2nd INTERNATIONAL SCIENTIFIC SYMPOSIUM
Interdisciplinary Approach to the Scientific Research of the Adriatic Sea
InspireAdriatic 2025

Zagreb, 19 – 20 May 2025

BOOK OF ABSTRACTS

Book of Abstracts of the 2nd International Scientific Symposium
Interdisciplinary Approach to the Scientific Research of the Adriatic Sea – InspireAdriatic 2025

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Foreword

Following the successful first InspireAdriatic symposium, held in Zagreb in 2023 and attended by 80 participants from various countries and scientific disciplines, the Ruđer Bošković Institute and the Organizing Committee were pleased to host the 2nd International Scientific Symposium “Interdisciplinary Approach to the Scientific Research of the Adriatic Sea” - InspireAdriatic 2025.

This year’s symposium took place on May 19-20, 2025, in Zagreb, at the Algebra Bernays University. It brought together over 90 participants from eight countries: Albania, Belgium, Croatia, France, Germany, Italy, Montenegro and Slovenia. The scientific program featured five invited lectures, 19 selected oral presentations, and 32 poster presentations, concluding with a panel discussion that encouraged further interdisciplinary dialogue.

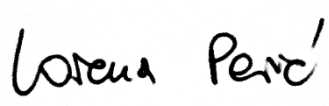
Conceived as a continuation and further development of the discourse initiated in 2023, the InspireAdriatic 2025 Symposium aimed to foster scientific exchange across disciplinary, institutional, and national boundaries. It provided a platform for both emerging and established researchers to reflect on the current state of knowledge, methodologies, and pressing challenges concerning the Adriatic Sea and its broader Mediterranean context. Recognizing the Adriatic as a dynamic and complex marine ecosystem - facing mounting pressures from climate change, pollution, overfishing, and increased maritime traffic - the symposium promoted a holistic and integrative approach to marine research. Participants explored the interactions among physical, chemical, biological, geological, and socio-economic processes that shape the region’s ecological integrity and resilience.

In light of ongoing geopolitical and environmental challenges across the Mediterranean and Black Sea basins, the symposium emphasized the importance of cross-border cooperation, shared methodologies, and long-term collaborative networks to ensure the protection and sustainable management of these interconnected seas.

InspireAdriatic 2025 served as a truly multidisciplinary forum, where perspectives from oceanography, marine biology, chemistry, environmental sciences, ecology, geosciences, climate research, and socio-environmental studies converged. Through this cooperative endeavor, InspireAdriatic 2025 reinforced the strength and importance of a vibrant, interdisciplinary, and international scientific community committed to the Adriatic region and the challenges facing marine ecosystems more broadly.

This event is dedicated to the memory of Dr. Marko Branica, a pioneering advocate for marine research in Croatia.

Organizing Committee



Ines Sviličić Petrić, PhD **Lorena Perić, PhD** **Vlado Cuculić, PhD**

Prof. Marko Branica (1931 - 2004)

Since 1954, when he was employed at the Ruđer Bošković Institute in Zagreb, Prof. Marko Branica's life motto was that the Adriatic Sea is of the greatest importance for Croatia and its future. He understood that an effort must be made to provide appropriate education to coming generations of marine scientists. As early as 1971, he organized a postgraduate study in Oceanology at the University of Zagreb of which he was the head from the beginning, and in 35 years of its existence more than 200 students received their training and Master of Science degrees by taking this course. At that time, very few such courses, if any, existed in the Mediterranean region. The course was reorganized into a doctoral program in Oceanology at the University of Zagreb in 2006. Since then, more than 60 students have earned their PhD in Oceanology.

Following his visions, in 1972 he founded and directed a new department of the Ruđer Bošković Institute - Center for Marine Research (now Division for Marine and Environmental Research in Zagreb and Center for Marine Research in Rovinj). Furthermore, in 1980 Marko initiated the construction and founding of the Research station Martinska in Šibenik (Croatian middle Adriatic coast), as the Marine research facility of the Ruđer Bošković Institute. He coordinated the project of research and environmental protection of the Adriatic Sea and the relevant international research contracts. Marko Branica dedicated over four decades of research to aquatic sciences, addressing the key issues and shaping the agenda in environmental chemistry. In 1967, alongside other scientific breakthroughs, he published a pioneering article in marine and environmental electrochemistry, introducing the polarographic analysis of seawater samples. This marked him as the first marine electrochemist. This was widely recognized by the international scientific community.

As he used to emphasize, it is of great importance that young people engaged in science communicate with the world scientific community, go out into the world, follow current achievements, interconnect with representatives of excellence. Since this is not always possible, excellence will be brought to Croatia. Marko Branica is known for bringing together scientists from different countries. Since 1970 he organized scientific meetings biennially in Croatia, in a series of 14 meetings which became known as the Chemistry of the Mediterranean

International Symposia. These conferences attracted attention of both young researchers and prominent scientists in a unique combination of high-level marine science and ample possibilities for discussion and social interaction between young and senior researchers, in a truly "summer- school" atmosphere.

Marko Branica devoted a lot of time to international advisory and organizational activities. As an expert of the International Atomic Energy Agency (IAEA) for nuclear materials and nuclear plants safety problems, he paid multiple visits to Brazil (1972, 1975 and 1979) and Peru (1973). As a UNESCO expert, he developed the research programs for chemical oceanography in Athens and Paris (1978) and the United Nation Agency development program for the Oceanographic Institute in Athens (Greece). Much of his energy was also devoted to the activities of the International Commission for Scientific Research of the Mediterranean Sea (CIESM). In a period of 25 years, from 1970 to 1995, Marko presided over several mandates over the CIESM Chemical Oceanography Committee. When Croatia became a member of this organization in In 1992, he became the first Croatian national delegate.

Dr. Marko Branica mentored 27 doctoral and numerous master's and graduate theses, published 250 papers and 9 patents, which made him one of the most cited marine chemists. Among other awards and recognitions, the impact of his research was acknowledged by the Royal Netherlands Academy of Arts and Sciences, which awarded him the Dr. A.H. Heineken Prize for the Environment in 1992.

Dr. Branica's work has had a profound influence on aquatic, marine, and environmental chemistry worldwide, and this impact will endure.

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Symposium programme

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10:15-10:30	SL1 - M. Wagner - Towards a sustainable gravel beach management along the Croatian coastline
10:30-10:45	SL2 - S. Beqiraj - Assessment of existing and proposed MPAs in Albania: the need to review their environmental state and reconsider their proposed conservation status
10:45-11:00	SL3 - A. Steckenreuter - Acoustic telemetry as an innovative tool to track aquatic animals
11:00-11:15	SL4 - P. Radolović - Microplastic problem - concept of an autonomous sampling vessel
11:15-11:45	Coffee break
Session 2:	
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12:15-12:30	SL5 - M. Peharda - Variegated scallop *Mimachlamys varia* - new archive of sea temperature data
12:30-12:45	SL6 - S. Grđan - Ocean acidification: an understudied stressor in the Adriatic sea
12:45-13:00	SL7 - B. Hamer - Mediterranean mussel *Mytilus galloprovincialis* Lamarck, 1819 valve gaping behaviour as an indicator of favourable environmental conditions

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15:45-16:00	SL9 - A. Jaklin - Recent phenomena and changes in the Northern Adriatic
16:00-16:15	SL10 - J. Hartkamp - Describing specific benthic environments on the cliffs of the Lastovo island
16:15-16:30	SL11 - F. Grgurević - Zooplankton diversity and trophic interactions in the area influenced by island trapped waves (Southern Adriatic)
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Tuesday 20th May 2025.

08:00-09:00	**Registration of participants**

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Session 5:	
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13:15-15:15	**PANEL DISCUSSION: Navigating turbulent waters: science and sustainability in the changing Adriatic and closing of the Symposium**

INVITED LECTURES

IL1 Science-Policy Interactions, Inter- and Transdisciplinary Research – Success Factors for Integrated Coastal Zone Management

Ante Ivčević

Priority Actions Programme/Regional Activity Centre (PAP/RAC) - UNEP/MAP, Split, Croatia

How do policy-makers effectively manage densely populated coastal zones with limited resources? What strategies do they employ to advocate for coastal setbacks or other climate change adaptation measures? Integrated Coastal Zone Management (ICZM) is a long-standing policy framework aimed at promoting sustainable coastal development. While it is not new or revolutionary, does it still fulfil its intended purpose? To address this question, I will begin by providing a theoretical analysis of the key components that influence the success of ICZM: integration, implementation, the interface between science and policy, and governance mechanisms.

Next, I will present several examples from the Mediterranean basin to illustrate how the framework operates in practice and extract lessons learned from current ICZM planning efforts. Finally, I will discuss the role of science in shaping the context-specific interpretation of ICZM. While the effective integration of science and policy requires time, energy, and steadfast institutional commitment, collaborative knowledge creation between science and policy—ideally extended to encompass the broader community—is crucial for achieving sustainable solutions.

IL2 UV filters unfiltered: what happens to sunscreens after use?

Sonja K. Fagervold

Banyuls Oceanological Observatory, Sorbonne University, Banyuls, France

Organic UV filters are key components in many cosmetic products, including sunscreen creams. The use of sun care products is increasing, which raises concerns, particularly in coastal areas with high tourism pressure. Over 30 different compounds are currently used as UV filters in the EU. Once released into the environment, the fate of these filters depends on their chemical properties, persistence, and degradation.
Our team investigates several aspects of UV filter fate and effects, including the analysis of these compounds in local environments, their ecotoxicological impacts on various marine organisms, and their degradation and transformation. Interestingly, some filters can be transformed by marine organisms, such as corals and worms, complicating the assessment of their real-life environmental concentrations and effects.
Additionally, the degradation of organic UV filters in the environment remains a significant question. We have shown that many organic UV filters are recalcitrant to degradation, likely due to their limited bioavailability to microorganisms involved in this process and/or the chemical stability of certain filters. However, some organic UV filters are degraded by specific groups of microorganisms, suggesting that degradation requires a particular set of enzymes and/or conditions. Understanding the processes that organic UV filters undergo is crucial for a comprehensive assessment of their long-term risks to coastal ecosystems.

IL3 Importance of nursery habitats: Addressing threats and challenges

Sanja Matić-Skoko

Institute of Oceanography and Fisheries, Split, Croatia

Seagrass, wetlands, and salt marsh ecosystems are increasingly recognized as important Mediterranean nursery grounds due to the range of ecosystem services they provide. These services include carbon sequestration, coastal protection, nutrient run-off filtration, sustaining biodiversity, and providing habitat and food for various fish and invertebrate species.
However, these ecosystems are heavily impacted by climate change, fisheries, coastal development, eutrophication and invasive species. Anthropogenic stressors contribute to: (1) habitat degradation and loss due to coastal development and destructive practices; (2) sedimentation and pollution from terrestrial runoff; (3) direct exploitation by fisheries which final result in the ecosystem services and biodiversity reduction.
The requirements for nursery identification are numerous and complex, necessitating interdisciplinary scientific approaches and methods to determine all the ecological services that such areas provide, including those already lost due to degradation.
Ecosystem services refer to the variety of benefits that humans derive from ecosystems. The ecological values of ecosystem services often stem from ecosystem functions (e.g., habitat provision for fisheries, carbon and nutrient cycling) that incorporate integral biological components of ecosystems. Valorising nursery areas is necessary for the creation of management and protection strategies. Conservation and restoration aim to protect not only specific species and habitats but also the functions of ecosystems that are important for the social, cultural, and economic well-being of coastal region societies.

IL4 On the linkage of the atmosphere and the ocean: responses of sea surface to source-depended atmospheric deposition inputs

Sanja Frka

Ruđer Bošković Institute, Zagreb, Croatia

The oceans and seas are facing increasing pressures from anthropogenic forcing that alter their biological, chemical, and physical properties at both local and global scales. One particularly vulnerable area is the sea surface microlayer (SML), the uppermost layer at the air-sea interface, which is highly sensitive to human impacts, climate change and other forms of environmental stress.

The SML mediates the overall exchange of energy and matter between the ocean and the atmosphere, influencing global biogeochemical cycles and climate regulation. Recent studies conducted under the BiREADI CSF IP-2018-01-3105 project in the central Adriatic, emphasized that the SML, particularly in coastal regions, is highly responsive to atmospheric deposition of nutrients and pollutants.

These external inputs have the potential to alter the plankton community structure, organic matter production, and, consequently the chemistry of the SML, with significant implications for global air-sea exchange processes, including the exchange of climate-relevant gasses mediated by the SML. To assess the impact of ambient aerosols from diverse sources on plankton populations and sea surface chemistry, the first incubation microcosm experiment of its kind was conducted in the central Adriatic area.

We demonstrate that intense, but realistic additions of aerosols from anthropogenic sources and biomass burning emission differently impacted the SML and the underlying water by altering community structure and biogenic organic matter composition due to their different chemical composition. To better understand the biochemical adaptation strategy of phytoplankton at the level of individual species to the effects of specific constituents of deposited atmospheric particles, the change in organic matter composition produced by phytoplankton was also studied through laboratory tests on phytoplankton monocultures. The main findings of our recently completed and ongoing (ADRIAirBURN IP-2024-05-6224) research projects will be presented and discussed, focusing on lessons learned and best practices.

IL5 Mercury in the Adriatic seawater, sediments, and biota: origin, transformations, and trends

Igor Živković

Jožef Štefan Institute, Ljubljana, Slovenia

Mercury (Hg) contamination in the Adriatic Sea is a critical environmental concern due to its persistence, toxicity, and ability to bioaccumulate in marine ecosystems. Decades of research in the Adriatic and Mediterranean Sea have significantly advanced our understanding of mercury dynamics in these regions.

The Adriatic Sea's unique geochemical and hydrodynamic characteristics, combined with anthropogenic pressures, have created a complex system of mercury inputs, transformations, and distributions.

Key sources include historical mining activities (Idrija mine), industrial discharges (chlor-alkali plants), and atmospheric deposition, which contribute to mercury budget and consequently to its accumulation in seawater, sediments, and biota. Studies on mercury speciation have revealed its transformations between inorganic and organic forms, particularly the formation of methylmercury, a highly toxic compound that bioaccumulates in marine organisms, posing risks to both ecosystems and human health.

Long-term monitoring has identified spatial and temporal trends, highlighting contamination hotspots and areas of concern. This presentation underscores the importance of interdisciplinary approaches in unravelling mercury's biogeochemical pathways and its ecological impacts. By synthesizing established knowledge, this lecture will focus on the origins and trends of mercury in the Adriatic and Mediterranean regions.

ORAL PRESENTATIONS

SL1 Towards a sustainable gravel beach management along the Croatian coastline

Maximilian Wagner[1,2], Duje Kalajžić[1], Čedomir Benac[1], Els De Keyzer[2], Pascal Hablützel[3], Marcelo Kovačić[4], Hannes Svardal[2,5], Igor Ružić[1]

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[2]Department of Biology, University of Antwerp, Antwerp, Belgium
[3]Flanders Marine Institute (VLIZ) InnovOcean Campus, Ostend, Belgium
[4]Natural History Museum Rijeka, Rijeka, Croatia
[5]Naturalis Biodiversity Center, Leiden, Netherlands

Croatia is one of Europe's top summer tourist destinations, known for its numerous pocket gravel beaches. However, natural gravel beaches are rare and valuable coastal resources. Therefore, growing tourism demand has led to the construction of artificial beaches, often without considering natural oceanographic conditions or local geological fabric and sediment composition. These interventions increasingly impact coastal habitats, which support diverse biological communities and ecosystems. Furthermore, current management strategies largely overlook the biota directly associated with gravel beaches. This knowledge gap is underscored by the recent discovery of previously unknown endemic predatory fish species on Croatian gravel beaches, highlighting the urgent need to integrate ecological perspectives into beach management and resource conservation. In a previous study, we identified two sympatric, specialized gravel fish species in the Adriatic Sea, each occupying distinct microhabitats and showing high sensitivity to sediment composition changes. Interestingly, both species were also found in artificial beaches, suggesting their potential as bioindicators for monitoring and managing human-made gravel beaches. Building on these findings, the bilateral (Croatia and Belgium) project CROBEach aims to enhance our understanding of gravel beaches as natural resources by investigating biodiversity and functional relationships across artificial and natural beach types in the northern Adriatic Sea. We will disentangle complex interactions among gravel beach taxa and their recruitment patterns using an interdisciplinary approach of geological analyses and modern biodiversity screening methods, including whole-genome sequencing and DNA metabarcoding.

SL2 Assessment of existing and proposed MPAs in Albania: the need to review their environmental state and reconsider their proposed conservation status.

Sajmir Beqiraj[1], Stela Ruci[1], Denada Kasemi[2], Brunilda Veshaj[2]

[1]Department of Biology, Faculty of Natural Sciences, University of Tirana, Albania
[2]Department of Biology, Faculty of Technical and Natural Sciences, University of Vlora, Albania

Although the establishment of MPAs in Albania was first proposed in the National Biodiversity Strategy and Action Plan since 1999, and later emphasized in various environmental policy documents (strategies, action plans, and management plans), the process of MPA designation and management has been slow. Of the eight proposed areas, five have remained only in the proposed status, without formal proclamation, despite years of studies, assessments, and consultation processes for some of them. In the three existing MPAs (Karaburun-Sazan, Butrint, and Porto Palermo), although progress has been made in developing conservation and management policies, rapid environmental degradation remains a serious concern. Recent studies and assessments of the ecological and environmental conditions of both existing and proposed MPAs in Albania, focusing on macroalgae, seagrasses, benthic invertebrates, and fish, have revealed significant habitat degradation and a rapid loss of biodiversity values. Additionally, the limited implementation of existing legislation regarding MPAs and CPAs has allowed these impacts to intensify. Based on the recent findings from the studies and assessments mentioned, experts have emphasized the need to review the environmental state of these areas and reconsider their proposed conservation status. Key documents proposed for revision include the National Biodiversity Strategy and Action Plan, the Strategic Plan for Marine and Coastal Protected Areas, and the individual Management Plans for the existing MPAs.

SL3 Acoustic Telemetry as an Innovative Tool to Track Aquatic Animals

Andre Steckenreuter[1]

[1] Innovasea - Fish Tracking, Cologne, North Rhine-Westphalia, Germany

Acoustic telemetry is a well-established tool that has been used around the world for more than three decades to get an understanding of the spatio-temporal movements and associated behaviour of a wide range of aquatic animals. This technology is based on transmitters being attached to individual animals who will then be recorded by deployed receivers, i.e., hydrophones, in strategic locations when in detection range. Unlike with satellite tags, animals do not need to break the surface in order to be detected. There are also fewer limitations on tag size and battery life, meaning a broader selection of animals can be tracked (starting from a total weight of at least 6 g). Acoustic telemetry will allow, for example, to detect migration corridors (or changes of those over time), identify crucial areas of physiological and behavioural importance (such as spawning, mating, foraging, nursery, and resting habitats), and the intrusion and distribution of invasive species, to name just a few. The Adriatic Sea has been identified as one of the hotspot for a need for the initiation of a regional acoustic telemetry network in the Eastern Mediterranean Sea. Individual researchers that use this technology in certain regions of the Adriatic Sea (and beyond) may share their data via one of the existing network databases to leverage each other's receiver infrastructure in order to extend the scope of their scientific findings. Results will greatly improve management plans and decisions for fishing practices, potential marine protected areas (MPAs), etc.

SL4 Microplastic Problem - Concept of an Autonomous Sampling Vessel

Patrik Radolović[1], Luka Žužić[1], Deni Vale[1], Ener Špada[1], Vedrana Špada[1]

[1]Istrian University of Applied Sciences, Pula, Croatia

Marine plastic pollution, particularly microplastics, is a growing global issue that threatens marine ecosystems. Developing a vessel capable of collecting both macroplastics and microplastics along the coastline allows for continuous monitoring, with a focus on coastal areas most affected by human activity. The Jadranko v1.0 project introduced a robotic vessel as a proof of concept for microplastic collection. Equipped with a video system and real-time GPS tracking, the vessel is remotely controlled via radio. Initial tests confirmed its ability to collect samples successfully but also revealed several limitations, including a short operational range (under 200 m), analog video transmission, and insufficient motor power. Collected microplastic samples will be analyzed using advanced recognition technologies to classify particles based on type and size. This data will contribute to a growing database on microplastic pollution, helping researchers better understand its distribution and impact. By improving autonomous marine sampling, the Jadranko project supports scientific efforts to combat plastic pollution. Its findings will aid in developing strategies to reduce environmental contamination, promoting cleaner oceans and a healthier ecosystem for future generations.

SL5 Variegated scallop *Mimachlamys varia* - new archive of sea temperature data

Melita Peharda[1], Hana Uvanović[1], Niels J. de Winter[2], Bernd R. Schöne[3], Niko Bujas[1], Ratko Cvitanić[1], Jeoren van der Lubbe[2], Ivica Janeković[4]

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[3]Johannes Gutenberg Universität, Mainz, Germany
[4]The University of Western Australia, Perth, Australia

Scallops (family Pectinidae) belong to a speciose bivalve taxon that inhabits different geographic areas ranging from the tropics to polar regions. They also occur as well-preserved fossils and, as such, serve as an interesting high-resolution archive for the analysis of spatial and temporal variations in the past marine climate and environment. In this study, our main target species was the variegated scallop, *Mimachlamys varia*, which is of potential commercial interest, occurs as fossils in sedimentary deposits, and whose growth patterns are still not well studied. Our second target species was *Aequipecten opercularis*, which has received increasing attention in sclerochronological research and, for the purpose of this study, was used as a control taxon. Specimens were collected in November 2024 during the SOLEMON expedition in the northern Adriatic Sea, using a commercial fishing vessel. To determine the oxygen (δ18Oshell) and carbon (δ13Cshell) stable isotope values, shell powder was acquired from the external shell surface of both taxa by manual micro-drilling. Adriatic Sea temperature and salinity values were obtained from the ROMS numerical model and were used to calculate predicted δ18Oshell values. Measured δ18Oshell data were then manually aligned along the predicted δ18Oshell curve, enabling the reconstruction of the seasonal timing and rate of shell growth. Results were further compared to those previously published for other scallop species of the Adriatic Sea, as well as other regions. The research was conducted in the framework of the project RIBAR (Next Generation EU—National Recovery and Resilience Plan 2021-2026).

SL6 Ocean Acidification: An Understudied Stressor in the Adriatic Sea

Sanja Grđan[1], Sam Dupont[2], Luka Glamuzina[1], Ana Bratoš Cetinić[1]

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Carbon dioxide levels have increased by 50% since the industrial revolution, primarily due to the burning of fossil fuels, urbanization and the intensification of agriculture. The oceans absorb about 27% of atmospheric CO_2, altering seawater carbonate chemistry — a process known as ocean acidification. Surface ocean pH has already decreased by 0.11 and is projected to decrease further by 0.08-0.37 by year 2100. Carbonate chemistry in coastal areas is also influenced by biological processes, freshwater inputs, organic runoff and upwelling of CO_2-rich water. These factors are contributing to diurnal and seasonal pH fluctuations and are impacting key species and ecosystem services. Ocean acidification affects organisms on all trophic levels and often interacts with local and global stressors such as eutrophication and rising sea temperature. Despite increasing global attention, biological response to ocean acidification in the eastern Adriatic remains poorly understood, leading to gaps in our understanding of the adaptive capacity of local populations and ecosystem-level responses. In our recent study we investigated how the predatory gastropod *Hexaplex trunculus* responds to future ocean acidification scenarios, considering local pH variability. The results highlight the complexity of adaptive strategies and trade-off mechanisms under low pH — some traits remained unchanged, while others varied with temperature, metabolic activity and longevity of exposure. Many keystone species and ecologically important habitats in the Adriatic Sea still need to be studied to understand the wider impacts of projected low pH on marine communities.

SL7 Mediterranean mussel *Mytilus galloprovincialis* Lamarck, 1819 valve gaping behaviour as an indicator of favourable environmental conditions

Bojan Hamer[1], Ivan Balković[1], Luca Privileggio[1], Elisa Pignoni[1,2], Kristina Grozić[1], Dijana Pavičić-Hamer[1]

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Mussel *Mytilus galloprovincialis* is an important commercial mariculture species and a powerful bioindicator often used to assess marine pollution in coastal and estuarine areas. More recently, behavioural markers have been used to assess changes in mussel and ecosystem health in response to various threats and as part of biological early warning systems (BEWSs). Mussel valve movement-gaping (VG) is widely recognized as an integrative measure of physiological functions such as respiration, feeding and excretion, which can change under stressful conditions in response to a deteriorating environment and pollution. Using a valve gaping monitoring system (VGMM) based on an Arduino microcontroller platform and Hall sensors, we monitored the VG of six mussels during their 4-day acclimatisation to laboratory conditions. After acclimatisation, three mussels served as controls and three mussels were exposed to abrupt daily salinity changes: 37->26->37->18->37. By analysing the VG results, it was possible to determine the normal daily behavioural rhythm of the mussel, i.e. >70% filtration time with the valve open >50% and 1-5 rest periods with the valve open <30%, as well as the VG changes of the control and the mussels stressed by seawater salinities (26 and 18). The results obtained contribute to the current knowledge on the normal VG behaviour which is needed for further experimental work. In general, there is great potential for the application of VGMM in/ex situ as an indicator of suitable environmental conditions (salinity, food), extreme conditions (temperature, climate change) and the presence of diseases.

SL8 Reproductive cycle of the Mediterranean scallop (*Pecten jacobaeus* L.) from the Krka River estuary in relation to environmental conditions

Valentina Šebalj[1], Petar Zuanović[2], Tomislav Šarić[2], Ivan Župan[2]

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Scallops (Pectinidae Rafinesque, 1815) are sublittoral, epifaunal bivalves sensitive to changing environmental conditions. The Mediterranean scallop (*Pecten jacobaeus* Linnaeus 1758) is a commercially important bivalve in the Adriatic Sea under constant fishing pressure, which can negatively impact its population. Understanding its biological characteristics, particularly concerning its reproductive cycle in relation to environmental conditions, is crucial for its effective management.

From December 2021 to May 2023, 300 specimens of *P. jacobaeus* were collected from the Krka River estuary, and processed in the laboratory, and gonadosomatic (GSI) and muscle (MI) indices were calculated seasonally.

The GSI results indicate that *P. jacobaeus* experiences three potential spawning peaks annually: a major one from late winter/ early spring till summer, a weaker one in early fall, and a possible third one in early winter. A significant negative correlation between GSI and MI, implies that energy allocation is divided between muscle and gonads, indicating that muscle reserves are utilized for gonad development. The sea temperature emerged as the most significant environmental factor influencing the reproductive cycle of the Mediterranean scallop, showing a significant negative correlation with GSI. In contrast, river inflow positively correlated with GSI, suggesting that food availability has an important role in supporting gonadal development. Additionally, an extreme decline in salinity can have detrimental effects on reproductive patterns.

To preserve the population from the Krka River estuary, the fishing season should be closed during the spring season when spawning is at its peak.

SL9 Recent phenomena and changes in the Northern Adriatic

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In the end of the seventies seasonal occurrences of intense population „booms“of jellyfish *Pelagia noctiluca* were noticed. In the mid-eighties, intensified episodes of excessive phytoplankton development and excretion of organic matter. In the fall of 1989 a complete anoxia developed in the bottom layer. Consequently, a total mass mortality of benthonic organisms occurred on the area of approximately 1,200 km2. In 1994 the presence of an invasive tropical green algae *Caulerpa taxifolia* in the Malinska harbour (Krk Island) was confirmed. In 2004 even more invasive *Caulerpa cylindracea* were noticed in the Vrsar harbour. Due to the ever-growing concern of introduction and spread of harmful invasive species in the Adriatic, during 2014 and 2015, port benthic community research was performed as a part of the BALMAS project. From the year 2016 on, in the western Istrian coast even bigger aggregations of the invasive comb jelly *Mnemiopsis leidyi* started to appear. In June 2018 an oil spill of cca 3.8 tons of motor fuel happened in the Bršica port basin in the Raša Bay. In 2019 a mass mortality of the fan shell Pinna nobilis started in the Adriatic, caused by a plasmodium infection. From the year 2020 on numerous medusae, both along the coasts as well in the open waters started to appear; last year it was barrel jellyfish *Rhizostoma pulmo,* and later fried egg jellyfish *Cotylorhyza tuberculata*.
Unfortunately, problems and hazards we are inflicting on our sea are multitudinous, from global to the local ones that are still present.

SL10 Describing specific benthic environments on the cliffs of the Lastovo Island

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Paramuricea clavata has been reported as one of the most common gorgonians in the eastern Adriatic Sea, structuring hard bottom coralligen communities. During summer stratification period at the Lastovo Island, internal trapped waves (ITWs) have been reported which affected daily thermocline displacements. It can be hypothesized that those temperature oscillations do not allow temperature-sensitive organisms like *P. clavata* to develop. To get insight into the benthic community structure in relation to these temperature shifts, diver-operated photographic identification was utilized from 2021 to 2023. A set of thermistors was mounted on the cliffs between 5 to 45 m of depth in the same period. The diving campaign led to the discovery of the crevice within the cliffs, including *P. clavata* and the rare and nearly threatened gold coral *Savalia savaglia*. Subsequentially, a set of additional thermistors was mounted inside this crevice. A total of 38 taxa were identified, with the domination of *Leptopsammia pruvoti*, *Adeonella calveti*, and *Aplysina cavernicola* contributing 88.9%, 66.7%, and 51.9% respectively at the cliffs. *P. clavata* and *S. savaglia* were exclusively recorded within the crevice contributing to the community up to 45.2% and 41.9%, respectively. Only 17.7% of *P. clavata* was found to be healthy, and over 39% of the skeletons were affected with *S. savaglia*. Further monitoring of this exclusive environment and protecting the area and surroundings could contribute to overall ecosystem health.

SL11 Zooplankton diversity and trophic interactions in the area influenced by Island Trapped Waves (Southern Adriatic)

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Island-trapped waves (ITWs) alter both physical and biological conditions leading to relatively higher nutrient concentrations in the surface layer. This study explores summer zooplankton diversity and trophic interactions in the Lastovo island archipelago. Zooplankton was sampled daily following the frequency of ITWs events in July 2021 and 2022. Overall zooplankton diversity was analyzed using the light microscopy analysis and metabarcoding of 18S rRNA gene V4 variable region.

The light microscopy of microzooplankton revealed 84 taxa in 2021, and 70 in 2022, and the community was dominated by *Codonellopsis schabi*, *Tintinnopsis angulata*, *Onceaidae*, *Metacylis joergenseni*, *Microsetella norvegica*, Radiolaria, *Oithona nana*.A total of 52 mesozooplankton taxa were identified in 2021, and 77 in 2022, with dominance of *Oithona similis*, *Onceaidae*, *Oikopleura longicauda*, *Paracalanus parvus*, *Calocalanus* sp., *Acartia clausi*, *Evadne spinifera* and *Centropages typicus*. Of the aforementioned genera, *Oithona, Oikopleura, Paracalanus, Acartia, Tintinnopsis* and *Calocalanus* were also confirmed by metabarcoding, while the others were solely identified by microscopic analysis indicating limitations of used barcode.

Pronounced shifts in zooplankton community composition were determined, with nano-feeders (*Evadne spinifera*, *Oithona* spp., *Paracalanus parvus parvus*) exhibiting the most dynamic responses to ITWs-induced changes in nanophytoplankton availability. Micro-feeders, such as *Centropages typicus* and *Temora stylifera*, showed depth-specific distribution patterns, reflecting their feeding preferences and adaptability to ITW-driven variations in food sources. Pico-feeders, including tintinnids, radiolarians, and *Oikopleura longicauda*, played a crucial role in the ecosystem with tintinnids exhibiting the strongest response to ITWs, while *Oikopleura longicauda* responded with a time lag, suggesting complex trophic interactions.

SL12 The dynamics of pollen deposition and its biogeochemical consequences in the coastal Adriatic seawater

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Pollen is released in the air in large amounts during the pollination season as coarse bioaerosol particles (10-100 μm). Rich in organic compounds such as proteins, fatty acids, and carbohydrates, pollen is mainly transported by wind, mixed within the atmospheric boundary layer, and removed through dry and wet deposition. In the POLLMAR project (2023-2027), we investigate dynamic of pollen deposition into the oligotrophic coastal seawater of the Šibenik region and its biogeochemical consequences. We will highlight initial findings of field campaign conducted during the 2024 pollination season by showing the first results of analyses of organic matter components in surface seawater layer and their correlation with airborne pollen concentration and type, along with a qualitative analysis of pollen in surface seawater. The results indicate continuous pollen deposition from the air into coastal waters, with identified pollen types matching the dominant Mediterranean vegetation of the study area. Our research is crucial for understanding climate change impacts on Adriatic biogeochemistry. In the coming decades, rising temperatures are expected to increase the frequency of dry periods in the Mediterranean, prolonging the pollination season. Additionally, higher atmospheric CO_2 levels will boost pollen production, leading to increased airborne concentrations and more frequent deposition of pollen into the coastal Adriatic Sea.

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SL13 Carbohydrates in atmospheric deposition over the coastal central Adriatic Sea: input dynamics, distribution, and potential sources

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Carbohydrates (CHO) are key components of organic matter in both atmospheric and marine environments, playing an important role in biogeochemical cycles. During the pollination season, airborne pollen, rich in carbohydrates, contributes to the transport of organic carbon from the atmosphere to the ocean. This study, part of the POLLMAR project, investigates CHO concentrations and their distribution in atmospheric wet and bulk deposition, as well as in seawater surface layers at two central Adriatic coastal sites. By analyzing samples from both the atmosphere and marine environment, we assess the role of atmospheric deposition in delivering CHO to coastal waters. Airborne pollen counts were also monitored to evaluate its contribution to CHO levels. Results showed significant variations in CHO concentrations between sites, indicating that local/regional factors, along with atmospheric deposition type, influence CHO distribution. Elevated CHO concentrations in the sea-surface microlayer suggest a combined influence of atmospheric deposition and *in situ* production, reflecting complex air-sea interactions. At one site, pollen was identified as a major CHO source in the sea-surface microlayer, highlighting its role in shaping the coastal organic carbon pool. Understanding pollen deposition is crucial for predicting how changes in atmospheric organic matter composition and meteorological patterns may impact marine carbon biogeochemistry in the Adriatic region.
This work was supported by the Croatian Science Foundation under the project number HRZZ-IP-2022-10-6348 (POLLMAR). We thank N. Vuletin from the Institute of Public Health of Šibenik-Knin County for airborne pollen counting.

SL14 Rogoznica Lake: Exploring the Environmental Interactions

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Lake Zmajevo oko (ZO) near Rogoznica, Croatia, is an euxinic marine lake with a deteriorating ecosystem. Usually, the vertical water column is hydrostatically stable with anoxic bottom waters and a thin middle zone - around the chemocline - rich in sulphur bacteria. However, every few years, ZO mixes vertically, during which oxygen is depleted throughout the water column, and all aerobes are killed. From the ZO intensive research, which started in 1996, such mixing events have been happening more often, and consequently, the ecosystem of the lake is rapidly deteriorating. In this work, we present the latest physico-chemical data analysis with an emphasis on the hydrostatic stability of the water column concerning the meteorological and oceanographic influences, most notably, the fast lake response to the environmental change. In that context, we also discuss the recent findings regarding the lake-sea underground water exchange and its potential impact on the lake's stability. Lastly, we round our latest efforts to investigate the phenomenon of the anoxic holomixia using a numerical model adjusted to ZO conditions. This research aims to fill in the knowledge gaps in the ZO holomictic anoxia preconditioning related to seasonal, interannual, and climatic impacts.

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SL15 Copper redox speciation in Krka River Estuary: a case study

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Copper (Cu) is an essential micronutrient for phytoplankton, while elevated concentrations of its free ion can be toxic (Lopez et al., 2019), thereby understanding its speciation in natural waters is crucial. More than 99 % of total dissolved Cu is organically complexed (Moffett and Dupont, 2007) and thiols such as cysteine are proposed as candidates for strong Cu binding ligands (Ruacho et al., 2022). In this study we present Cu redox speciation in the stratified Krka River Estuary (Croatia) in July 2024. For the determination of Cu redox speciation, an adapted solid phase extraction method is used and Cu concentrations in Cu(I) and Cu(II) fractions are determined by differential-pulse anodic stripping voltammetry (Crmarić et al., 2024). The measured Cu(I) ranges from 50.2 to 82.2 % of the total dissolved Cu. The maximum of Cu(I) is measured in the surface layer of the water column, where the presence of cysteine-like compound is detected by square-wave cathodic stripping voltammetry, which, along with measured maximum of chlorophyll a, indicates the importance of ligands of biological origin in Cu(I) binding.

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SL16 Distribution of Trace Metals and Rare Earth Elements in Seawater and Sediments of the Pula Bay

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An extensive study of trace metals (TM) and rare earth elements (REE) distribution, fractionation and speciation in seawater and sediments in the Pula Bay was conducted. Total concentrations were determined by stripping voltammetry, ICP-MS and AAS. A preconcentration system using Nobias Chelate-PA1 resin was developed in order to enable the ICP-MS analyses of TM and REE in seawater samples. Bioavailable concentrations in seawater samples were determined by diffusive gradients in thin films (DGT) and chelating resin Chelex-100, while a modified first step of BCR sequential extraction was used for sediment samples.

Zinc, Pb and Cu concentrations in seawater increased significantly from the reference point towards the inner bay, as do the concentrations of elements in the sediment (except Mn). The REE concentrations in seawater samples ranged from 0.09 ng/L (Tb) to 24.2 ng/L (Y) represent the first set of data for the Croatian Adriatic coastal sea. Concentrations of REE in the sediments are slightly higher than other sites at the Adriatic coast, but in accordance with the geochemical atlas for that region. The DGT bioavailable fraction ranged from 34 % (Cu) to 92 % (Cd), and the results are comparable to model data and bioavailable fractions obtained using Chelex-100 resin.

Risk assessment of seawater showed no risk with regards to Croatian/European legislation, which is not the case when compared to some other water quality criteria or using a comprehensive risk assessment method. Considering total concentrations, Hg emerges as the major pollutant in sea sediment, followed by Pb.

SL17 Rare earth elements dynamics in the stratified Krka River estuary

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Rare earth elements (REE) are gaining attention as potential microcontaminants in aquatic systems, particularly in estuarine environments. We investigated REE geochemical behaviour in highly stratified Krka River estuary, analysing their concentration profiles along the surface brackish and bottom seawater layers. Using a preconcentration technique with NOBIAS Chelate-PA 1 resin and ICP-MS, we detected REE concentrations down to 10 pg/L. Their behaviour was interpreted alongside other trace elements and dissolved organic matter. Shale-normalized REE patterns revealed a depletion of light REE relative to heavy REE, positive La and Y anomaly, and negative Ce anomaly. Additionally, a positive Gd anomaly was observed at the beginning of the estuary, slightly exceeding the threshold that differentiates natural from anthropogenic sources. In the surface layer, significant REE removal at low salinity was observed, followed by the removal of iron and several other trace elements, likely due to the coagulation of riverine colloids. This effect was less pronounced for heavy REE which also showed the strongest correlation with dissolved organic matter parameters. With further salinity increase, REE concentrations increased, peaking at coastal sea stations. The bottom layer showed a progressive REE increase from river to seawater end-member, except for a mid-estuarine anomaly, where heavy-to-light REE ratio decreased and other trace metal concentrations increased (Fe, Mn, Pb, Zn), indicating desorption from particles and/or groundwater influence. The potential bioavailability of REE was assessed using diffusive gradients in thin films (DGT). This study highlights the complex interplay of estuarine processes governing REE distribution and mobility.

SL18 The Deep Adriatic Transient

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The deep Southern Adriatic Pit (dSAP) is a Mediterranean region highly sensitive to climate change, influenced by dense water cascading from the northern Adriatic and heat/salt transport from the Eastern Mediterranean. Historical (since 1957) and modern (permanent and opportunistic CTD sampling, Argo floats, fixed moorings) measurements reveal a mid-2000s transition in dSAP thermohaline properties. Previously marked by steady increases in temperature, salinity, and density, with substantial saw-tooth decadal variability, the dSAP has experienced unprecedented warming (0.8°C) and salinization (0.2) over the past decade, accelerating in time and reversing density trends. The inflow of much more saline waters reduced SAP stratification and altered dense water properties at its source in the northern Adriatic. This at least fivefold acceleration of the high-emission regional climate projections may have substantial effects on the Adriatic biogeochemistry and living organisms, increasing sea level rise trends and more.

SL19 Insights into record salinities in the Southern Adriatic Sea during autumn 2024

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During the PER24 Campaign in October 2024, conducted aboard the R/V Gaia Blu, extreme salinities were recorded in the Southern Adriatic Sea. CTD measurements revealed salinity maxima reaching 39.07 psu in the surface and shallow intermediate layers, representing an anomaly exceeding two standard deviations above the long-term mean. Taking advantage of complementing LADCP measurements, existing Argo float observations, satellite-derived data and available numerical model outputs, we assess potential drivers of these exceptional conditions.

Among others, we investigate local drivers such as preceding convection, hydrological anomalies and heat fluxes, and remote drivers such as changes in the expected advection of saline Levantine Intermediate Water (LIW) from the Northern Ionian and the linked Adriatic-Ionian Bimodal Oscillating System (BiOS). We further compare these conditions with historical observations, noting differences in the occurrence of previous surface salinity maximum events as well as changes in regional circulation.

While our findings are preliminary, they raise important questions about their implications for physical processes such as heat retention, inter-basin exchanges, and dense-water formation, as well as biogeochemical processes that impact the marine food web. Thus, systematic monitoring of these conditions is essential—firstly to understand the underlying mechanisms, and secondly to analyze their potential effects under future scenario projections, which could support stakeholders in developing effective mitigation and adaptation policies.

POSTER PRESENTATIONS

PP1 Sediment contamination in the eastern part of the Kaštela Bay

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In aquatic environments, sediments may act as both a final sink and a potential source of contaminants. Changes in physico-chemical conditions can release contaminants back into the water column, posing a continuous risk to marine life, especially benthic organisms. The goal of this study was to investigate the vertical distribution of ecotoxic metal (Hg, Cd, Pb, Cu, Zn, Ni, Cr), polycyclic aromatic hydrocarbons (PAHs), and tributyltin (TBT) in three locations within the Kaštela Bay, a site in the Adriatic Sea well known for its exposure to the anthropogenic pressure, primarily industrial, port and agricultural activities. In total, three sediment cores were sampled from the eastern part of the bay, two near the former chloralkaline plant (KB-1, KB-2) and one near the mouth of the River Jadro (KB-3). The results revealed elevated concentrations of ecotoxic metals, PAHs, and TBT at all studied locations. The highest contamination levels were observed for Hg and TBT. Mercury concentrations ranged from 0,33 to 4,60 mg/kg, with the highest concentrations found close to the former chloralkaline plant. All subsamples exceeded the Effects Range-Median (ERM) limit proposed by NOAA, except two subsamples that crossed the Effects Range-Low (ERL) threshold. Concentrations of TBT were found in the range of 1,6 μg/kg to 105,6 μg/kg. All subsamples, except the deepest layer of the KB-1 core, exceeded the proposed Environmental Quality Standards (EQS) of 1,6 μg (TBT)/kg (d.w.). These findings confirm the negative long-term impact of anthropogenic activities on the environment of Kaštela Bay.

PP2 Assessment of Heavy Metal Contamination in Fish Caught Using Recreational Fishing Gear in the Central Adriatic Sea

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In fish samples caught using recreational fishing gear - longline, the concentrations of heavy metals were measured. The samples were collected from two stations in the central Adriatic Sea - one station was under the direct influence of an urban area, while the other served as a reference station, located far from urban influence. After dissection, fish muscle and liver samples were lyophilized and subsequently processed using acid digestion, followed by analysis with ICP-MS technology. Statistical analysis of the obtained data revealed interesting results.

PP3 Biological responses of mussels after exposure to environmentally relevant polypropylene and pyrene concentrations: a multi-biomarker approach

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We wanted to evaluate the early toxic effects with a focus on environmentally relevant concentrations of polypropylene (PP) and pyrene - pollutants common in coastal waters. Moreover, PP particles are known to adsorb PAHs, thus forming more complex pollutant effect. During a 14-day exposure period, mussels were exposed to untreated and laboratory-aged polypropylene particles (PP, ca. 40 µm, 1 mg L^{-1}), pyrene (50 µg L^{-1}) and aged PP with adsorbed pyrene. As MP and pyrene can affect mussels via mechanisms such as inflammatory responses, bioenergetic disturbances, DNA damage, several endpoints were assessed in the present study, including biomarkers of antioxidant capacity, neurotoxicity and DNA integrity after 7 and 14 days. Digestive glands and gills were used as indicator tissues. Additionally, whole organism responses were measured as respiration and heart rate.
The accumulation of microplastics in mussel tissues was analyzed at the end of the experiment and showed that less PP particles accumulated in the gills than in other tissues. Exposure to aged PP had the greatest effect on respiration rate, while heart rate was more strongly altered by two pyrene-containing treatments (pyrene and pyrene + aged PP). Biochemical biomarkers showed different trends depending on the exposure, sampling time and indicator tissue, highlighting the complexity of the simultaneous effects of MPs and adsorbed pollutants on marine organisms.
These results emphasize the importance of retrieving sound data from experiments at environmentally relevant concentrations to understand the effects in complex environmental conditions, especially given the alarming decline of mussels in their natural habitats.

PP4 *Caulerpa cylindracea*: first insight into its vitamin and mineral content

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A non-indigenous species of seaweed has been rapidly spread from the Indo-Pacific to the Mediterranean by shipping activities and aquarium trade. A thermophilic green algae *Caulerpa cylindracea,* has been detected in the Adriatic Sea, raising ecological concerns. Despite its widespread presence, no data on vitamin and mineral content exists in the literature. This study aimed to fill this knowledge gap in the literature by analyzing the essential micronutrient composition of *C. cylindracea*. Samples were collected in December 2024 in the waters near Kamenjak, Premantura, Northern Adriatic Croatia, at about 10 m depth by dredging. They were dehydrated and analyzed for their nutritional properties in terms of vitamins and mineral content. The results revealed a notable presence of vital minerals, including iron (428 mg/kg), Mn (164 mg/kg), as well as a diverse range of other minerals. It is worth noting that heavy, potentially toxic minerals such as Cd, Cr, Cu, Pb, and Ni were not detected. Interestingly, the seaweed exhibited significant levels of vitamin E (525 μg/g), which is recognized for its antioxidant properties. These findings provide the first insights into the micronutrient profile of *C. cylindracea,* underscoring its potential nutritional value and the need for further research into its possible applications.

PP5 Distribution and dynamics of *Posidonia oceanica* seagrass in Sakarun Bay (Dugi Otok, Croatia)

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According to the EU Habitats Directive (DIR 92/43/EEC), *Posidonia oceanica* is recognized as a priority habitat for conservation due to its ecological functions and role in supporting biodiversity. Understanding the distribution and dynamics of seagrass is essential for developing effective conservation strategies. This study combines geospatial technologies and in-situ diving observations to assess the status of *P. oceanica* in Sakarun Bay, an ecologically significant area within the Natura 2000 network. Spatial and temporal changes were analyzed using open-source satellite imagery from the PlanetScope constellation (2016-2023). The extent of *P. oceanica* was delineated through manual vectorization at a 1:2000 scale, with NDVI (Normalized Difference Vegetation Index) analysis applied to enhance seagrass identification. A GIS-based overlay analysis was conducted, classifying spatial changes into three categories: regression (loss), expansion (gain), and stability (no significant change). NDVI revealed a decline in chlorophyll content, indicating potential environmental stress that could impact the stability of the ecosystem. In-situ diving surveys revealed the presence of the invasive green macroalga *Caulerpa cylindracea,* along the edge line of *P. oceanica*. This study underscores the necessity of continuous monitoring and conservation efforts to protect *P. oceanica*, particularly in ecologically sensitive areas such as Sakarun Bay. The findings provide valuable insights for future management strategies to preserve *P. oceanica* and mitigate invasive species' impact.

PP6 Hybrid Method for High-Quality Land Use/Land Cover (LULC) Model Generation

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Accurate Land Use/Land Cover (LULC) models are essential for environmental monitoring, spatial planning, and hydrological-hydraulic modelling. However, challenges such as spectral similarity, shadow interference, and object misclassification affect model quality. This study aimed to develop a high-accuracy LULC model using multispectral imagery from the Micasense RedEdge-MX DUAL sensor mounted on a Trinity F90+ VTOL UAV. The study area encompassed approximately 9.3 km² within the topographic basin of Biograd na Moru. A total of 146,170 images were captured across ten spectral bands, producing a dense point cloud of 84.5 million points and high-resolution Digital Surface Model (DSM) and Multispectral Model (MSM) at 8.18 cm resolution.

A hybrid classification approach was used, combining (1) GEOBIA vs. Pixel-Based classification, where SVM within GEOBIA performed best; (2) Deep Learning for building extraction; and (3) manual corrections to remove artefacts such as automobiles, correct misclassifications, digitize roads obscured by vegetation, and reclassify shadows into relevant land cover classes.

The final LULC model included 14 classes, such as asphalt, concrete, rock, gravel, sand, roof tiles, sheet metal, plastic, bare soil, grassland, olive groves, coastal conifers, and water bodies. Accuracy assessment using ROC curves showed an AUC of 0.918, confirming excellent model reliability.

This high-accurate LULC model serves as a critical dataset for flood modelling, erosion risk assessment, and urban planning. The study highlights the effectiveness of integrating automated and manual techniques to produce high-accuracy LULC models.

PP7 Isolation of marine bacterial cultures with potential for bioremediation application

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Environmental pollution by xenobiotics is considered a major threat to the environment and human health. Due to the toxicity and difficult biodegradability of a variety of pollutants such as pesticides, plastics and agrochemicals, their presence in the environment is increasing and becoming more persistent. Biological processes such as bioremediation have recently been intensively investigated as an environmentally friendly treatment alternative. Bioremediation utilises the metabolic potential of microorganisms that can mineralise or convert organic compounds into less harmful compounds that can be integrated into the natural biochemical cycle. The microorganisms used for bioremediation can be isolated from different environmental systems and conditions. The marine system is one of the most unfavourable due to its different and changing environmental conditions. Bacteria isolated from marine ecosystems are considered more favourable for the bioremediation of poorly degradable pollutants.

In this study, marine bacteria were investigated to evaluate their potential for use in bioremediation. Three dominant bacterial cultures were isolated from the southern part of the Adriatic Sea, all belonging to the Gram-positive bacteria group. These results contribute to a better understanding of microbial diversity in the sea and open up possibilities for their practical application.

PP8 The challenges of managing *Squalus acanthias* in the Adriatic Sea

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Shark species are especially vulnerable to overfishing due to their k-selected traits, which are characterized by late maturity, longevity, and low fecundity. The spiny dogfish *Squalus acanthias* is a small demersal shark found mainly in temperate continental shelf seas. Currently, this species is classified by the IUCN as endangered in European seas. Understanding the life history traits of overfished species is crucial for their conservation and for the implementation of sustainable management strategies.

In this study, samples of *S. acanthias* were collected in the Jabuka/Pomo Pit area during the 2022 MEDITS survey. This area is an important nursery ground and plays a crucial role in the sustainability of demersal fisheries in the central Adriatic. This is due to its unique hydrographic and geomorphologic features which are favourable for the aggregation, reproduction and recruitment of several commercially important demersal species.

Samples of muscle tissue were collected and preserved in absolute ethanol for molecular analyses. To assess genetic diversity and population structure within the Adriatic and across the Mediterranean, two mitochondrial genes—cytochrome c oxidase subunit I (COI) and NADH dehydrogenase subunit 2 (ND2)—were amplified and analyzed.

For age estimation, the second dorsal fin spine was removed by cutting horizontally just above the vertebrae. The number of annuli was determined by counting the alternating translucent and opaque zones visible on the cross-section under a light microscope.

The obtained results were compared with previous studies conducted in other parts of the Adriatic.

PP9 Quality of the marine environment in the vicinity of wastewater treatment outfall UPOV Cuvi, Rovinj, NE Adriatic Sea

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Municipal wastewater treatment plants (WWTPs) are crucial for maintaining public health and protecting the environment by treating and safely disposing of wastewater and sewage. However, these facilities also have the potential to impact the local marine environment if they are not operated in accordance with official guidelines and designed capacities. To assess the status of the marine environment in the Rovinj coastal area, sediment samples were collected near the WWTP (UPOV Cuvi) and compared with those from an open sea-site (RV001) and a mariculture site in Lim Bay. Additionally, mussels (*Mytilus galloprovincialis*) were grown in Lim Bay and UPOV Cuvi areas using Mussel watch installations. Sediment and mussel samples were analyzed for 8 metal(loid)s, 16 polycyclic aromatic hydrocarbons, total polychlorinated biphenyls and emergent contaminants (microplastics). According to SQG analyses, the results of this study indicate good environmental quality across all investigated areas. Among all analyzed metal(loid)s, Zn was the most abundant element across all sample types and areas. The analyzed PAHs were associated with combustion sources at all locations. Despite mussels from Lim Bay being of higher quality, mussels from both sites complied with the EU regulation on permitted levels of contaminants in seafood (EU 2023/915). Microplastics contents in sediments (RV001 - UPOV Cuvi - Lim Bay) and mussels (RV001 - Lim Bay - UPOV Cuvi) were variable. Based on contaminant analyses, there is no evidence of the negative ecological impact of UPOV Cuvi on the studied marine environment. The observed results can be additionally explained by site-specific oceanographic characteristics.

PP10 *Stylochus mediterraneus* Galleni, 1976 predation on Mediterranean mussel *Mytilus galloprovincialis* Lamarck, 1819

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High numbers of polyclad flatworms belonging to the species *Stylochus mediterraneus* have been reported in recent years along Istrian coast, Croatia, causing high mortality rates in shellfish farms, especially among Mediterranean mussel *Mytilus galloprovincialis*. In order to determine whether flatworms attack only weakened mussels or they are also able to kill healthy individuals, a laboratory experiment was conducted. For that purpose, a newly developed valve gaping monitoring system (VGMM) was used, consisting of the Arduino microcontroller platform and Hall sensors attached to the mussels' shells. The system relies on the fact that valve gaping (i.e. opening and closing of the shell valves) can be used as an indicator of stress, disturbance, predation, but also of the normal circadian rhythms related to feeding, breathing, breeding, etc. Mussel valve gaping was monitored during acclimation period of one day after which they were exposed to *S. mediterraneus* predation. VG monitoring continued until the death of the first mussel (two days). VGMM clearly showed daily rhythm of VG of mussels before and after exposure to flatworms, changes in VG of exposed mussels compared to the control, timing of the flatworm attack, mussels' responses and, eventually, death. It was concluded that *S. mediterraneus* is likely an opportunistic species, but also predates on healthy mussels. This research provides new insights in *S. mediterraneus* behaviour.

PP11 Growth of *Pecten jacobaeus* in the eastern Adriatic Sea - why location matters?

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Bivalves deposit shell material during their lifetime, and the growth patterns and age of many species can be determined from growth increments on their external shell surfaces and/or shell cross-sections. Shell growth varies through ontogeny and can also have temporal and spatial variations dependant on the environmental conditions. Some scallop species (family Pectinidea), have clearly visible annual growth lines on the external surfaces of their shells that enable reliable analysis of growth patterns. *Pecten jacobaeus*, a commercially important scallop species that lives in Mediterranean coastal waters, is one of them. In this study, we analysed variations in growth and age of *P. jacobaeus* specimens collected from five locations in the eastern part of the Adriatic Sea. To obtain insights into spatial variations in feeding ecology, we analysed nitrogen and carbon isotopes in mussel tissues. Sampling was conducted in late 2023 and the first half of 2024, and between 45 and 60 specimens were collected at each location. In the northeast Adriatic, samples were collected by commercial vessels, while at other sites (Iž, Maslenica, Prokljan, Pelješac) commercial SCUBA divers were used. The shell lengths of analysed specimens were up to 149.5 mm, while their estimated age were up to 12 years. Obtained data on shell height at age were fitted to the von Bertalanffy growth function. Growth was also estimated using the Gulland-Holt plot, and a relative growth function was constructed. The research was conducted in the framework of project RIBAR (Next Generation EU—National Recovery and Resilience Plan 2021-2026).

PP12 Short overview of bathing water assessment in area of Boka Kotorska Bay (2019-2022)

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Investigation comprised Boka Kotorska Bay (Montenegro) as very sensitive ecosystem which required special measures to maintain its environmental as well as development status. The Bay faces bacterial growth and eutrophication as a result of slow water circulation, little water ventilation and exchange with the Adriatic Sea as well as numerous uncontrolled sewage discharges.

The aim of study was to analyze the trend of bathing water quality in Herceg-Novi Bay, in areas quite close to the open sea with a water retention time (RT) of 5 days on the surface. The samples were taken from 2019 to 2022, from 16 locations that are affected by sporadic faecal pollution and often vary in sanitary quality. Seawater samples were collected 30 centimetres below the surface and processed the same day, within 4 hours of sampling. The monitoring program of bathing water quality in the Montenegrin coast is regulated with the Rulebook ("Official Gazette of Montenegro", No. 028/19), and aligned with criteria of the Republic of Croatia, somewhat stricter compared to the BWD. The highest number of sites with "poor" annual quality was recorded during 2022, mainly in areas near freshwater inflows and with muddy bottoms. In the final assessment (2019-2022) not a single location had an "excellent" rating. These results indicate the need for more serious efforts to identify and reduce the sources of bathing water pollution in this area.

PP13 *Ex situ* cultivation and in situ impact of extreme temperatures on the brown macroalga *Gongolaria barbata* from a coastal lagoon in the northern Adriatic Sea

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Cystoseira sensu lato species are brown macroalgae which are essential habitat-forming species in the Mediterranean, particularly in the shallow rocky shores. These algae form dense underwater forests that provide structural complexity, supporting high biodiversity and serving as nurseries and shelters for various marine organisms. However, numerous studies have documented the decline of fucalean forests across the Mediterranean, resulting in the replacement of complex algal communities with less structurally diverse opportunistic species. *Gongolaria barbata* is one of several canopy-forming species found on the Istrian rocky bottom. Over the last decades, its populations on the Istrian coast have become fragmented and limited to a few shallow habitats, including the coastal lagoon of Šćuza. To support population restoration efforts, we investigated the feasibility of cultivating *G. barbata* through both *ex situ* and *in situ* experiments. The *ex situ* experiment involved growing juvenile specimens under controlled conditions with varying light intensity. The *in situ* experiment assessed the long-term survival and growth of transplanted juveniles in a natural lagoon environment under extreme conditions. Results showed that light intensity significantly influenced the growth and survival of juvenile *G. barbata* in *ex situ* conditions. The *in situ* experiment demonstrated that cultivation is feasible; however, growth was highly affected by the seawater temperature fluctuation at the transplant site. These findings highlight the feasibility of cultivating *G. barbata* for population restoration, emphasizing the importance of optimizing light conditions in ex situ settings and accounting for the significant impact of seawater temperature fluctuations on growth and survival *in situ*.

PP14 *Legionella* monitoring in the Adriatic region and marine vessels' internal water systems as microbial reservoirs

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During the last few years *Legionella* monitoring was conducted in 16 counties in Croatia, six of which are located in the Adriatic region. Sampling comprised the mainland and island locations as well as two ferries and a national park. Water samples were taken from both the man-made water systems and natural water environments. Samples were analyzed in an accredited microbiological laboratory in accordance with the ISO 11731:2017 Water quality — Enumeration of *Legionella* standard. Twenty percent (23/115) of samples from the counties in the Adriatic region tested positive for *Legionella*. Colonies that tested negative for *Legionella pneumophila* Sg 1 and *Legionella pneumophila* Sg 2-14 on the latex agglutination test were further subjected to molecular analyses for species-level identification. In total, four species of *Legionella* were detected in samples hailing from the counties in the Adriatic region. It is worth mentioning that *Legionella* was also detected in a sample taken from a ferry's internal water system. Marine vessels' internal water systems encompass diverse networks including internal seawater systems (ISS) and ballast water. These systems can serve as microbial reservoirs and dispersal vectors of invasive species and pathogens. ISS, utilized for essential ship functions, and ballast water which is critical for stability, facilitate the transport of diverse microbial communities across biogeographical barriers. This can lead to biofouling and ecosystem disruption as well as present a public health hazard through the potential dissemination of pathogenic organisms.

PP15 Salinity Dynamics in Vrana Lake, Croatia: Seasonal Variations and Spatial Distribution

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Coastal shallow lakes, such as Vrana Lake in Dalmatia, Croatia, face significant threats from saltwater intrusions from the sea exacerbated by climate change, including rising temperatures, sea levels, and declining precipitation. This study explores the seasonal variations and spatial distribution of salinity in Vrana Lake through a year-long analysis of 230 *in situ* salinity measurements and a comprehensive monitoring network. It evaluates 15 GIS spatial interpolation methods for salinity distribution, identifying Simple Kriging - Trend as the most effective method based on root mean square error and mean error metrics. Furthermore, the research compares salinity levels at northern, central, and southern monitoring stations with lake water levels over a 17-year period (2008-2024). Results indicate significant seasonal salinity variations: during winter and spring, high water levels result in low salinity in the northern lake area due to limited underground saltwater influx, while the southern region maintains high salinity year-round from seawater inflow through Prosika canal and Jugovir submerged groundwater discharge. Conversely, lower summer and autumn water levels lead to increased salinity throughout the lake, driven by increased evaporation and seawater influence from both surface and underground connections to the Adriatic Sea, particularly along the western shore. This research enhances the understanding of seawater intrusion's impact on water dynamic and salinity distribution in Vrana Lake through comprehensive monitoring network, providing valuable insights for management strategies to protect the lake's ecosystem in the face of climate change.

PP16 Ultrasound-assisted extraction of pigments from Adriatic Sea macroalgae

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Macroalgae are a rich and sustainable source of diverse pigments, which are valuable bioactive compounds with extensive applications across various industries. For their optimal utilization, efficient extraction procedures are of crucial importance. This study investigated the pigment content of four macroalgae species from the Adriatic Sea—*Colpomenia sinuosa* (brown alga), *Enteromorpha* sp., *Ulva lactuca* (green algae), and *Corallina officinalis* (red alga)—using ultrasound-assisted extraction (UAE) at 40°C for 15 minutes. The efficiency of 96% ethanol and acetone as extraction solvents was evaluated through spectrophotometric analysis. The extracted pigments were quantified at wavelengths specific to chlorophyll a, chlorophyll b, and carotenoids. The results revealed significant variations in pigment content across algal species and solvents. *Ulva lactuca* ethanol extracts exhibited the highest total pigment content, while *Colpomenia sinuosa* acetone extracts were richest in pigments among acetone-based extractions. Chlorophyll b was the predominant pigment in all extracts, whereas carotenoid content was notably lower. Ethanol proved more effective for chlorophyll extraction in most samples, except for *Corallina officinalis*, while acetone was more efficient for carotenoids. These findings emphasize the importance of tailoring extraction methods to specific algal species and pigments to optimize recovery and maximize the potential of algal bioactive compounds for industrial applications.

PP17 Investigating Labile and Inert Copper Fractions in Marine Ecosystems via Liquid-Liquid Extraction

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As has been known for decades, copper (Cu) is an important micronutrient for marine organisms and its concentration increases with ocean depth, showing a nutrient-like behaviour. Elevated concentrations can be toxic to phytoplankton and some microorganisms, which are thought to release organic ligands to buffer free Cu^{2+} concentrations to maintain their biological activity (1). Recently, it has been hypothesised that there are two distinct Cu pools in the ocean, namely the labile Cu fraction, which is thought to accumulate in surface waters probably through photochemical decomposition of the inert fraction (2). In order to determine whether the Cu in the Krka estuary is completely labile or whether there is an inert Cu fraction, the liquid-liquid extraction method was optimised. It was assumed that salicylaldoxime (SA) is present in sufficiently high concentrations so that all of the Cu released by the natural ligands is captured due to ligand exchange. Toluene was used as the organic solvent and we only extract copper complexed with salicylaldoxime (SA). The extracted copper-SA complex in the organic phase was determined by cathodic stripping voltammetry (CSV). The purpose of the applied methodology is to better understand the speciation of copper, its bioavailability and its biogeochemical cycle.

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PP18 Extracellular polymers from marine diatom *Cylindrotheca closterium* (*Bacillariophyceae*) - preliminary characterization and antioxidant properties

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Microalgae have become a valuable source of new bioactive substances that have potential uses in the food, cosmetics and biomedical industries. In this work, we investigated the extracellular polymers (EPS) of the marine diatom *Cylindrotheca closterium*, which is commonly found during phytoplankton blooms in the northern Adriatic (Najdek et al. (2005), Svetličić et al. (2011)). We isolated EPS released by *Cylindrotheca closterium* in the stationary phase and performed its basic chemical and nanostructural characterization. The antioxidant properties of EPS were evaluated by ABTS and H_2O_2 scavenging assays, as well as by total antioxidant capacity (TAC) assay. Our results showed that *C. closterium* EPS possesses antioxidant activity, supporting its potential as a natural bioactive substance.

PP19 New northernmost records of the invasive species common lionfish *Pterois* cf. *miles* from the Mediterranean Sea

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Two common lionfish *Pterois* cf. *miles* specimens were found in the central-eastern Adriatic. The first specimen was caught in Rt Kobila on the island of Brač at a depth of 12 m, and the second in Mija Luka Bay on the island of Šolta at 9 m. Both specimens were caught while scuba diving. These sites represent the northernmost occurrence area compared to the previous sites in the Adriatic Sea and the Mediterranean. However, they are not sufficient to establish that the species occurs in significant numbers in this area. Still, urgent investigations are certainly needed to avoid negative impacts on the local ecosystem.

PP20 The occurrence of tar balls in the Mljet National Park island and their connection with microplastics

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Residues of petroleum derivatives, known as tar balls, are found in the environment often forming secondary clusters that accumulate organic and inorganic particles, among which microplastics are particularly notable. The study of these formations is crucial for several reasons, including the determination of the geochemical characteristics of tar balls (investigating the source of spilled oil, differentiating and correlating oils, and monitoring the degradation process and weathering state of oils under various conditions), as well as identifying the types and characteristics of microplastic particles 'trapped' within them. The collection and research of tar balls were conducted in the Mljet National Park, and the results of the geochemical analyses will be presented. These samples were geochemically characterized by gas chromatography coupled to mass spectrometry (GC/MS), and measurements of the saturated fractions from tar balls were carried out using a quadrupole mass spectrometer Agilent MS 5975C interfaced to an Agilent 7890A gas chromatograph. The GC oven temperature was ramped from 60°C to 145°C at 15°C/min, then increased to 315°C at 2°C/min, and maintained at this temperature for 15 minutes. Terpenes and steranes biomarkers were identified using m/z 191 and 217 fragments, respectively. Analysis of isolated particles from tar balls was conducted by FTIR spectra on a Bruker Tensor 27 in the region from 400-4000 cm-1. The aim of this research is to understand the relationship between tar balls and microplastics, as two contaminants that often occur together, to better comprehend the formation and movement of such accumulations.

PP21 Comparative Chemical Analysis of Sediments and Mussels for Assessing the Environmental Quality of the Rovinj Coastal Area, Northern Adriatic Sea, Croatia

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Coastal areas are particularly vulnerable to anthropogenic pollution, which requires monitoring strategies to assess and maintain good environmental status (GES) according to the Marine Strategy Framework Directive (MSFD).
This study assesses the pollution status of Rovinj's coastal waters using a comparative approach combining chemical analyses of sediments and mussel watch monitoring according to the national and international sediment quality guidelines (SQGs). The sediments provide a long-term record of pollutant accumulation (indicator D8.C1), while mussels (*Mytilus galloprovincialis*) serve as bioindicators of bioavailable pollutants in the water column-marine food web (indicator D8.C2).
Sediment samples were collected from five locations (S1-S5, May 2022) while mussels were exposed and caged ~120 days at the control location (Lim Bay) and the Harbour (April-July 2022). Both the sediments samples and the mussels were analysed for metals (As, Cd, Cu, Cr, Hg, Ni, Pb, Zn), polycyclic aromatic hydrocarbons (16 PAHs) and polychlorinated biphenyls (PCBs) in accordance with EU Water Framework Directive (WFD) and the EU regulations on food contaminants. The majority of the sites showed measured concentrations below ecotoxicity thresholds, except for S1 (Rovinj Harbour, ΣPAH 3.18 mg/kg) and S2 (Rovinj Marina, ΣPAH 3.64 mg/kg) as well as a slight increase in Ni compared to the ERL benchmark of 20.9 mg/kg (S3 = 30 mg/kg, S4 =34 mg/kg). However, all results were below the N1 threshold with the calculated QPECm values <1.00, suggesting no significant ecological risk. The findings confirm a continued improvement in the environmental quality of the assessed areas, maintaining a good environmental status.

PP22 Mussel Meal as a Fish Feed Supplement: Effects on Juvenile Gilthead Seabream (*Sparus aurata*) Growth

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Mussels are a natural dietary component of the gilthead seabream *Sparus aurata* Linnaeus, 1758, making mussel meal (MM) a promising feed supplement. This study investigated the effects of adding MM, obtained from undersized *Mytilus galloprovincialis* Lamarck, 1819 in Lim Bay, to commercial feed (CF) in gilthead seabream diets. A six-week feeding trial was conducted at high seawater temperatures (25-26 °C) using 180 specimens, divided into four groups: two control diets (CF; CF + sunflower oil) and two experimental diets (CF + sunflower oil + 2.5% MM; CF + sunflower oil + 5% MM). Growth performance, health status, feed intake, and condition index were assessed every two weeks. At the end of the trial the proximate composition and fatty acid profiling of the dorsal muscle tissue were determined. A very good quality of the commercial feed used was confirmed by the control group which showed slightly higher relative weight gain and a lower feed conversion ratio. The MM-fed groups displayed reduced crude protein and saturated fatty acid levels but increased monounsaturated and polyunsaturated fatty acids. Due to the high content of DHA and EPA in the MM used, an increase in these fatty acids was observed respectively in the gilthead seabream muscle tissue, although the overall effect was not statistically significant. From a sustainable point of view mussel meal serves as a source of natural proteins and lipids, making it a viable feed supplement in the final stage of fish production to enhance the quality of farmed fish.

PP23 Development of an autonomous system for spatial mapping, object recognition at sea, and dynamic route adaptation

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The issue of marine pollution, particularly plastic pollution and microplastics, presents a serious global environmental challenge with long-term consequences for the marine ecosystem. Within the Jadranko v1.0 project, a robotic vessel was developed as a proof-of-concept for collecting macroplastic and microplastic samples along coastlines. However, testing revealed limitations in communication range, motor power, and video transmission, which spurred the development of an advanced vessel version. Jadranko v2.0 represents a significant technological breakthrough by increasing the vessel's autonomy from level 0.5 to level 2, enabling independent operation under controlled conditions and dynamic route adaptation. By integrating navigation and sensor systems such as GPS, accelerometers, LIDAR, depth cameras, and ultrasonic sensors, the vessel will be capable of accurately mapping its surroundings, identifying and locating objects at sea, and autonomously collecting waste samples. The perception system will facilitate obstacle detection and process optimization for collection, while categorizing the gathered samples by size and composition will contribute to the creation of a comprehensive database on marine microplastics. These technological advancements will allow for more efficient monitoring of microplastic levels, laying the groundwork for future innovations in environmental protection and maritime robotics.

PP24 Impact of aging and organic matter on trace metal adsorption onto plastics under marine conditions

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Plastic litter is prevalent in marine environments, interacting with pollutants like trace metals (TM). Plastics adsorb TM, influencing their transport and bioavailability. A key factor in TM adsorption is plastic surface degradation, mainly from ultraviolet (UV) radiation. Organic matter (OM) from seawater also affects TM interactions with plastics.

To investigate the effect of UV radiation and OM on TM adsorption on plastics in marine environment, the model experiment was performed. Filtered and UV irradiated seawater was spiked with TM (Zn, Cd, Pb, Cu, Ni and Co) and humic acid (HA), while plastic samples (polypropylene (PP) and polystyrene (PS)) were previously UV irradiated for 0, 4 and 52 days. Adsorption of TM onto plastics was monitored over time (7 samplings in 14 days), and metal amounts leached by acids from the plastic surfaces were measured using anodic and cathodic stripping voltammetry. Changes of the plastic surface caused by UV radiation were monitored using atomic force microscopy (AFM), scanning electron microscopy (SEM) and Raman spectroscopy.

Results indicate that both presence of OM and UV radiation influence TM adsorption on plastics, but the effect of UV-induced plastic aging surpasses the influence of HA. Different TM showed different trends of adsorption, with Pb increasing in the first 24 hours after which it stabilized. These findings highlight the dynamic nature of TM adsorption on plastics, influenced by both environmental conditions and plastic degradation. Understanding these interactions is crucial for assessing the role of aged plastics in TM distribution in marine systems.

PP25 Surface saline lakes in the Adriatic and Mediterranean seas

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In the Levantine Basin, salinity peaks regularly near the surface during summer due to heating, evaporation, and limited mixing, contributing to the formation of Levantine intermediate and deep waters through winter heat loss and wind-induced mixing. A recent study revealed that similar high-salinity layers, termed 'surface saline lakes' (SSLs), also occur in the Adriatic Sea. Using data from Argo profiling floats across the Mediterranean, we analyzed upper-layer profiles (0-200 m) to identify SSLs through an objective algorithm that detects sharp salinity gradients at their base. This method quantified SSL depth, temperature, potential density anomaly (PDA) gradients, and stability using the Schmidt Stability Index. SSLs are highly seasonal, nearly disappearing from February to April and peaking between August and October. They were found in all Mediterranean basins, including the Adriatic Sea, with the Levantine Basin showing the highest frequency—65-70% of profiles from July to December. During the August-October peak, over 35% of profiles across basins detected SSLs, even in the Western Mediterranean, though with lower salinity and weaker gradients. Our analysis revealed a significant positive trend in SSL depth, with decreasing thermohaline gradients over time. These changes may reflect ongoing climate-change-induced salinization and shifts in Mediterranean water mass dynamics or be part of natural multidecadal variability. Regardless, the findings highlight the role of surface heat and water exchange in shaping intermediate and deep-water properties across the Mediterranean.

PP26 Update on the status of the invasive blue crab, *Callinectes sapidus*, along the Albanian coast

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The blue crab, *Callinectes sapidus*, native to the Western Atlantic, has rapidly spread along most of the Albanian coast in recent years. This species is considered an invasive alien species in the Mediterranean Sea, where it has been introduced and expanded over several decades. Since 2010, its distribution and establishment along the coasts of Albania, have been continuously monitored. A more detailed assessment was conducted in eight coastal lagoons, seven in the Adriatic Sea and one in the Ionian Sea. In 2023-2024, a specific assessment was also carried out at the mouth of the Shkumbini River, in the Adriatic Sea. These studies focused on the presence and distribution of the blue crab, its population structure, and its establishment along the Albanian coast. Biometric measurements and weightings were taken for a large number of crabs from each lagoon. The sex ratio between males and females was determined, and the age and sexual maturity of each individual were assessed. Statistical analyses were performed to evaluate correlations between the measured parameters. Additional data were collected regarding the seasonal entry and exit of blue crabs in each lagoon through the opening and closure of communication channels between the lagoon and the sea, as reported by local fishermen. Furthermore, questionnaires were distributed to local fishermen to gather their insights on the presence and distribution of the blue crab in each study area, as well as its impacts on fish populations and other native species.

PP27 REE distribution and normalization pitfalls in samples of the eastern Adriatic region

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To facilitate interpretation, eliminate the effect of the Oddo-Harkins Rule, and highlight anomalies in the behavior of individual rare earth elements (REE), the REE content is normalized to a reference material[1]. Common ones include chondrite, the Upper Continental Crust (UCC), and various shale composites; the Post-Archean Australian Shale (PAAS), the North American Shale Composite (NASC), and the European Shale (EUS). While some reference materials are used more frequently than the other, here we discuss the different normalization materials for samples from the eastern Adriatic region (marine sediments, soils). The eastern Adriatic region is characterized by a predominantly carbonate lithology in the wider coastal area, and a high content of carbonate minerals in marine sediments, which are not relevant hosts of REE. At the same time soils in this area show naturally elevated levels of REE[2].

As a generally geochemically coherent group whose sedimentary occurrence reflects the geology of the source area, the REE content and variations in marine sediments can serve as a tool in provenance investigations. However, this also relies on the accurate selection of reference material.

In this context, we examine the REE content in recent marine sediments of the eastern Adriatic, covering samples from the northern, central and southern Adriatic, to assess spatial variations and provide a baseline for further studies.

[1]Bau, M., et al., 2018. Applied Geochemistry, 90, 142-149. 10.1016/j.apgeochem.2018.01.008

[2]Salminen, Ret al., 2005.FOREGS Geochemical Atlas of Europe, Part 1: Background Information, Methodology and Maps. Geological Survey of Finland, Espoo, p. 526. Available online at: http://www.gtk.fi/publ/foregsatlas/

PP28 Unraveling microbial responses to pollution: Can benthic communities serve as bioindicators of marine ecosystem health

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Microbes in marine sediments play a crucial role in biogeochemical cycling and ecosystem functioning, yet remaining understudied compared to terrestrial and freshwater ecosystems. Coastal marine ecosystems are vital providers of ecosystem services but are also among the most heavily exploited. Within the Mediterranean, where over 50% of the population resides in coastal zones, human activities exert significant pressures on these environments, threatening biodiversity and ecosystem stability.

As part of the CSF project MicroLink, this study investigates the impact of long-term pollution on benthic microbial communities by analyzing sediments from Adriatic ports exposed to multiple pollutants. Using targeted amplicon sequencing and shotgun metagenomics, we assessed taxonomic shifts in bacterial, fungal, and protist communities, functional gene pools changes, and pollution effects on microbial interactions. Multilevel approach allowed to identify specific microbial features that could serve as new indicators of marine ecosystem health. Our findings pointed to the strength and value of the microbial taxonomy, identifying Rhodobacteraceae, Ectothiorhodospiraceae, Cyclobacteriaceae, Boseongicola, B2M28, Subgroup 23, Sva0485, and Thiogranum as key biondicators. Fungi emerged as the most sensitive community members, while heavy metal pollution clearly weakened microbe-microbe interactions. Metagenomic analysis revealed shifts in functional diversity at polluted sites, with an increase in genes related to antibiotic and metal resistance, hydrocarbon degradation, and mobile genetic elements. However, biogeography proved to be a stronger determinant of microbial community structure than pollution. These findings support the potential of microbial-based monitoring tools for marine conservation and highlight the importance of considering benthic microbiome health when assessing overall marine ecosystem health.

PP29 Insights into the transformations of methyltins in marine sediments

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Methyltin compounds (MeTs) occur in the marine environment both from anthropogenic sources and through the natural process of Sn methylation. The methylation of Sn is ecologically significant as it alters the biological activity and transport of Sn in the marine environment, converting non-toxic, low-mobility inorganic Sn into soluble, mobile and environmentally harmful MeTs. Despite their importance, the formation and behavior of MeTs remain poorly understood. The transformations include the methylation of Sn and the degradation of MeTs, both of which are driven by abiotic processes and microbial activity, but the specific kinetics and microorganisms involved are yet to be explored.
In this study, the kinetics of MeTs transformations in marine sediments were investigated by *in situ* incubation of sediments and porewaters under oxic and anoxic conditions. In addition, the potential of 28 metal-resistant bacterial species isolated from marine surface sediments to methylate inorganic Sn and degrade MeTs was investigated. The transformation rate constants were calculated based on the measured MeTs concentrations in the samples over time.
The results indicate that methylation of Sn occurs effectively in sediments, especially in porewaters, with higher efficiency in oxic layers. However, none of the tested bacterial species showed the ability to methylate inorganic Sn. In contrast, the tested bacteria exhibited the ability to degrade MeTs, suggesting that the microbial degradation of MeTs is an efficient process in the marine environment. These results provide valuable insights into the behavior of MeTs and highlight the microbial contribution to their transformation in marine ecosystems.

PP30 First insight into the prevalence and diversity of *Clostridiodes difficile* isolated from marine sediments in the Adriatic Sea

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Clostridiodes difficile (formerly *Clostridium difficile*) is a Gram-positive, spore-forming, anaerobic, motile bacterium, ubiquitous in nature. It causes serious diarrheal infections in individuals with disturbed gut microbiota. While particularly linked to hospitalized elderly patients after antibiotic therapy, community-acquired infections are increasing. The primary niche for *C. difficile* multiplication is the gut of humans and animals, but its spores are commonly found in soil and aquatic environments, especially in areas affected by fecal pollution or manuring. *C. difficile* strains are distributed into more than 900 PCR ribotypes and studies that determine their presence in environmental samples greatly contribute to understanding the spread and identifying potential sources of infection. Here, for the first time, we aimed to isolate *C. difficile* from marine sediment samples and determine PCR ribotypes. Fourteen sediment samples were collected in May and June 2021 from three Adriatic Sea locations during the MicroLink research project (IP-2020-02-6510): the northern Adriatic (port of Pula) and the southern Adriatic (Šibenik Bay and Vranjic Basin), selected as sediments of high or extreme disturbance level categories. The main aim was to determine the geographical distribution and diversity of *C. difficile* and to compare the northern and southern Adriatic regions. Total of 36 representative isolates – 16 from Pula, 13 from Šibenik and 7 from Vranjic - indicated high diversity of PCR ribotypes across all sampling sites. The next step is genome sequencing of representative isolates to fully understand the ecology and dynamics of transmission and spread of this pathogenic bacterium in Adriatic marine sediments.

PP31 Transformations, mobility, and persistence of organotin compounds in the marine environment (TransOTin project)

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Tributyltin (TBT) enters the marine environment through its use as a biocide in antifouling paints. As it is highly toxic to certain aquatic organisms, TBT has been banned in many countries around the world for almost two decades. According to the EU Water Framework Directive, it is classified as a priority pollutant that must be monitored regularly. Despite the ban, it is still present in the marine environment, including in Croatia. The ongoing discussions raise the question of whether the contamination was caused by illegal paints or by the release of an ″old″ TBT from polluted sediments.

This study presents the objectives and methodology of the project "Transformations, mobility, and persistence of organotin compounds in the marine environment" (TransOTin), funded by the Croatian Science Foundation. This interdisciplinary research integrates *in situ* investigations, advanced analytical techniques, molecular methods and sedimentological analyses to explain the processes that TBT undergoes in the environment. Key research questions include: (i) the study of TBT degradation in sediments and the role of benthic microbial communities and sediment properties in its persistence; (ii) the identification of microbial communities involved in TBT degradation as a basis for bioremediation strategies; and (iii) the assessment of the contribution of polluted sediments as a source of TBT pollution for the water column.

The efficiency of microbial transformations depends on community structure and diversity, which vary across environments subjected to different anthropogenic pressures. Additionally, understanding the transfer dynamics of TBT between sediments and water column requires investigation at contaminated sites. Therefore, the selection of appropriate study locations is a key aspect of this project. This work presents the selected sites, encompassing areas with different TBT pollution levels in both coastal and transitional waters. The temporal trends of TBT concentrations (2016–2024) at these sites will be presented.

PP32 Antibiotic resistance in *Vibrio* spp. from fish and bivalve aquaculture in the Adriatic Sea

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Aquaculture is rapidly expanding globally, particularly in marine environments. In Croatian aquaculture, farming of fish and bivalves, is highly dependent on natural seawater conditions, increasing vulnerability to environmental stressors and bacterial infections. *Vibrio* species are commonly present in marine ecosystems, but some of them are responsible for vibriosis, a major disease affecting Adriatic aquaculture. Species like *V. harveyi* and *V. alginolyticus* are associated with mass mortalities in aquaculture, while *V. parahaemolyticus*, *V. cholerae*, and *V. vulnificus* pose human health risks most often contaminated seafood. Antibiotic resistance, driven by overuse and pollution, remains understudied in Adriatic aquaculture.

This study investigated *Vibrio* species composition and antibiotic resistance profiles in three fish aquaculture regions (North, Central, and South Adriatic) and two bivalve farming areas (North and South Adriatic) to compare differences between regions and aquaculture types.

Our results indicate that members of the Splendidus and Harveyi clades are predominant across all aquaculture types and locations. Significant regional differences in antibiotic resistance profiles were observed among fish farming sites, while no such variation was detected in bivalve farming regions. Resistance patterns also differed between clades, suggesting intrinsic differences in susceptibility. The detection of antibiotic-resistant *Vibrio* spp. in bivalve aquaculture—despite the absence of antibiotic use—implies external contamination pathways, likely through anthropogenic discharge. These findings underscore the importance of regional surveillance and tailored antibiotic stewardship strategies in marine aquaculture systems.

InspireAdriatic 2025 Panel: Navigating turbulent waters: science and sustainability in the changing Adriatic

May 20, 2025, Venue: Algebra Bernays University, Gradišćanska 24, Zagreb, Croatia

Moderator: Vlado Cuculić, PhD, Ruđer Bošković Institute, Zagreb, Croatia

Panellists:

Sonja Fagervold, PhD, Banyuls Oceanological Observatory, Sorbonne University, France; Igor Živković, PhD, Jožef Štefan Institute, Ljubljana, Slovenia; Ante Ivčević, PhD, PAP/RAC (UNEP/MAP), Split, Croatia; Slavica Matijević, PhD, Institute of Oceanography and Fisheries, Split, Croatia; Sanja Matić-Skoko, PhD, Institute of Oceanography and Fisheries, Split, Croatia; Ivica Vilibić, PhD, Ruđer Bošković Institute, Zagreb, Croatia; Tvrtko Smital, PhD, Ruđer Bošković Institute, Zagreb, Croatia

Audience: symposium participants and other interested parties

Highlights:

- The InspireAdriatic 2025 continued to be a platform of interest for sharing the scientific results and new ideas through community that is interesting in working on marine topics and Adriatic and Mediterranean Sea. The general opinion of the participants is that there is a need for such platforms for the gathering of scientists, such as InspireAdriatic 2025, where the latest knowledge about research of the Adriatic Sea and topics of great importance for those involved would be given.
- The review and comparison of marine research practices in France, Slovenia, and Croatia, with examples from these countries' activities were given (S. Fagervold, I. Živković, A. Ivčević, respectively). The overall conclusion is that the lack of coordination and communication among the numerous scientific, expert, and working bodies (national and international) represent major obstacles.
- There is a need to establish an informal network of experts to enhance coordination, collaboration, and communication among the various stakeholders in marine and environmental research. One of examples is the "KIC All Waters" initiative, led by a Danish consortium, involves Croatia and aims to address innovations across various sectors. Specifically, Croatia will play a key role as one of the co-location centres and this will be the part of a proposal to be submitted (T. Smital).
- A significant portion of the discussion focused on the policy of data accessibility for the broader community of professionals in the field. This topic was sparked by audience questions, emphasizing the need to make data more readily available. Most panellists voiced strong support for open science and the adoption of robust data management policies. However, there has been considerable concern about the researchers becoming data collectors. The growing focus on Interreg projects and monitoring activities has reduced the time researchers can dedicate to actual scientific work. However, these initiatives do provide the funding necessary to acquire essential scientific equipment (S. Matijević). It was also emphasized the lack of transparency in Croatia's data policies (I. Vilibić, S. Matić-Skoko). There was a broad consensus that it is unsustainable for scientists to shoulder responsibilities

outside their core scientific work. Also, T. Smital added that the lack of data should not be used as an excuse for inaction by the EU. However, the issue of data sharing and accessibility is increasingly highlighted across various countries. Over 95% of data generated in environmental science is publicly funded, which means it should be accessible to all, but the question remains: when will this data be made available - should it be accessible immediately after publication, and how long does it typically take for data to be published? Clear guidelines and recommendations are essential to address these questions. Despite these challenges, this is a problem that can and should be resolved.

- A very important issue about the lack of technicians and professional experts was raised. All panellists agreed that there is a shortage of highly skilled professionals carrying out top-tier projects. This shift is particularly evident in the environmental research facilities where technician and expert's positions have transformed into scientific roles. Similarly, lab technicians who were once highly skilled experts capable of quickly creating prototypes are now relegated to basic physical tasks. Additionally, experienced specialists, such as glassblowers, who were once employed within the research centres are now outsourced (I. Vilibić, V. Cuculić). An example from Slovenia was shared, where technicians are no longer hired, and scientists have taken on all responsibilities, including technical tasks (I. Živković). All of this has had a profound impact on scientific research.

- Regarding the situation in Croatia, it was emphasized by all panellists from Croatia that the core issue lies in implementation. There is a persistent lack of continuity, with new strategies often not building upon previous ones. While marine science is more expensive than other fields and there is considerable funding available, it remains insufficient to fully support environmental research.

- Due to the positive feedback from the majority of InspireAdriatic 2025 participants, as well as requests from other interested parties, the Organizing Committee has decided to continue the International Scientific Symposium *Interdisciplinary Approach to Scientific Research of the Adriatic Sea (InspireAdriatic)*. The upcoming third symposium will build on the success of previous events, further strengthening collaboration and scientific exchange within the Adriatic research community and beyond.

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