spanning from 2021 to 2023, the primary objective was to collect ecological data using scientific diving and non-destructive protocols. The focus was on three habitats: seagrass meadows (habitat code 1120*), reefs (habitat code 1170), and marine caves (habitat code 8330). Specific protocols were applied in each habitat, with over 30 dives annually conducted. Scientific dives covered distinct bathymetric zones: 0-42m for seagrass meadows and 0-20m for reefs and marine caves. Given the inaccessibility of the coastal zone, most dives were boat-based. The gas mixtures employed were 21% oxygen for general diving and 50% oxygen as deco gas for deep dives in seagrass meadows. Results from the seagrass meadow assessments revealed a favorable ecological status with upper and lower distribution limits at 15m and 39-40m, respectively. Pressures included anchorage and ubiquitous marine litter, with extensive matte morte in one site attributed to past flash floods causing prolonged turbidity. Rocky reefs presented a degraded ecosystem marked by the absence of large predators and a high abundance of non-indigenous species. Barren grounds and seasonal macroalgae dominated the benthic coverage at depths bellow 2 m. At 0-2 m depth the structure of macroalgal communities were assessed to be in an unfavorable ecological status, although certain stations located at the western part of the study area presented a substantial cover of canopy-forming and shrubby algae. Overall, the impacts of long-term overfishing were evident throughout the study area, with marine litter and abandoned/lost fishing gear present at most surveyed sites. The exploration of 38 marine caves along the rocky coasts revealed rich benthic diversity with sponges and fish dominating. These caves harbored protected and rare species yet faced threats from non-indigenous species and litter. The comprehensive monitoring efforts underscore the need for targeted conservation measures to safeguard the ecological integrity of Samaria National Park and similar coastal ecosystems. Overall, climate change has induced pressures such as the successful establishment of non-indigenous species, including invasives, while overfishing and marine litter have led to the impoverishment of reefs, also affecting shallow cave systems. Other local factors such as the exposure to wave action during the winter and the widespread freshwater inputs on the seabed and inside caves should also be considered in future studies, as potential shapers of benthic community structure.

# Lionfish (*Pterois miles*) in the Mediterranean Sea: available knowledge and updates on the invasion front (OP11)

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Invasive species often severely impact ecosystems and human activities in the areas that they invade. The lionfishes *Pterois miles* and *P. volitans* are regarded as the most successful invasive fishes in marine ecosystems. In the last 40 years, these IndoPacific predators have colonised the tropical western Atlantic Ocean, with welldocumented detrimental effects on the local fish communities. Around 10 years ago, a second invasion began in the Mediterranean Sea, which is being colonised by *P. miles*. Given the invasive potential of *P. miles* and the fact that the ecology and biodiversity of the temperate/sub-tropical Mediterranean offer a different setting from the tropical western Atlantic, specific knowledge on this second invasion is needed. We recently reviewed the scientific knowledge available on the ecology of invasive lionfishes and highlighted knowledge gaps on the recent Mediterranean invasion. In addition, we interviewed dive centres on the whole Mediterranean coast to update our knowledge on the spread of *P. miles*. While the history and development of the Mediterranean invasion are resolved and some mitigation plans have been implemented locally, the study of the interactions of *P. miles* with Mediterranean species and their impact on the local biodiversity is in its infancy. Closing this gap will lead to important fundamental insights in invasion ecology and will result in predictions on the impact of *P. miles* on the ecology and ecosystem services of the Mediterranean. Such information will have practical implications for policy makers aiming to devise sound and efficient mitigation plans.

# A window to the future: field research at unique $CO_2$ vents along the coast of Ischia (Italy) (OP12)

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We will provide an overview of current research that seeks to investigate species and ecosystem resilience under present conditions and future climate scenarios of ocean warming and acidification. We take advantages of two "natural laboratories" to study the effects of global environmental change on organisms and ecosystems along the coast of Ischia island (Naples, Italy), characterized by: (i) highly variable seasonal temperatures and extreme marine heatwaves, which have increased in frequency, intensity, and extent across the Mediterranean Sea, and (ii) unique natural volcanic $CO_2$ vents, which cause local acidification of seawater and affect the surrounding ecosystems. These $CO_2$ vents are used as natural analogues to assess species and whole-ecosystem responses in the long-term to future acidification conditions. We conducted field observations across the $CO_2$ vent systems, spanning four habitats, including shallow rocky reefs surrounded by the seagrass *Posidonia oceanica* (1-3 m depth), semi-submerged caves (5 m depth), reefs (11 m depth), and deep reefs (4048 m depth). This presentation will highlight case studies in which we combined: (i) coastal oceanography, including characterization of temperature regimes, water chemistry and pH variability, using high-resolution sensors, (ii) ecological and physiological field surveys and laboratory experiments mainly with corals and sponges; and (iii) trait-based approaches, where species are characterized by their life-history traits (*e.g.* morphology, growth rates, longevity, presence of calcareous structure). We found that both species and trait diversity decreased, and that ecosystem properties (understood as the interplay between species, traits, and ecosystem function) shifted with acidification. We found that shifts in trait categories, each associated with key ecological functions - autotrophs, filter feeders, herbivores, and habitat-forming species - were habitat-specific, indicating that ocean acidification may produce divergent responses across habitats and depths. Finally, we will conclude by acknowledging the emergence of new technologies with applications in coastal science, which can help scientists and stakeholders gain new understanding for assessing, mitigating, and even solving key challenges in marine coastal habitats.

# Seagrass archives on the search of the environmental history of the Eastern Mediterranean coasts (OP13)

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Seagrass sediments, known as "matte," serve as invaluable archives for reconstructing the environmental history of coastal ecosystems. Here, we assessed the potential of *Posidonia oceanica* dead matte areas, where sediment has been preserved after canopy loss, to act as a biogeochemical sink and provide a coherent record for longterm dynamics of degraded seagrass meadows in the Mediterranean Sea. Sediment cores were collected from both living *P. oceanica* meadows and dead matte across various sites in Greece, particularly those affected by tourist development. We combined dating techniques ($C^{14}$ and $^{210}Pb$), analysis of sediment variables (grain size, dry bulk density, organic carbon content and stable carbon isotopic composition (δ13C), metal content, and species diversity assessment (environmental DNA metabarcoding). We documented changes in carbon and metal accumulation over the past (100 - 500 years) and approximated the timing of canopy loss. Our findings reveal that dead *P. oceanica* matte retained its capacity as a biogeochemical sink and, akin to its living counterpart, serves as an effective archive for reconstructing environmental change in coastal areas of the Mediterranean afflicted by environmental and anthropogenic perturbations leading to *P. oceanica* degradation and loss.

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# Efficient Stereo-DOV approaches for investigating mesophotic reef assemblages: the case of a red coral (*Corallium rubrum*) demography study in the Aegean Sea. (OP14)

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Advancements in technical diver training and the commercialisation of specialised dive equipment, such as diver propulsion vehicles and closed-circuit rebreathers, has trickled down to the scientific diving community during the last decade, giving a boost in the field of mesophotic reef research across all ecoregions. However, *in situ* studies conducted with scientific diving in the realm of depths beyond 30 m still face issues of high cost, increased training requirements, and unavoidable higher decompression sickness risk – making time spent by scientists at these depths very valuable compared to shallow water diving-based research. Standard sampling and survey methodologies applied by scientific divers in shallow waters are not always designed with timeefficiency in mind, rather than simplicity of application, and more than often, accurate underwater measurements and estimations of ecological parameters require concentrated and time-consuming effort. Thus rises a need for the development of new and/or the adaptation of traditional ecological survey techniques to suit the time and cost constraints of deeper scientific diving.

In the frame of the "FAO GFCM Research Programme on Mediterranean Red Coral", a specialised deep diving survey was designed and implemented in March 2022 in the northwest Aegean Sea, with the objective to acquire valuable information on demographic and morphometric characteristics of red coral (*Corallium rubrum*, L. 1758). Deep open-circuit SCUBA diving with mixed gases (trimix) was performed at two sites where the red coral presence had been previously confirmed with the use of ROVs, in the depth range of 50-60 m. Due to time limitations regarding available gas supply and decompression obligations imposed by scientific diving safety protocols in force, *in situ* measurements of red coral colonies was decided to be conducted with a custom-built diver operated stereo video (stereo-DOV) system, allotting all the available time at depth collecting data by visually sweeping the substrate along a 30 m continuous transect. Red coral colonies' height, width and basal diameter were estimated on the stereo-video footage with specialised software, whereas red coral densities were estimated based on coral counts within virtual quadrats (0.5 x 0.5 $m^2$ surface area) over-imposed on 30 systematically random stereo-video frames.

The system proved to be very practical with no complications for straight-forward use in deep scientific diving and highly accurate measurements were made for a greatly larger number of red coral colonies and substrate surfaces that would be possible by direct visual counts and measurements conducted by a diver. Similar efficiency is expected for demographic and morphometric measurements of other sessile benthic species, i.e. gorgonians and black corals, as well as mobile benthopelagic species such as reef-associated fish, thus contributing to significant advances in the performance of deep mesophotic reef research all over the world.

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# Assessment of benthic communities in sea caves of Dugi Otok Island (Adriatic Sea, Croatia) (OP15)

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Sea caves constitute unique refuge habitats, harbouring rich biodiversity, and are protected by the European Union's Habitats Directive (habitat code 8330) and the Barcelona Convention. Despite the high number of sea caves known from the Croatian coastline, no study has quantitatively focused on their biodiversity. In the current study, an assessment of the benthic assemblages in three blind-ended and a tunnel-shaped cave (within a depth range of 0-13.5 m) of Dugi Otok Island (Adriatic Sea, Croatia) was performed. During SCUBA diving surveys, a total of 175 photoquadrats were collected for the quantitative analysis of their sessile community structure, while motile taxa were recorded with visual census, within 3-minutes transects in three ecological cave zones (entrance, semidark and dark zone). Sessile taxa were identified to the lowest possible taxonomic level and their surface coverage was calculated using PhotoQuad software. In total, 140 sessile taxa (57 Porifera, 19 Bryozoa, 18 Macroalgae, 15 Ascidiacea, 7 Cnidaria, 7 Mollusca, 6 Polychaeta, 5 Hydrozoa, 4 Brachiopoda, 1 Foraminifera and 1 Cirripedia) as well as 75 motile taxa (26 Osteichthyes, 20 Mollusca, 16 Crustacea, 10 Echinodermata, 2 Polychaeta and 1 Nematoda) were identified, including 18 protected species. The species number in the studied caves ranged from 88 to 96 sessile taxa and 22 to 53 motile taxa. Porifera presented the highest species number in all caves. Serpulid polychaetes, encrusting bryozoans and sponges (e.g. *Spirastrella cunctatrix*, *Thymosiopsis cuticulatus*, *Diplastrella bistellata*) presented the highest coverage in the different caves while the fishes *Chromis chromis* and *Apogon imberbis* presented the highest abundance among motile species in the entrance and semidark zones of all caves, respectively. Sessile community structure significantly differed among different caves and between their zones, while the motile fauna differed only among zones. The sessile fauna of the tunnel-shaped cave was also very different from that of the blindended ones. Ongoing analysis of the collected material is expected to shed more light on this rich cave biodiversity. The research work was supported by the Hellenic Foundation for Research and Innovation (HFRI) under the 4th Call for HFRI PhD Fellowships (Fellowship Number: 10597).

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# Looking for the best fitting plane: BORA as an innovative multi-habitat artificial reef structure for the restoration of Mediterranean coralligenous species (OP16)

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The prioritization of the monitoring, conservation, and restoration towards shallow coastal areas led deeper habitats to be highly neglected and more exposed to human activities. Among these habitats, the coralligenous is a typical Mediterranean bioconcretion formed by the accumulation of calcareous algae growing in dim-light conditions. Five coralligenous types have been described so far, with overhangs and terraces being the most characteristics and creating strong environmental gradients (e.g., light, nutrient, hydrodynamism) in a very limited space. Although listed as a natural habitat of community interest by the European Habitats Directive (92/43/EEC) and attracting millions of divers every year, it still lacks effective conservation measures. Many stressors are currently impacting its communities, with climate change and artisanal fishing being considered the main threats. Organisms characterised by three-dimensional (3D) structures (i.e., octocorals, sponges, bryozoans) demonstrated to be the more susceptible, with dramatic declines of their populations recorded at Mediterranean level. The implementation of successful restoration actions is fundamental to contribute to the recovery and preservation of the benthic 3D complexity typically defining these habitats. In the framework of the Italian National Plan of Recovery and Resilience (PNRR), this study presents the first application of the BORA (Multifunctional barriers for the restoration of the coastal environment), a newly patented artificial reefs, designed to supply an *ad-hoc* hard substrate for the recovery of coralligenous habitat formers and associated fauna. The BORA are 2 m cubical structures, with a customized shelves system (12 cm thick), that can vary in number, size (from 2 to 4 m in length) and orientation, mimicking the terraces and overhangs of the coralligenous. All the components are made of concrete, reinforced by steel, and covered with biogenic and mineral materials to optimise organisms' settlement. The innovative modular shape of the BORA contributes to the creation of a wide range of micro-habitats and environmental gradients that provide the optimal niche for various species along the same structure. The structures will be placed on sandy/detritic bottoms, nearby damaged coralligenous outcrops, and to test their efficiency, two coralligenous ecosystem engineers, *Paramuricea clavata* and *Corallium rubrum,* were selected to be transplanted on the structures. BORA explants' survival and growth will be monitored and compared with transplants on natural substrates in the nearby areas. These actions will contribute to the still insufficient effort in the restoration of coralligenous habitats, in synergy with the aims of the United Nations Decade on Ecosystem Restoration and the recently approved European Nature Restoration Law.

# Towards a better understanding of the ecophysiology and impact of quagga mussels in Lake Geneva (OP17)

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The quagga mussel (*Dreissena rostriformis bugensis*) is an invasive species recognized as particularly threatening freshwater ecosystems in Europe and North America. Its invasion contributes to the standardization of natural habitats and causes a loss of biological diversity through the decline and disappearance of local species. The settlement of this filter-feeding mollusc is also likely to affect the biogeochemistry through the modifications of exchanges or sequestration of elements at the sedimentwater interface. Scientific diving has become a very useful tool during the past years in Lake Geneva with the goal to better understand the ecophysiology and some of the impacts of this small bivalve that have entirely colonised the largest natural deep lake in Western Europe. This presentation will give us the opportunity to show some of our last results.

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# Tracking changes in benthic community composition along the seabird colony impact gradient with a photo-quadrat surveys in the Arctic (OP18)

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The study started in 2018 in Isfjorden (Spitsbergen), continued at Bear Island (2021, 2022) and in Bellsund (Spitsbergen, 2023, 2024), aims to explore influence of large seabird colonies on the benthos in nearby coastal waters. The primary methodological approach centred around a photoquadrat survey at the three sites at each location: two located close to seabird colonies (potentially impacted) and a distant one (control). Scientific divers documented the seabed at 20-meter intervals, each time taking 3 photos of the area, covering distances ranging from 60 to 200 meters from the bird cliffs and shoreline. The photoquadrat survey served as a easy to use tool in visually capturing the ecological nuances of the seabed beneath the guillemot (*Uria lomvia*) and kittiwake (*Rissa tridactyla*) colonies, as well as the control area. This method aimed to provide a tangible representation of the benthic environment, offering insights into potential variations in species distribution and abundance. In conjunction with the photoquadrat survey, the study incorporated stable isotope ($\delta^{15}N$ and $\delta^{13}C$) analysis on selected tissues of benthic invertebrates to assess the ornithogenic enrichment of the local benthic communities. The integration of both photo-quadrat and isotopic techniques allowed for a more comprehensive understanding of the complex ecological dynamics in order to unravel the intricate relationships between seabird colonies and the marine ecosystem.

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# It does not count who counts: the observer effect in visual surveys of sublittoral rocky reefs is negligible (OP19)

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Rocky reefs are submarine substrates that arise from the seafloor in the sublittoral zone, which support an uninterrupted zonation of algal and animal communities. They represent a quantitatively trivial fraction of the marine environment but are of great scientific and economic importance, and represent a major biodiversity reservoir to be protected. Rocky reefs therefore demand accurate studies on their spatial patterns and time dynamics. Diving is the preferred methodology for their investigation: early examples utilized destructive sampling, with collection of organisms by scraping; more recently, non-destructive techniques, such as photographic or visual surveys have been preferred from a conservationist perspective. Photographs have the advantage of fast underwater work and provision of reference collections; on the other side, their analysis is time-consuming. Visual surveys, on the contrary, make immediately available the data collected. However, a problem often neglected is the variability between observers, which might blur the efficiency of habitat characterization and evaluation. Observers might differ for both their expertise (e.g., specialization) and experience (e.g., number of scuba surveys done or length of the scientific career). In this paper, we compare the output of vertical transects carried out in summer 2021 by two diving scientists with different levels of experience (over 3000 scientific dives in ca 40 years of career versus 200 scientific dives in 3 years) on five rocky reefs in the Marine Protected Area of Portofino (Ligurian Sea, NW Mediterranean). Both observers recorded on a diving slate the occurrence and semi-quantitative abundance of conspicuous epibenthic sessile species every 5 m of depth between 5 m and 50 m, hovering 0.5-1 m above the substrate and inspecting an area of approximately 4 $m^2$. A total of 80 species of macrophytes and invertebrates was found: 51 species were detected by both observers, 16 by the senior observer only and 13 by the junior observer only. Both observers recognized four main assemblages, clearly discriminated by depth. 1) At 5-15 m, the assemblage was dominated by the brown algae *Halopteris scoparia* and *Padina pavonica* and by the alien green alga *Caulerpa cylindracea*; the red algae *Ellisolandia elongata* and *Jania rubens* added at 5 m. 2) At 20-25 m, the dominant species were the brown algae *Dictyopteris polypodioides*, *Dictyota dichotoma*, and *Zanardinia typus*. 3) At 30-40 m, the octocoral *Eunicella cavolini* dominated the assemblage together with the brown alga *Ericaria zosteroides* and the red alga *Phyllophora crispa*. 4) Finally, at 45-50 m the assemblage was characterized by the octocoral *Paramuricea clavata*, the sponges *Agelas oroides*, *Axinella damicornis* and *A. verrucosa,* the zoantharian *Parazoanthus axinellae* and by encrusting calcareous Rhodophyta. The observer effect was rarely important, similarity between the two surveys ranging between 76.9% and 95.7%. Differences mostly concerned the assemblage at 20-25 m, and were essentially due to species patchiness rather than to the observer experience. In no case, however, differences between observers were greater than environmental variability.

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# Development of a quantitative diving survey protocol for assessing food web structure and shifts in shallow rocky reefs (OP20)

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The rapid change and degradation of marine ecosystems necessitates the development of efficient tools for a comprehensive assessment of their status. To achieve an effective ecosystem approach, understanding how macroscopic components (macroalgae, fish, and invertebrates) combine to shape the structure and functioning of shallow rocky reefs is essential. The ECObiomass diving survey protocol was thus developed for the integrative assessment of shallow rocky reef food webs in areas with varying human pressures. This sampling protocol estimates the biomass of most trophic levels along three 25-m long strip transects, at 10 m depth. Fish abundance and size estimation is performed through stereo videography. Abundance and surface cover of primary producers are estimated through photoquadrat samples, while invertebrates are assessed through *in situ* and video counts, along with body measurements. Algal samples are selectively collected for dry weight estimation of the most common species per station. Fish and invertebrate biomass are estimated for most species using allometric length-weight relationships. The ECObiomass protocol was applied for the first time in 26 rocky reef sites in the Aegean and Ionian seas (NE Mediterranean, Greece). The outcome provides a quantitative representation of the trophic structure of shallow rocky reefs, allowing the assessment of ecological status and revealing shifts from reference ecosystem states. Food wed indices were also employed to jointly assess shallow rocky reefs in the NE Mediterranean. The ECObiomass protocol follows an integrative approach, includes accurate quantitative methodologies for data collection and accounts for non-indigenous species and functional trophic groups. It is an efficient tool that can be applied for the assessment of shallow rocky reef food webs.

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# Functional responses of the Chilean scallop, *Argopecten purpuratus* (Bivalvia: Pectinidae), to environmental variability along the Chilean coasts: past achievements (OP21)

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The aim of the OSTIÓN (ECOS Sud) project was to improve our knowledge of the individual metabolism of Argopecten purpuratus (Bivalvia: Pectinidae), and in particular its spatio-temporal variations in response to environmental fluctuations (temperature, oxygen, phytoplankton blooms), within two of Chile's main scallop beds and/or culture areas (La Rinconada Bay north of Antofagasta and Tongoy Bay south of Coquimbo). A 2-day periodicity of shell growth ring deposition was determined in Rinconada Bay, by marking individuals with calcein (mark-recapture technique using SCUBA). In situ measurements of individual scallop metabolism (respiration and ammonia excretion) and benthic metabolism in toto were carried out in both bays in 2008 and/or 2009, using benthic chambers (surface area: 0.18 m2) and multiparameter probes (YSI 6920v2). Five study sites (3.5-13 m depth) representative of the main benthic biotopes were experimented; SCUBA divers carried out all incubations (42 dives in all). Periods of phytoplankton production and/or oxygen deficit in bottom water were targeted. Incubations were carried out under hypoxic conditions (down to 40% DO saturation) in Rinconada Bay, unlike those in Tongoy Bay. Net respiration of the benthic community showed marked inter-annual variations in both bays, with similar trends (decrease) between years (Rinconada: -3 to -14 mmol O2 m-2 h-1 in 2008 vs. -3 to -6 mmol O2 m-2 h-1 in 2009; Tongoy: -8 to -19 mmol O2 m-2 h-1 in 2008 vs. -5 to -8 mmol O2 m-2 h-1 in 2009). Net production of the benthic community also showed marked spatial and temporal variations (1-7 and 11-29 mmol O2 m-2 h-1 at La Rinconada and Tongoy, respectively) linked to changes in nutrient fluxes (N, P and Si). In particular, the latter highlighted a shift in the preferential form of nitrogen consumed by microphytobenthos at Tongoy between years. Individual scallop metabolism was measured on two size groups (60-61 and 75-80 mm mean shell height) in November 2009. A clear effect of hypoxic conditions on ammonia excretion and respiration rates was shown according to scallop size. Overall, scallop respiration ranged from 5.5 to 18.7 µmol g-1 DW soft tissue h-1 and ammonia excretion from 6.2 10-3 to 28.4 10-3 µmol g-1 DW soft tissue h-1. The study of the functional responses of A. purpuratus to environmental forcing provides valuable information on the species' plasticity to variations in the coastal environment and current population dynamics. By comparing study areas, they also allow a better understanding of the suitability of scallop culture sites (particularly in terms of bottom culture of juveniles) and the likely evolution of natural stock dynamics under the hypothesis of global climate change.

# Using underwater Structure from Motion (SfM) as a blueprint for Marine Nature-Based solutions in Eastern Mediterranean (Cyprus) (OP22)

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Globally, coastal ecosystems are significantly valuable in terms of their ecological and socioeconomic value, as they support high levels of biodiversity and productivity. Collectively, the numerous benefits provided to humans by ecosystems are referred to as “ecosystem goods and services”. The goods derived from marine ecosystems are the products obtained from these habitats, such as fish harvests, wild plant and animal resources while recreation and tourism are familiar services provided by many marine habitats. Coastal hardsubstrate habitats are particularly important in this regard, characterised by increased structural complexity, and are considered one of the most taxonomically diverse marine habitats, providing habitat for many vertebrate and invertebrate species. However, coastal ecosystems are plagued with numerous stressors, such as climate change, tourism activities, aquaculture operations, and port and marina operations. This is more evident in the case of Cyprus. Aligned with sustainable management and actions, the exploitation of marine resources should consider physical, ecological, engineering and socioeconomical disciplines. Artificial structures can potentially provide a wider range of available resources (e.g., microhabitats, food, nutrients), which gives rise to a greater variety of ways in which they can be exploited; that is, they offer a greater number of niches. In this work, we present the methodological approach and the preliminary findings of the research initiative “Deep Blue Lab”, which aims to develop 3D-printed cementitious artificial reefs to restore and enhance marine ecosystems and biodiversity. We introduce a novel framework of custom-made ecosystem restoration solutions based on the needs of each area. We present the use of scientific diving methodologies, such as 3D image acquisition through Structure from motion (SfM), to provide the “blueprint” for marine Nature-Based Solutions in Cyprus, and we advocate the use of this method as a way to monitor the biological characteristics of coastal ecosystems. Using high-resolution acquisition systems, the complexity micro- and macro-complexity of rocky ecosystems and other biological structures (i.e. coral reefs) are digitally reconstructed and better transferred into a multitude of marine nature-based and bioinspired solutions. Conclusively, we demonstrate a framework for the development of artificial structures that can serve as underwater observatories for biological and environmental measurements while at the same time enhancing biodiversity and restoring threatened or depleted populations of marine species.

8th European Conference on Scientific Diving ECSD8

# An incubation chamber for water column sampling: experimental trial with marine sponges in an IMTA system (OP23)

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One of the greatest challenges in *in situ* experimentation involves the difficulty of controlling environmental factors, which in the marine environment can vary drastically, such as marine currents that change the temperature, turbulence or water flow in the environment surrounding the organisms and therefore affect their metabolic processes. In this sense, in the last decades different designs of benthic chambers of all types have been developed to study sessile organisms in different substrates, but none to study them in the water column, as usually placed suspended on ropes in IMTA systems. In this work, a flexible incubation chamber has been designed to study the water column around sponges located in the Remedia Life IMTA system (southeastern Italy). For this purpose, domestic plastic vacuum bags have been modified by adding a tube with Luer-lock valve. Under water, sponge explants were added in their respective rearing modules. The chambers were hung in the long-lines already set up in the IMTA system at the same depth as the sponges present and were monitored for 4 h. During this period, four 50 mL samples were collected by syringe to estimate the bacterial load inside the chamber using flow cytometry. At the end of the experiment, the volume of each bag and parameters such as pH, dissolved oxygen and temperature were calculated. Bags without sponges and with dye served as controls for bacterial load and leakage, respectively. The design of the chambers proved to be successful, with an almost constant mean volume (11.51 ± 0.24 L) and no visible leakage of the contents. On the other hand, the syringe sampling system served to evidence the filtration capacity of the sponges, with final retention values up to 97%. Moreover, the possibility of working on the surface with the chambers still hermetic made it possible to use a multiparameter probe that showed a 30.38% (4.81 SE) reduction of dissolved oxygen in the presence of the sponges. All in all, the designed chambers can be used to study the environment associated with organisms in the water column, as in IMTA systems with vertical collectors, and thus better understand their true ecosystemic role.

# Scientific diving in Greece in the framework of underwater archaeology The case of Crete (OP24)

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When in 1875 and 1884 the first dives for archaeological reasons were conducted at Mentor shipwreck and the Strait of Salamis neither the concept of scientific diving was known, nor the diving itself was largely known. This was followed by the first investigations of ancient shipwrecks, like those of Antikythera and Mahdia, missions that were considered particularly difficult. The development of SCUBA by J.-Y. Cousteau and E. Gagnan in 1943 inaugurated a new era in underwater archaeological research.

In Greece the Ephorate of Underwater Antiquities was established in 1976 and up to date, directs or supervises underwater archaeological research. As if by fateful coincidence, the stages of diving progress have always included Antikythera and/or Crete. Cousteau with Calypso's crew visited Antikythera in 1953, and he started his extended research in Greece in 1976 from Crete, concluding it in Antikythera.

In 2010, the Ephorate set a Department in Crete. During its first project at the bay of Heraklion archaeologists of the Ephorate were trained in the rebreather (Sentinel) diving and the use of DPVs for their research. The following year saw the launch of a three-year project that included surveys in Western Crete and Antikythera. Due to that the Antikythera Shipwreck was re-located and 3d mapped. In 2015, the excavation of the Shipwreck began in -53 m., which lasted until 2017 with impressive results in terms of the scientific information obtained. All means of technology like rebreathers, DPVs, the Exosuit ADS, a ROV for recording, an AUV for mapping, etc. were all put in disposal of archaeological science during the project.

At the same time the Department of Crete carried out extensive investigations in the bay of Elounda, the bay of Palaikastro, around the islets of Lefki, Chrysi and the wider area of Ierapetra, as well as occasional investigation all around the island. These included systematic aerial and underwater surveys at ancient harbour works, building remains, ancient and modern shipwrecks. Dives are now carried out with SCUBA and DPV's equipment, with which the necessary scientific procedures are carried out including photogrammetry, filming, georeference, excavation, recovery, aerial photography, geophysical investigations, etc. All resulting data are included into the Ephorate's GIS database. The aim is to continue on this path involving the public (citizens science), considering diving and its technology as tools of the archaeological science in the framework of what is termed scientific diving.

# Navigating the Depths of Shallow Water Archaeology (OP25)

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The advent of SCUBA, development of marine geophysics and, more recently, advances in underwater robotics have made once inaccessible underwater environments reachable, unlocking unprecedented opportunities for exploration. However, amidst the pursuit of ever greater depths, the easily accessible and highly significant shallow water environment has received less attention. Despite covering only a fraction of the Earth's surface, the littoral zone is home to one-third of the world's population. The wealth of archaeological, biological and geological information within this liminal space underscores the importance of investigating shallow waters. Nevertheless, shallow waters run noisy, characterised by turbulent and dynamic waters, variable bottom topographies and a strong susceptible to surface conditions, all of which pose challenges to traditional survey methods. Using crannogs, or artificial islands, as a case study, this paper delves into the intricacies of investigating shallow water environments. Constructed and used in Scotland and Ireland from the Neolithic to the medieval period, crannogs offer a unique lens into the past, with their waterlogged deposits containing a wealth of artefacts and ecofacts from the distinctive communities that used them. However, positioned both above and below water, these liminal sites present numerous challenges and necessitate unique methodologies that can bridge maritime and terrestrial environments. Through five years of investigations, a diverse array of terrestrial and maritime methodologies has been employed, highlighting the complexity of exploring shallow water environments but also underscoring the ability to implement innovative, adaptive techniques. Scientific diving has been used consistently at the forefront of these investigations, showcasing its integral role in this process. By continuing to refine shallow water research techniques, we can navigate collectively towards a more nuanced understanding of the economical, ecological and culture significance of the littoral environment.

# Scientific documentation of Underwater Cultural Heritage in Greece. The case of diveable 20th c. historic wrecks (OP26)

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Diving a historic wreck has become an attractive endeavor for recreational divers around the world. However, one should not forget that these sites are part of Underwater Cultural Heritage and to handle them properly means they should be treated as assemblages of scientific value. Keeping the above facts in mind it becomes evident that there is a need for effective scientific documentation methodologies in order not only to assess and monitor their condition for cultural preservation purposes but also to gather valuable data in order to produce interesting narratives and educational material for the general public. Greece has recently commenced a procedure to provide dive access for recreational diving to a great number of 20th c. wrecks of historical-archaeological value. This study focuses on this category of sites proposing a holistic documentation approach addressing all stages of UCH management (evaluation, conservation, interaction with the public, environmental context etc.) by the use of scientific divers, modern technology, and interdisciplinary collaborations.

# The archaeology of diving and diving's cultural significance in antiquity (OP27)

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The archaeological investigation of diving is based on a range of direct and indirect evidence. Illustrations in art, descriptions and relevant terminology in written sources, diving- related pathologies on human bones and objects that can be linked to diving are the most common types of direct evidence for it. Additionally, fishers' access to the underwater world can be indirectly traced through the archaeological remains of certain marine organisms that could not be exploited with surface-based technologies. This presentation will discuss ancient diving in the context of Bronze Age Aegean Sea (especially the 2nd millennium BC) and will elaborate on its cultural impact on the economy and world views of coastal and inland communities at the time. It will do so by presenting recent research on the maritime aspects of Bronze Age societies in the Aegean Sea.

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# Over a century of activities at the Antikythera shipwreck: Evolution of the applicable underwater research methods and latest scientific achievements (OP28)

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The shipwreck site of a Roman-period cargo vessel which perished at the depths of Antikythera Island in Greece (40-55m), is worldwide known for one of the earliest marine archaeological operations that took place there. This site was first explored during the beginning of the 20th century and its excavation is still ongoing. The aim of the presentation is to summarize the evolution of the underwater working and scientific methodological protocols which have been applied during fieldwork over the various documented programs that took place at Antikythera, and outline the results of the latest efforts. At first, a random underwater encounter with ancient artwork remains triggered a series of interventions at the Antikythera shipwreck, which initially took place in the year 1900 by a group of non-scientifically trained sponge divers, supervised by officials of the Hellenic Government and assisted by the Greek Royal Navy. In those days, no standardized scientific procedures or concrete working practices were in place for underwater archaeology. Then, in 1976 the Antikythera shipwreck was revisited by the renowned underwater exploration pioneer Jacques-Yves Cousteau, by request of the Greek Government. The site was excavated utilizing techniques which were considered state-of-the-art at that time, adhering to newly emerging documentation protocols. Over the years, Marine Archaeology gradually evolved into a formal academic discipline with concrete scientific standards. Presently, a research program that started in 2012 by the Ephorate of Underwater Antiquities of the Hellenic Ministry of Culture and Sports, and continues under the Swiss School of Archaeology, is licensed to study the Antikythera shipwreck until the year 2025. Novel marine archaeological practices are developed within this program, such as the introduction of micro-geoarchaeology in the investigation of ancient shipwrecks. Available archaeological evidence that was raised from the Antikythera seabed several decades ago and newly exposed macro- and micro- finds, are comparatively studied against the up to one-century-old archival data from previous operations, to better understand the formation processes of the shipwreck site. In this process, more information is also generated on the characteristics of the ancient ship, its luxurious cargo, its crew and passengers, with additional help from modern laboratory analytical techniques.

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# British Antarctic Survey Diving Operations (OP29)

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This poster describes the British Antarctic Survey (BAS) scientific diving operation. The marine ecosystems of Antarctica are challenging but rewarding environments for scientific exploration and study, and diving facilitates this. BAS employs a small team of scientists and support staff to conduct year-round SCUBA diving from the Bonner Laboratory at Rothera Research Station, Antarctica (67º South). With water temperatures consistently around 0 ºC, strict protocols and specialist equipment are used to maintain the safety and well-being of divers while efficiently carrying out complex underwater tasks. Diving logistics vary with season; open-water dives use small boats, while under-ice dives in the winter season use skidoos and sledges. Diving through sea ice requires close monitoring and assessment of the ice as it forms and cutting of dive holes using a chainsaw. There are over 30 established dive sites around Rothera. Scientific diving activities include underwater survey, species collection, sediment coring and water column sampling. BAS's long-term data sets and monitoring programs provide crucial insight into seasonal, annual, and ongoing trends in the Antarctic marine environment. This in turn informs the management and conservation of this vulnerable region and the wider planet earth.

References:

Homepage – British Antarctic Survey - https://www.bas.ac.uk/

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# Best practices and other educational materials to prevent scuba diving impact in the Mediterranean Sea (OP30)

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The need to preserve the integrity of the seabed and its biodiversity (Descriptors 1 and 6 of the Marine Strategy Framework Directive, 2008/56/EC) makes it essential to identify the key factors to prevent damage resulting from recreational scuba diving.
The main objective of this study is to provide attractive and user-friendly best practices and other visual resources (slides, infographics, video clips) to be shared among dive leaders to increase divers' awareness towards marine environment and to encourage environmentally responsible diving behavior. The proposed tools were created after a careful review of 29 scientific articles on the impact of diving in the Mediterranean Sea which allowed us to i) understand if, why and how underwater activities can represent a threat to underwater landscapes, and therefore to ii) highlight the combination of factors most likely to lead to harm, including the vulnerability of the organisms, the physical characteristics of the dive site, and the behavior and physiological conditions of the divers. Furthermore, a map was produced using a spatial indices approach based on dive pressure and site vulnerability to identify priority areas that urgently require the implementation of an efficient pre-dive briefing.
To verify the effectiveness of the proposed educational material, during the summer of 2023 the underwater behavior of two groups of divers (trained vs. untrained, 218 and 576 records respectively) was monitored at the Tremiti Islands MPA in collaboration with the Laboratorio del MA.RE. S.r.l.s. Each diver was identified by a tag placed on the tank and by a nickname to guarantee their anonymity. Interactions between divers and the environment included simple contact with the substrate (82%), disturbance/damage to living organisms (1.7%), and resuspension of sediment (16%). Untrained divers touched the seabed more often than trained divers, especially when using a camera, regardless of their certification level.
The proposed material could be used during pre- and post- dive briefings, for educational or training activities aimed at recreational, technical, and scientific divers alike, as well as marine citizen scientists.

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# ISO standards for scientific diving. Are those standards addressing Occupational Scientific Diving or Citizen Science Diving? (OP31)

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Following a demand from the Blue Economy EU Funded project ScienceDiver to the ISO Technical Committee ISO/TC 228 working on Tourism and related services. Working group 1 of TC228 (diving services) started to work in 2021 (14/04/21) on three standards addressing the training of scientific divers “as a whole”, gathered in a fuzzy concept. The convenor of WG1 composed a team of experts including recreational diving training agencies, individual scientists and members that became ISO liaison organisation or not. If, at the end of the first meeting, the basement for the standard were the ESDP standards with an additional level lower than the ESD needed for North American associations, but ended up different.

This paper (1) untangles the elements coming from the semantic used, (2) assesses consequences of this situation on occupational scientific diving, if it were to persist, and (3) proposes an action plan to encourage the increasingly vital integration of citizen science (amateur scientific divers) into large-scale coordinated scientifically validated projects.

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# Scientific diving hazards demand specific safety standards (OP32)

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It is widely accepted scientific divers became scientists first and then divers and projects may accommodate divers of no scientific background as assistant personnel. However, fieldwork of various sciences carries risks, which differs depending on several factors, Researchers regardless their discipline, when working underwater are under common risks rising from the special conditions of the water ambiance. The purpose of a scientist working underwater is to observe and collect data employing diving methods. Construction, maintenance and repair tasks traditionally associated with commercial diving are not included within scientific diving.

Depending on the type of research, scientific dives, however versatile, require dedicated planning to ensure effectiveness and safety. Safety depends upon appropriate regulations, crew training, operational practices, individual capability, individual responsibility and the scientific aims.

We address the purpose of assessing health and safety during scientific diving as to minimize the risk of injuries let alone of a fatal incident. The assessment should identify potential sources of occupational hazard; it ascertains whether and with what measures these sources may be eliminated and risks minimized; and should compose preventive measures necessary to control hazards and protect those conducting underwater research. The assessment sets forth the need for standards for training and certification that will allow harmonization within the scientific community that adopt them. At the same time risk-assessment operation and training standards will ensure health and safety of scientists and prevent the project manager from liability exposure (training syllabus, medical control, modern equipment, gas quality etc).

The risk assessment should be written and all members of the field work group must be familiar with it. The person carrying out the risk assessment must have full knowledge of the special risks that exist when staying in and working under water. Example issues addressed in the assessment are composition of the diving team: number, training, competence and experience; tasks allocation within the diving team and any other member of the filed-work group; diving and scientific instrumentation; breathing gas and decompression table; use of diving vests if any diver uses a dry suit, life lines and intermediate lines; communication between divers and safety co-workers and between divers; the deployment time for safety divers; weather, water and bottom conditions at the diving and workplace; the coordination of the underwater tasks to be carried out with other possible tasks on-site; planned actions in the event of an accident and an emergency and nearest decompression chamber and transfer time.

The ability to work safely ultimately comes down to the capabilities, training and support of the individual scientist diver and his/her awareness and motivation. Having rules is not enough to ensure safety: the individual must know the rules and have the capacity to follow them appropriately. Understanding the rationale behind any rule is important to having it followed.

# An academic curriculum targeted at providing skills and knowledge to aspiring scientific divers (OP33)

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The term Scientific Diving refers to a specialized form of diving performed by scientists- trained in diving techniques- and skilled divers with the intention of performing scientific research under the surface of a water body. Nowadays in many European countries, the state included law ordinances related to scientific diving in order to ensure safety, a standard level of diving skills and the related legislation knowledge of the diving personnel. The most appropriate approach to achieve the required technical brilliance and theoretical knowledge is a combination of in situ technical training and a series of academic lessons organized in modules based on discrete topics. The verified accomplishment of these lessons and their succeed examination would be the criteria for anybody to be administered the qualification of scientific diver adequacy. The suggestion of the National and Kapodistrian University of Athens (NKUA) on the scientific diving training includes the distinction between theoretical and practical training. Respecting the harsh modern way of life and the constrained free time of a contemporary working individual, theory lessons should be scheduled to be actualized in distance via a digital environment and in terms of self-paced education. This method offers multiple advantages to the learner. It provides the opportunity to attend the lessons whenever one chooses to and to re-attend them as many times one desires to. The curriculum is built upon the principal of escalating difficulty, beginning from an introductory to scientific diving and concluding with sophisticated applications of the objective (e.g. underwater photogrammetry). Each topic is analyzed in a specific module. It is expected that after the completion of the distance learning process, the apprenticed scientific diver will have obtained a theoretical base on a variety of related topics, as knowledge of the diving gear, safety protocols and applications of scientific diving. The in-situ implementation of all the earned knowledge will be fulfilled in courses organized by the Faculty of Geology and Geoenvironment of NKUA and actualized with the involvement of diving centers and trainers specialized and experienced in scientific diving. The field courses are supported by advanced theoretical lessons. The practice in the field focuses on the proper use of the underwater collection of samples and data, the practice of safety drills according to the diving protocols and the research techniques and methodology. The NKUA offers an integrated curriculum on scientific diving, with a view to create a new generation of skilled scientific divers.

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# Where geomorphology and natural hazards meet scientific diving: the case of the submarine landslide at Gialtra, North Euboean Gulf, Greece (OP34)

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On June 8, 2023, a 4.8M earthquake occurred near Atalanti, Central Greece, at 12:33 PM GMT, with minimal damage locally but felt over 100 km away. Shortly after, local residents 30-km to the north noticed that a section of beach in Gialtra (Evia) had disappeared into the embayment to the north of the beach. This site is located at a point on the western part of Evia on the south side of Gialtra Bay on the EdipsosLichada peninsula, in a western portion of the Euboean Gulf graben.

The point of land has formed at the northern convergence of NW- and NE-facing beaches, with longshore transport shifting due to wind fields to consistently accumulate sediment to the point. The slope from the beach, after a 5-10 m wide beachface, drops from approximately 2 m to 30 m depth within 75 m of the beach, continuing gently to approximately 40 m depth 200m offshore.

For the study of this landslide a multidisciplinary approach was adopted. Direct observations through diving, submarine photogrammetry, RTK-GNSS beach profiles, aerial photogrammetry, sidescan sonar, interferometric bathymetry, and sediment samples were taken. This site is an excellent example of earthquake-triggered submarine landslides in a relatively closed gulf which may further produce a tsunami. It is also an excellent example of how different methodologies from different disciplines and tools may be combined to study natural hazards in coastal and shallow submarine areas.

# Exploring Coastal Evolution: Integrating Scientific Diving, Geomorphological research, and Sea Level Changes (OP35)

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Past sea level changes are assessed and quantified by different types of sea level indicators (e.g. biological, sedimentological, geomorphological, archaeological), which are identified during field work. The research of past sea level changes requires the detailed mapping of these indicators, and those found exposed or uplifted are more easily identified and documented and are often used to estimate past changes in sea level and tectonic movements. Conversely, submerged sea level indicators are more difficult to observe. However, on many occasions underwater observations can shed light on differential tectonic movements (Evelpidou et al. 2021) and provide a better understanding of the coastal evolution of a particular site. In this context, scientific diving is a necessary tool for coastal geomorphologists to be able to identify, map in detail and document such submerged findings. In this work we discuss how scientific diving can become a powerful tool for exploring the coastal evolution, by presenting case studies from the eastern Mediterranean.

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# Importance of scientific diving in 30 years of research in marine lake Zmajevo Oko, Adriatic Sea (OP36)

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Zmajevo Oko Lake (Eastern coast of Adriatic Sea) is a small (150 by 80 m) and shallow (14 m) karstic marine lake with a weak connection to the sea through a few cracks in the surrounding limestone. There are a few completely submerged (small) caves where incoming water current could be detected during tides. Tides in the Lake are reduced and have maximum(s) two after the surrounding sea. The Lake is eutrophic, euxinic, holomictic with almost permanent stratification (by salinity and/or temperature). Upper layers are highly hyperoxic with rich plankton and benthos populations. A permanent red layer with a dense population of bacteria is just below, dividing the upper layers from the lower, anoxic layer which is rich in dissolved hydrogen sulphide. Some years, usually in late autumn, holomictic events happen; the stratification disappears, water in the Lake overturns becoming anoxic throughout the water column resulting in complete mortality of aerobic organisms (six times in the last 30 years). The Lake acts as a bioreactor and our recent results show that it is subjected to climate change and could be an example of what consequences this change could bring to other shallow, enclosed marine bodies.

We have been studying peculiar ecological characteristics of the Lake since spring 1992 in order to unveil processes which drive such a unique environment. Our tasks have encompassed, among others, sampling and characterisation of sediment, water and marine life, recording recoveries after mass mortalities, setting and collecting dataloggers. All of the tasks have been accomplished using scientific SCUBA diving (SSD) in the field as an excellent tool for in situ research and data collecting. During years of SSD in the Lake our diving team experienced diving in zero visibility and in a toxic environment, performing special speleo-diving tasks including sampling of incoming water during tides, diving in very warm or very cold water, setting and collecting data loggers in very distinct places, etc. A number of various SSD dives in a period of thirty years yielded such a quantity of data that numerous scientific papers were published; some still in preparation. Our present SSD task is to find cracks (in the Lake and outside) through which the Lake is connected with the surrounding sea and to characterise bio-geo-chemo-physical processes in the cracks. In the contribution we will present part of our scientific results and some challenges of SSD in the Lake which we have encountered during the course of time, and the solutions we came up with.

# I want to break free… of mucilage! SUEX Discovery vacuum pump as an innovative tool for the mucilage removal from benthic coralligenous organisms (OP37)

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Climate change (CC) is strongly affecting the Earth's biodiversity, and a major concern is addressed in the marine realm. The Mediterranean basin, due to its semi-enclosed nature, is warming faster than the global average. Rising temperatures, together with water eutrophication, were found to trigger a significant increase in mucilage outbreaks (i.e., agglomeration of gelatinous organic material, produced by both planktonic and benthic algae). Reducing the light availability and the water flow, massive mucilage events may cause severe damage to benthic organisms, suffocating sessile invertebrates. Recent studies demonstrated that mucilage is responsible for inducing oxidative stress in the octocoral *Paramuricea clavata*, leading to tissue necrosis. In this context, the SUEX Discovery – diver operated dredge (DOD), a vacuum pump designed for underwater archaeological prospections, was here adapted for the removal of mucilage affecting coralligenous assemblages. By combining the power of a scooter engine, and conveying the water input into a collector tube, the innovative compact design of Discovery – DOD allowed an easy manipulation during underwater operations. The Discovery - DOD was used in two sites (Isuela and Testa del Leone) inside the Portofino Marine Protected Area. At a depth of around 30 m, twelve quadrats of 50 x 50 cm were deployed and tagged at each site. The mucilage removal occurred in July 2023 ($T_0$) in both locations, with pictures taken before and after the removal; a second monitoring event occurred 50 days later ($T_1$). Since *P. clavata* was the most abundant organism, a separate analysis was conducted: from a total of 134 colonies, 88% were found affected by mucilage at $T_0$, while only a 9% at $T_1$. All other taxa covered by mucilage were, instead, clustered in four macro-categories (Porifera, Cnidaria, Macroalgae, Bryozoa). The rate of organisms with mucilage was 64% at $T_0$, with Macroalgae representing the most susceptible taxa (~78%), and of 12% at $T_1$, with Bryozoa being the less affected (~2%). Overall, vertically structured species were mostly exposed to mucilage, except for the precious red coral *Corallium rubrum*, which thriving mainly in overhangs and crevices of coralligenous bioconstructions, looked more protected against mucilage coverage. Considering the growing trend of thermal anomalies, the development of an effective management to mitigate CC-related impacts calls for the attention of the scientific community. This will help not only the resilience of marine habitats and species but will also meet the 30x30 international agenda.

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# ResuS: Handling of lacustrine sediments in barrages – a case study from the RWA Freiberg (OP38)

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Barrages in the ore mountain region, Germany, comprise sediments with highly elevated amounts of heavy metal aggregates, such as As, Pb, Cd, Zn and Cu. These mineralizations origin in the geogenic background in the delivering lithologies. Water management requires continuous sediment removal to assure general operating security and flood protection. Concerning a circular economic strategy, a perspective use of the sediments as soil substrate, soil conditioner, peat substitute, or mineral aggregates for the brick industry or top layers in contaminated sites could be accomplished. Aim of the BMBF research project “ResuS – Recycling of subhydric sediments” is to identify a proper treatment technology that guarantees an integral, recycling-focused, adaptive and economic concept for a highly diverse reutilization of as much parts of the lacustrine sediments as possible. To reach these aims, complex techniques for subaquatic samplings have to be developed. Based on the analytical findings, treatment technologies are to be identified and tested, and recycling options have to be verified.

First findings show a quite diverse inventory of sediments, which show rather complex chemical and sedimentological signatures depending on their position in the lacustrine system as well as hydraulic and biological influences.

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# Using digital twins to advance our understanding and management of popular dive sites (OP39)

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Digital twins of underwater areas are an incredibly useful tool that not only allow us to visually represent dive sites but can also assist in monitoring marine ecosystems by improving the speed, precision and accuracy of data used for management and conservation. Three-dimensional models of natural and artificial reefs can be used to assess succession and productivity regarding their complexity when combined with biological data of fauna and flora densities and assemblages. In an effort to support both divers and dive centres in exploring Cyprus' waters, the Cyprus Marine and Maritime Institute (CMMI), in collaboration with the Ministry of Tourism and the University of Southampton, aims to create accurate and highly detailed digital twins of 48 popular dive sites. Notable sites include MS Zenobia, the underwater museum MUSAN, and Greenbay. Commenced in the second half of 2023 and continuing until 2025, this project has already yielded significant results. The presentation will unveil these initial outcomes and showcase the use of advanced techniques, such as small-scale photogrammetry, large-scale underwater photogrammetry, aerial photogrammetry, and marine geophysics. These methods contribute to the creation of highly detailed and accurate digital twins, enabling the monitoring, studying, and public dissemination of the dive sites. The presentation will also demonstrate how these models are integrated with underwater video footage, images, directional information, and spatial data, providing valuable resources for both dive centres and individual divers, catering to beginners and seasoned professionals alike. By merging digital information with the digital twins, divers can access details ranging from underwater points of interest to biological data of fauna and flora densities, archaeological remains and potential hazards. With all these information in hand the project partners aim to enhance recreational diving experiences, improve dive site management and safety, and support dive tourism across Cyprus.

# SCUBA diving as an essential tool for monitoring global ocean temperatures (OP40)

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Long term observations of ocean temperature are essential for our understanding of natural variations and trends caused by climate change but there is a shortage of depth-resolved temperature data, especially in coastal areas. Determining temporal and spatial variation via remote sensing in coastal areas is challenging. Satellite products are commonly used to measure sea surface temperature (SST) but are affected in coastal areas by proximity of land or aerosol interference. In addition, satellite SST records only the skin or sub-skin temperature at the sea surface and measurements have been found to differ from in situ records.

Most scientific and recreational diving occurs in shallow coastal areas and tends to be highly replicated. There are currently three main methods that divers can use to contribute meaningful datasets: using temperature download data from dive computers; deploying and maintaining cost-effective recording stations; or developing autonomous loggers that record and automatically transmit georeferenced temperature data using any diving activity opportunistically.

Most modern diving decompression computers record profiles of temperature as a function of depth and time, and with as many as 10 million SCUBA divers world-wide, most wearing one or more dive computers, there is clear potential for divers to gather depth-resolved data. Recent studies have used large datasets of downloaded dive computer records to validate this approach for obtaining reliable monitoring.

Dedicated aquatic temperature sensors can be relatively low-cost (€80-120) but are capable of recording large volumes of high-precision data. Small fixed stations can be easily established and require no more than 1-2 short dives per year to maintain; this can be built into existing dive programmes. Examples of how multi-depth, multi-year datasets obtained in this way can be used scientifically will be presented.

All types of diving can be further exploited through the use of autonomous costeffective recording instruments based on smart technologies. Prototype units that automatically transmit georeferenced temperature and salinity data are being developed and will be presented and discussed.

# ABSTRACTS_POSTER PRESENTATIONS

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## The GFCM research programme on red coral (P1)

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The precious red coral (*Corallium rubrum*) used in the jewellery sector has experienced a decrease in landings in the Mediterranean over the past decades and, in some areas, its shallow populations were considered nearly depleted. This has led GFCM to the implementation of a management plan regulating the harvesting activities in the Mediterranean region. However besides harvesting, this species is also impacted by climate change. Despite a wealth of studies on this species, important knowledge gaps persist, especially regarding the current status of the red coral populations in the Mediterranean Sea. A research programme on red coral has been initiated by the GFCM in 2020 joining experts from complementary areas and from different countries where red coral is present. This includes investigating the status of harvested red coral populations with onboard observers, stock assessment analyses, pilot socio-economical studies on red coral fisheries, and population genetic analyses. The integration of these different objectives will be useful to inform additional management and conservation measures addressing red coral in the Mediterranean.

In this framework, the genetic study of red coral populations will follow several objectives:

- an analysis at the Mediterranean scale of the genetic structure of red coralpopulations to identify the main lineages
- an estimate of local genetic diversity to identify potential areas with reduced geneticdiversity
- to study the interest of genetic markers for traceability: this includes i) identifyinformative genetic markers and ii) develop protocols to work on dry samples

These objectives will complement previous genetic studies of red coral populations, first by the geographical scope of the sampling (from Atlantic to Eastern Mediterranean), and second through a focus on deep populations (below 50 m) which are now the main targets for harvesting.

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# Evaluating Aquaculture's Impact on Maërl Bed Biodiversity (P2)

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Maërl beds, also known as rhodolith beds, are marine benthic communities primarily composed of unattached coralline calcareous algae. These beds form extensive habitats on sedimentary floors. They exhibiting sporadic and patchy distribution patterns in the Mediterranean due to their growth being constrained by specific environmental conditions such as light penetration, water temperature, water motion, and sedimentation. Typically found at depths ranging between 30 meters and 100 meters, Maërl beds in the East Mediterranean can extend down to approximately 180 meters. Maërl beds offer various ecosystem services, including climate regulation through $CO_2$ uptake and primary production, while their complex structures contributes to the increase of biodiversity in these grounds. However, Maërl thalli's slow growth rate which can span centuries, especially in higher latitudes, renders these beds a vulnerable, non-renewable resource.

In the context of aquaculture, Maërl beds arise from mussel rafts and fish farming activities. These threats may manifest as increased turbidity, reduced light penetration, smothering from the sedimentation of fine particulate organic and inorganic material, as well as oxygen depletion and toxic conditions due to anaerobic mineralization of buried organic matter. While Maërl beds are recognized as vital habitats, comparable to *Posidonia oceanic*a meadows in the Mediterranean in their ecological importance, research on their biological aspects has been limited due to the difficulties in studying these habitats.

With the growing trend of aquaculture expanding into deeper waters, Maërl beds are expected to face increasing pressure in the coming years. Addressing this gap, in October 2023, the scientific diving team of IMBBC conducted a survey in the NE Corinthian Gulf at Trachilos to assess the impact of aquaculture activities at two different depths (shallow and deep) and distances (near and far). Our results revealed a severe impact of aquaculture installations on Maërl beds and their associated benthic fauna. This study highlights the need for integrated management plans that balance aquaculture relocation with the conservation of these fragile marine ecosystems.

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# Exploring Blue Carbon Potential in the Southern European Kelp Forest Fringe (P3)

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The Southern European coastline boasts an extensive fringe of the last coastal kelp forests of the continent, with a significant portion dominated by species such as Laminaria ochroleuca, Laminaria hyperborea, and Saccorhiza polyschides, covering approximately 1800 hectares. Over more than a decade, a comprehensive dataset has been compiled, comprising historical data that sheds light on the trends of abundance of these kelp forests. Taking advantage of this knowledge and additional assessment of more than 500 sampling points, including scientific diving methods to perform examination of biomass, standing stock, growth, and carbon content, we estimated the potential of these forests in terms of blue carbon. Key findings from this study reveal an overall average kelp abundance of 4.38 ± 2.89 individuals per square meter. The primary productivity of Laminaria hyperborea, measured as growth, was found to be 0.07 ± 0.05 grams of primary production per individual per day. Furthermore, the carbon content within these kelp forests was estimated to be approximately 30% of the total dry weight. Additionally, a detailed mapping effort covered 90 kilometres of coastline and approximately 150 square kilometres of substrate. These findings collectively indicate that the Southern European kelp forests, particularly those dominated by Laminaria ochroleuca, Laminaria hyperborea, and Saccorhiza polyschides, possess substantial blue carbon potential, with implications for both coastal ecosystem management and carbon offset strategies. This research serves as a valuable contribution to our understanding of the carbon dynamics and expands the baseline data needed to advance blue carbon research and management in these kelp-dominated ecosystems and their role in the services they provide, including mitigating climate change.

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# Baseline assessment of seagrass meadows in Chrysi Island (P4)

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The island of Chrysi, located in the southern part of Crete (Greece), holds significant ecological value as part of the NATURA 2000 network (GR4320003) for its terrestrial species diversity and habitats. Surrounding this protected area, the marine environment hosts invaluable meadows of Posidonia oceanica (L.) Delile, a keystone species for the Mediterranean coastal ecosystems, known for its plethora of ecosystem services. This study evaluated the baseline status of these seagrass meadows aiming to support the potential extension of the Special Area of Conservation (SAC) into the marine environment around Chrysi Island. Employing a combination of remote sensing techniques and in-situ observations, we assessed the meadows extent along the coastline. A specific station was chosen to identify the ecological status of the meadow, using structural variables, and evaluate the provision of the key ecosystem service of blue carbon via standard biogeochemical analyses. The bathymetric distribution of P. oceanica was found to be limited to specific depth zones (15 – 35 m), present in both soft and hard bottoms. The total area covered by these meadows was estimated at approximately 10 km2. Structural variables indicated lower values than those reported in the South Aegean Sea meadows. Shoot density was on average 333 ± 175 shoot m-2, leaf biomass was 0.5 ± 0.3 g shoot-1 and rhizome production was 52.1 ± 3.8 mg DW shoot-1 y-1 during the reconstructed period (2010 – 2021). The Ecological Quality Ratio, as determined by the WePOSI index, was 0.548, indicating a 'moderate' ecological quality of the meadow. Conservation status assessments using the Conservation Index, Substitution Index and Phase Shift Index, classified the meadow's condition as 'poor'. The visual assessment of the area suggested that the degradation of the meadow was probably related to past activity in the area, such as repetitive anchoring. The stock of organic carbon (Corg) at the top meter of sediment was 9.8 ± 3.0 kg m-2. The short-term (last 100 years based on 210Pb dating) sediment accretion rate was 0.40 ± 0.06 cm yr-1 and the long-term (last 300 years based on 14C dating) was 0.34 ± 0.05 cm yr-1. Short-term and long-term Corg accumulation rates were 44.6 ± 4.5 g m-2 yr-1 and 33.4 ± 10.2 g m-2 yr-1, respectively. These Corg sequestration values, while within the range of values reported for S. Aegean meadows, were on the lower end, likely related to the meadow's moderate ecological status, the moderate water depth and the high hydrodynamics of the area, which typically result in lower carbon sequestration. Given the study's findings, further research and conservation efforts are essential for the long-term health and resilience of these critical ecosystems.

# Anchoring Impact on Posidonia oceanica Meadows in Greek Coastal Zones: Insights from Scientific Diving Surveys (P5)

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This study investigates the anchoring impact on Posidonia oceanica meadows along Greece's coasts, where these critical marine ecosystems face significant threats from tourism-related activities. Our approach combined extensive transect-based surveys, the use of Diver Propulsion Vehicles (DPVs), and Remotely Operated Vehicles (ROVs) to thoroughly document and assess anchoring-induced damages. Specifically, fixed transects, each extending 50 meters, were established across meadows at depths ranging from 5 to 30 meters to systematically observe physical damage, habitat fragmentation, and dead matte formation attributed to anchoring. To enhance survey efficiency and cover extensive areas, DPVs were deployed, enabling divers to quickly navigate large sections of the seabed and identify dispersed damage sites. Furthermore, ROVs equipped with high-resolution cameras were utilized to obtain detailed seabed imagery, particularly in deeper zones, complementing diver observations and ensuring comprehensive damage documentation. The conservation status of the meadows was assessed using the Conservation Index (CI), which quantifies ecosystem health based on habitat extent, fragmentation, and dead matte presence, with values ranging from 0 (pristine) to 1 (completely degraded). Anchorinduced stress, characterized by the physical damage directly caused by anchoring activities such as seagrass uprooting and sediment displacement, was quantified by analyzing the extent and severity of observed damages within surveyed transects. Our findings revealed a direct correlation between anchoring practices and meadow decline, with observed losses ranging from 33 to 89%. The meadows exhibited pronounced fragmentation, leading to substantial area reductions (ranging from 2 to 75.4 ha) and a conservation status ranging from poor to inadequate (CI: 0.10 – 0.45). This research emphasizes the important role of scientific diving techniques in accurately estimating anchoring impact on Posidonia oceanica meadows, providing valuable insights into anthropogenic stressors on marine ecosystems. 8th European Conference on Scientific Diving ECSD8

# Survey and monitoring of benthic assemblages of submerged and semi-submerged caves of the Apulian coast in the province of Bari (P6)

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Submerged and semi-submerged marine caves represent an important resource for biodiversity. In the Mediterranean Sea, their importance is heightened by the presence of many species categorised as endangered by the IUCN and/or listed in Annexes II and III of the Bern Convention and the SPA/BD Protocol to the Barcelona Convention. The Apulia region stands on an exclusively carbonate base where karst phenomena are widespread, with large caves or small ravines that frequently reach the sea. Most of the Apulian marine caves have been surveyed and catalogued in the regional cadastre and many of them have been studied from a biocenotic point of view, especially in the northernmost portion (Tremiti Islands) or further south (Salento coast). However, numerous marine caves on the Adriatic coast near Bari are still largely unknown. To contribute to the knowledge of marine caves in this area, we have investigated three submerged (Cala Incina Tunnel, Cala Incina Cave, Cala Port'Alga Cave) and four semi-submerged (Colombi Cave, Rondinella Cave, Sirene Cave and Sella Cave) caves. Biological, topographical, morphological and geographical parameters were collected for each cave. The biological characterization of the cavities was carried out through video transects established from the cave entrance to the end of the cave. Five frames per station were extracted from the video and then analyzed using photoQuad software. In addition, the Ecological Quality Index (CavEBQI) was used to assess the health status of the seven caves. A total of 141 taxa, belonging to 8 phyla (Foraminifera, Porifera, Cnidaria, Mollusca, Annelida, Arthropoda, Bryozoa, Echinodermata, Chordata), were recorded. Among the phyla detected, Porifera was the most represented in all caves, both in terms of number of taxa and substrate coverage. The taxa found also include species of special naturalistic and conservation value currently included in the Bern Convention and the Habitats Directive: the sponges *Axinella polypoides*, *A. cannabina*, *Aplysina aerophoba*, *Geodia cydonium*, *Sarcotragus pipetta* and *Tethya aurantium*, the molluscs *Luria lurida* and *Lithophaga lithophaga*, and the sea urchin *Paracentrotus lividus*. In terms of ecological quality assessment, the CaveEBQI index values ranged from moderate ecological quality (4<CavEBQI<6) to good ecological quality (6<CavEBQI<8). The present research confirms the importance of coastal marine caves as reservoirs of biodiversity, highlighting the richness and distinctiveness of the benthic communities recorded, and providing important information related to coastal marine environments. This highlights the need to explore yet unknown stretches of coastline to establish a solid initial knowledge base for this habitat.

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# Scientific diving in France: an overview of the current practices in science (P7)

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The French National Committee for Scientific Diving (CNPS) takes on different tasks including acting as an observatory of occupational scientific diving practices and innovations (Thouzeau et al., 2019). Since 1991 in France, scientific diving has been recognized by law as an occupational sector and is therefore regulated with the aim to reduce the hyperbaric risk. Currently, French scientific diving encompasses many fields such as underwater life sciences and ecology, geosciences, social & cultural sciences including archeology, health & food, engineering sciences, energy... Due to the existence of overseas territories - with France's maritime spaces representing the world's second largest exclusive economic zone - French territories display an extensive variety of submarine habitats. Furthermore, the historical richness of scientific diving in France has led the French scientific diving community to be involved in all oceans worldwide. All subaquatic ecosystems, from the polar regions to the tropical belt, from drowned karsts to freshwater and high altitude lakes, including mesocosms and artificial structures are studied by diving scientists. On top of the traditional diving methods (apnea, open circuit and hookah) scientific diving benefited in recent years from the use of closed-circuit rebreathers but also from combining CCR and saturation methods, which greatly enhanced the study of the mesophotic zones. In light of the diversity of environments, disciplines and scientific issues, scientific divers are continuously innovating to perform outstanding research. This presentation will give an overview of recent work from the last decade, highlighting the importance of scientific diving in science in France.

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# The Roman fish tanks as the objective of an underwater multidisciplinary research (P8)

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Living in the era of continuous and rapid anthropogenic environmental changes, the human species is on constant alert in order to prevent the effects of its decisions and actions. To monitor and stand up to the environmental destabilisation, it is now clear that a multidisciplinary approach is needed. Climate and sea level changes are considered among the most significant threats. According to various valuations, the sea level will rise at least one meter in the following 80 or 100 years, causing a massive human displacement and chaos in the global human community. An excellent paradigm for interdisciplinary underwater research to confront the environmental risk of this menace, is the synergy of Geosciences with Underwater Archaeology. Both the two scientific branches are involved in the investigation of various environmental indicators of the past, trying to interpret past environmental changes and their repercussion as per their perspective. The roman fish tanks, well known as an ideal indicator of sea level changes, were the objective of this interdisciplinary approach. The vast majority of the verified roman fish tanks are found in the coastlines of Italy, but they were also detected in the seashores of Spain, France, the Adriatic Sea, Greece, Egypt, Lebanon and Israel. They were used for farming fish and their construction was held between the 1st century BC and the 1st century AD. On the one hand the fish distribution to the market, offers the archaeologists the opportunity to inspect the residency and the socioeconomic status of the distribution and consumption areas during the Roman Era. On the other hand, the geologists, investigating a roman fish tank in the present, might understand the geomorphological and the coastal evolution of the wider region and define the relative sea level changes throughout the roman times. The fish tank research methodology requires the underwater inspection, documentation and mapping of the research spot locations of the littoral. All the underwater research procedures are defined by the principles and the safety protocols that regulate the contemporary scientific diving. The first step of the research has to do with the underwater detailed survey of the area. Then, several parts of the constructions- such as the foot walks, the sluice gates, the tops of channels and the moles- are subject to measurements. The type of the personal required equipment of the researcher is defined by the operating depth of each occasion. In shallow depths (e.g. minimum depth of the roman fish tanks of France: −32 ± 5 cm) a researcher might use snorkelling equipment. In deeper depths (e.g. maximum depth of the roman fish tanks of Croatia: −175 ± 20 cm,) it is strongly advised to use scuba diving equipment. With the intention of achieving the maximum accuracy in the measurements of height and functional depth of the fish tank structures, the data of the tide and the atmospheric pressure of the exact time of measurement should be taken into account. The significance of the fish tanks' study is triple. Firstly, they have a great scientific value in terms of geology, ecology, archaeology and history. Secondly, their promotion as cultural heritage monuments motivate and aware about the environmental change and the sea level rise. Thirdly, the knowledge of the past environmental changes is proven the key to understand the present changes and, maybe, prevent the future ones.

8th European Conference on Scientific Diving ECSD8

# Development of geopolymer materials for underwater applications (P9)

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The development of materials for underwater applications is a complex challenge, especially when we take into consideration large water infrastructure. In this area, the most intensive research was provided on concrete materials [1,2]. Most of these investigations were made in the area of application in the marine environment. Some of them support the direct manufacturing of concrete structures underwater, offering a more convenient and efficient way to build [2-4]. The technology of concrete seems to be very efficient for that purpose, but despite this fact, it is high time to consider in this area some more environmental alternatives such as geopolymers. Although these materials are quite well characterized for traditional building applications, there are still some gaps in developing them for underwater structures. The material has to fulfill a lot of requirements, including proper mechanical properties, resistance to the abrasion process, and low water absorption and it has to be eco-friendly (low eutrophication index). The main goal of the provided research was to develop a new composite based on a geopolymer matrix for underwater applications. The work was focused on improving the water resistance to using different admixtures. The first step was a synthesis of organic-inorganic polymers, and prepare the samples using the casting method. The next step was an investigation of fresh material properties such as workability and investigation for prepared samples (mechanical properties, microstructure, and water absorption). The obtained results show the possibility of modification of geopolymer materials to improve the characteristics important for underwater applications.

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# Monitoring of the endangered Mediterranean *Pinna nobilis* (L., 1758) Populations in Protected Areas of the northern Aegean Sea through Distance Sampling (P10)

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The fan mussel *Pinna nobilis* (L., 1758), a critically endangered endemic Mediterranean species, has witnessed a substantial population decline throughout the Mediterranean attributed to mass mortality events (MMEs), notably beginning in Autumn 2016. The MMEs have been linked to the presence of the parasite *Haplosporidium pinnae*, although *Mycobacterium* sp. and *Vibrio mediterranei* were also detected in dead or moribund individuals. The MMEs necessitate urgent conservation interventions for the species. This study presents the results of the application of Distance Sampling through Line Transects (DSLT) for monitoring *P. nobilis* populations in Marine Protected Areas of the NATURA 2000 Network (GR1220002 & GR1270010) in Thermaikos Gulf.

The DSLT method is renowned for its reliability and established efficacy and has undergone rigorous validation in diverse regions of the Mediterranean. Its selection was grounded in its proven efficiency and applicability to marine ecological studies. Imperfect detectability is a pervasive concern in population studies, often leading to underestimations of key variables such as abundance, population density, and the probability of presence. Therefore, the application of this method within the context of *P. nobilis* aimed to surmount these challenges, ensuring a nuanced and accurate portrayal of the species' spatial distribution. Through the estimation of detection probability, this study ensured unbiased estimations of abundance and population density. For the needs of the study 31 transects perpendicular to the coastline at depths from 0 to 30.1 m were randomly established. A single-observer line transect survey, conducted through SCUBA diving, targeted both live and dead individuals (the latter to estimate pre-MME abundance and spatial distribution). The transects were defined by deploying nylon lines featuring water-resistant labels and segmented in 5meter intervals. For each segment, the dominant habitat-type and the depth, were recorded. For each detected individual, the size and its position in the transect were recorded. Habitat classification maps in the entire study area were created using satellite images and Object Based Image Analysis. Bathymetry maps of the study area were created using echo-sounder and interpolation methods in ArcGIS. Detectability was estimated using the software DISTANCE followed by a model-based analysis with GAMs in R to estimate abundance and obtain population density maps in the study areas. Notably, no live *P. nobilis* was detected. The best population density model for dead individuals included depth and habitat as predictor variables. The estimated abundance of dead individuals was ~5400 in GR1270010 and 30300 in GR1220002.

# Exploring structural and functional components of resilient canopy-forming macroalgae communities in the Greek Seas (NE Mediterranean) (P11)

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The loss of native canopy-forming macroalgae of the genus Fucales (*Cystoseira sensu lato* and *Sargassum* spp.) leads to significant degradation of rocky reef ecosystems across the Mediterranean. Identifying resilient canopy algae communities and exploring their distributional, structural and functional patterns is essential in understanding drivers of regression and determining sound management, conservation and restoration actions.

Three sites presenting resilient macroalgal canopies were studied by means of nondestructive scuba diving surveys along 50 m-length transects in 5 m and 10 m depth. At each site, ten systematic-randomly placed photo-quadrats (21 × 30 cm) were obtained, reef-associated fish abundance and sizes were recorded by using a stereo camera system and benthic macroinvertebrates abundance was counted visually within the strip transects.

Key structural elements of shallow rocky reefs are outlined and discussed herein, along with the assessment of the ecological status of the sites using the reef-EBQI index (Thibaut et al. 2017).

References: Thibaut et al. (2017). An ecosystem-based approach to assess the status of Mediterranean algae-dominated shallow rocky reefs. Marine Pollution Bulletin, 117: 311-329.

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# Shallow boulder fields harbour rich sciaphilic benthic assemblages: a case study in Elounda Bay, Crete (Eastern Mediterranean) (P12)

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Boulder fields are globally distributed habitats at the intertidal and shallow subtital zone, which are often neglected in biodiversity studies, as compared to reefs, seagrass meadows and soft sediments. The present study aims to provide a baseline biodiversity study of the macrobenthic invertebrate communities developing in shallow subtidal boulder fields in the broader area of the Gulf of Elounda (Eastern Crete), and analyse their spatial trends along the coastline. Specifically, seven sampling stations were studied, four within the sheltered and shallow Gulf of Elounda and three in the adjacent Mirambelo Bay. A total of 70 rocks were distinctly examined for their two opposing surfaces, i.e. illuminated vs shaded, using a non-destructive photographic method. The hosted sessile and motile organisms were identified at the lowest possible taxonomic level, and their coverage on the surfaces was estimated using appropriate software. Overall, 55 taxa were identified: (a) 47 taxa of sessile invertebrates, one of which was a Lessepsian species, (b) seven taxa of motile invertebrates, and (c) one taxon of motile vertebrates. Regarding diversity and abundance, sponges were the dominant group across all sampling stations. Significant differentiation in the abundance and coverage of organisms was observed between the exposed and sheltered surfaces. Specifically, the illuminated surface exhibited reduced presence of benthic invertebrates and dominance of macroalgal turf, while the shaded surface showed a much higher number of invertebrate taxa, both in terms of percentage coverage. Finally, comparisons of the communities among the sampling stations revealed a gradient of taxon richness between exposed and sheltered locations, indicating wave action and coastal hydrodynamism as a negative driver for this particular habitat's biodiversity. This first assessment of boulder field biodiversity in the Eastern Mediterranean showcases the high ecological value of this understudied habitat and paves the way for future studies with broader geographical coverage.

# LIFE NatuReef: Nature-based reef solution for coastal protection and marine biodiversity enhancement (P13)

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LIFE NatuReef aims to apply at a demonstration level the best practices available to the restoration of native oyster and sabellariid reefs, seeding the native species in a rare, nonurbanized, coastal stretch of the northern Adriatic coast: the Bevano river mouth (Ravenna municipality, Po Delta Park, Emilia-Romagna Region, Italy), which is a SAC and SPA under the EU Natura 2000 (IT4070009 - Ortazzo, Ortazzino, Foce del Torrente Bevano). *Ostrea edulis* and *Sabellaria spinulosa* are native ecosystem engineers able to create threedimensional reefs that retain sediments and dissipate wave energy, counteracting coastal erosion, which is particularly intense here, and creating ecological niches allowing for high biodiversity and nursery habitats. Native oysters have almost disappeared, and sabellariid reefs are now rare in the Mediterranean Sea, representing marginal habitats having lost most of their ecosystem functions at the regional level.

The restored reefs will enhance marine biodiversity, providing habitat and feeding ground for priority and non-priority threatened species, like sea turtles, seahorses, and seabirds. They will defend priority and non-priority habitats like beach dunes, coastal lagoons and pinewoods, from coastal erosion and salt intrusion. These reefs will provide numerous ecosystem goods and services: biodiversity enhancement, improved water quality and clarity, increased fish and shellfish production, sediment stabilisation and wave energy dissipation, prevention of coastal erosion, and a high cultural value. As living structures, they have the potential to grow and adapt and, to some extent, counteract some effects of climate change, like sea level rise and increased storm and flooding event frequency and intensity, contributing to the resistance and resilience of the coastal marine ecosystem.

After the topographic, geological, and biological surveys, a reef base made of limestone rubble enclosed in iron cages, will be positioned according to the results of the hydraulic models. Scientific divers will manually transplant oyster specimens and sabellariid worm nuclei from donor populations. The site will be monitored in subsequent years to assess key project indicators, and guided snorkelling, freediving, and scuba diving tours will be permitted. A digital twin, based on 3D underwater surveys, will also be made to allow virtual tours. The project LIFE NatuReef has been co-financed by the EU Programme LIFE 20212027 (G.A. 101113742).

# Integrating ROV and deep-SCUBA diving surveys for community status assessment of red coral beds in the E. Mediterranean Sea (P14)

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The precious red coral Corallium rubrum (L. 1758) is endemic to the Mediterranean Sea, with a centuries-long history of commercial exploitation across the basin. In the E. Mediterranean, little is known regarding the present state of its habitat and associated assemblages, owing to a bathymetric distribution well-beyond the range of non-technical diving. Here, we present an assessment of benthic biodiversity on red coral beds in the Aegean Sea, with the first application in this region of the Mesophotic Assemblages Community Status (MACS) Index. The field survey was conducted using two small-sized Remotely Operated Vehicles (ROVs) and mixed gas decompression diving. A total of 8 exploratory ROV dives were carried out at depths between 40 and 70 m, covering an area of 922 m2, while two deep SCUBA high-resolution video transects were performed at two selected sites between 50 and 60 m. Video analysis from both ROV and SCUBA surveys were used for the application of the MACS index, which is composed of an Index of Status and an Index of Impact. For the application of the Index of Status, ROV videos were split in sample units (SU) of 7.5 m2 of seafloor area, and all non-encrusting species were identified at the lowest possible taxonomic level. Since for some groups quantification was not feasible, each taxon was given an abundance class in each SU, ranging from 0 (absent) to 3 (abundant); structuring species were counted in each SU (and then given a class), and the height and density of the specimens was evaluated. In total, 102 taxa were identified, 75 down to the species level, of which 12 protected by EU and international legislation. Porifera was the most dominant group with 28 taxa, while Pisces, Cnidaria, and Echinodermata had 14, 13, and 13 taxa, respectively. For the Index of Impacts, we assessed sedimentation, epibiosis, necrosis, entanglement, and characteristics of marine litter. As a result, we can show how both sites are in a Good Ecological Status sensu Marine Strategy Framework Directive, still clearly impacted from various anthropic pressures. This project was funded as part of the GFCM Research Programme on Mediterranean Red Coral.

# Towards a genomic repository of the Eastern Mediterranean biodiversity with diving-based specimen collection (P15)

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The Mediterranean basin faces serious threats, especially in terms of rapid alteration and degradation of its native habitats, driven by increasing anthropic pressures and climate change. The basin is the third richest biodiversity hotspot of the world and conservation of its species is urgent. To this end, sequencing and building whole genome references of the iconic species of the area, will provide a solid basis to build future conservation tools for genetic monitoring. Under the Biodiversity Genomics Europe (BGE; https://biodiversitygenomics.eu/) project, we aim at showcasing the importance of building reference genomes and how critical they are for successful management strategies with two actions focusing on the Eastern Mediterranean Sea biodiversity. First, we are developing genome references for a number of keystone species of the Eastern Mediterranean marine environment laying the foundations for in depth downstream genomic analysis of this unexplored but critical group of species. The second action is to develop an application of genome references to conservation using the Mediterranean bath sponge, Spongia officinalis, as case study. We aim at exploring the genomic diversity and reveal the adaptive potential of this endangered species in face of foreseen environmental shifts, habitat degradation and intensive exploitation. Ultimately, the produced knowledge will guide efforts in the development of a restoration plan towards the effective management and conservation of this iconic sponge. Scientific diving emerges as an essential methodological component for all aforementioned actions, since in situ organism identification, established knowledge of local habitats and their hosted biodiversity, as well as selective sample collection to minimise impact, are critical requirements for such a demanding downstream genetic analysis.

Funding: This work is part of the Biodiversity Genomics Europe project (https://biodiversitygenomics.eu/) funded by Horizon Europe, co-funded by the Swiss Government and the British Government.

# Geographical progression of a mass mortality of the invasive echinoid *Diadema setosum* (Leske, 1778) in Crete, Eastern Mediterranean (P16)

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The long-spined sea urchin *Diadema setosum* is an echinoid of Indo-Pacific origin that invaded the Mediterranean Sea in 2006. It is an ecosystem engineer with an important ecological function in its native range, but it can have a detrimental effect on Mediterranean reefs due to grazing, enhancing the formation of barren reef areas through the depletion of canopy-forming algae. Recently, in 2022, a Mass Mortality Event (MME) affecting this species was recorded in the coasts of Turkey and the Dodecanese islands (Eastern Aegean Sea) in the eastern part of the Mediterranean basin. We are herein reporting a westward progression of the MME in 2023 affecting established *D. setosum* aggregations in six locations across the north and south coast of central and eastern Crete. We recorded the densities of these aggregations and the health status of the individuals using four 30 m transects in each site. Our results indicate that coastal areas of Crete with high densities of the invasive urchin are more susceptible to the pathogen possibly causing this MME. Furthermore, affected individuals have been observed only when the water temperature was below 20 ℃. Further monitoring is necessary in order to record the future progression of this MME and the potential for recovery of the affected aggregations.

# A new project on location, evaluation, and impact of ghost nets in the Valencian Community, Spain: some preliminary results (P17)

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Ghost nets are part of the fishing gear that is abandoned, discarded, or accidentally lost, causing a negative impact on marine biodiversity, from megafauna to fish and benthic communities (Perroca et al., 2022). According to current global estimates from the European Union, around 20% of fishing gear used every year is lost, or around 11,000 tonnes per year. Spain ranks among the Mediterranean countries with the highest number of recorded ghost nets, third among the 12 countries analyzed in a recent study (Perroca et al., 2022). A new project to evaluate the effects of ghost nets on marine biodiversity and ecosystems have been started in affected areas along the coast of Valencian Community, Balearic Sea, Spain. This preliminary study has been conducted with the support of local fishing and diving community to individuate different ghost nets affected areas. Cases of entanglement fauna has been studied in four affected sites, recording the number of entangled individuals and their species. Diversity and abundance of demersal fish in four affected sites has been studied, using Underwater Visual Census method. The presence and amount of microplastics has been studied to understand the level of contamination in these zones by sampling sediment. During 2023, we identified 10 affected sites within the Valencian Community, supported by local Government “Generalitat Valenciana”. We identified 21 entangled species, including 6 groups, from 3 different habitats. 14 of the species identified in the present study are listed by the International Union for Conservation of Nature (IUCN 2023), two of which are classified as endangered, two as vulnerable and two as near threatened. Microplastic analysis demonstrated the presence of polyamide, nylon, or polyethylene in the impacted areas, probably derived from the degradation of fishing nets (Vitale et al., 2023). These preliminary results highlight the importance of assessing the impact of ghost nets on marine biodiversity and their value in future restoration plans.

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