BOOK OF ABSTRACTS

This Book of Abstracts provides a comprehensive overview of the session content and is structured into three main sections:

I. Session Description – an introduction to each session, including its objectives and expected outputs
II. Session Program – a detailed schedule for each session, including speakers and timing
III. List of Abstracts – a complete compilation of all accepted abstracts

I. SESSION DESCRIPTION

ID: X9

Advancing the effective integration of ecosystem functioning and services into marine spatial planning, conservation, and restoration

Hosts:

	Name	Organisation	E-mail
Host (s):	Francisco R. Barboza	Estonian Marine Institute, University of Tartu	francisco.barboza@ut.ee
Co-host(s):	Carolyn Faithfull	Institution of Aquatic Resources, Swedish University of Agricultural Sciences	carolyn.faithfull@slu.se
	Anda Ruskule	Baltic Environmental Forum-Latvia	Anda.Ruskule@bef.lv
	Miguel Inácio	Environmental Management Research Laboratory, Mykolas Romeris University	miguel.inacio@mruni.eu
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Abstract:

Although the concepts of ecosystem functioning and services are increasingly recognized in global and European sustainability and environmental agendas, their effective integration into regional and national marine policies and decision-making processes remains limited and fragmented. Progress is hindered by diverse and often incompatible assessment approaches, as well as by persistent gaps and inconsistencies in data availability and quality. To overcome these barriers, there is a pressing need for harmonized approaches, supported by digital tools, models, and improved data sharing, that can translate ecosystem functioning and services into actionable guidance for marine planning, conservation, and restoration. This session will explore emerging approaches and practical examples that demonstrate how ecosystem functioning and services can inform marine policy, with a special focus on maritime spatial planning and the effective design and optimization of conservation and restoration measures. By bringing together the perspectives of decision-makers, practitioners, and researchers, the session welcomes contributions from

Europe and beyond that showcase advances in operational approaches, digital tools and models, and data sharing and integration.

Goals and objectives of the session:

1. Synthesize emerging approaches and digital innovations (tools, models, and data-sharing practices) that support the integration of ecosystem functioning and services into marine policy and governance.
2. Demonstrate practical applications in maritime spatial planning, conservation, and restoration that use ecosystem functioning and services to guide the design, optimization, and implementation of measures.
3. Foster dialogue among decision-makers, practitioners, and researchers to exchange experiences, identify barriers and enablers, and co-develop pathways for the more effective incorporation of ecosystem functioning and services into marine policy and governance.

Planned output / Deliverables:

Perspective paper providing a comprehensive overview of operational and innovative approaches for integrating ecosystem functioning and services into marine policy and governance, illustrated through promising examples that demonstrate methodological pathways for planning and management.

Session format:

The session will last two and a half hours, beginning with a 10-minute introduction to the state-of-the-art. The main part of the session will consist of a series of presentations in a 10+5 format. The session will conclude with a 30-minute roundtable discussion, providing space to reflect on cross-cutting themes, explore synergies across initiatives, and identify next steps.

Related to ESP Working Group:

Other

II. SESSION PROGRAM

Room: B1
Date of session: Tuesday, 19 May 2026
Time of session: 14:00 – 16:30

Timetable speakers:

Time	First name	Surname	Organization	Title of presentation
14:00-14:12	Carolyn	Faithfull	Swedish University of Agricultural Sciences	Perspectives on transboundary Baltic Sea marine ecosystem services applications
14:12-14:24	Jacek	Zaucha	Institute of Oceanology of Polish Academy of Sciences	Beyond Functional and Expert Zoning: The Role of Cultural Ecosystem Services in Marine Spatial Planning - Evidence from the Gulf of Gdańsk
14:24-14:36	Elina	Virtanen	Finnish Environment Institute (Syke)	Identifying valuable areas for cultural ecosystem services to support marine spatial planning: example from Finland
14:36-14:48	Sophie	Van Schoubroeck	University of Antwerp	Social values and ecosystem services in Marine Protected Areas: Insights from the Danish Wadden Sea
14:48-15:00	Lois	Watt	HELCOM (Baltic Marine	Mapping traits, functions and ecosystem services: introducing

			Environment Protection Commission)	BALM - a Baltic Sea Ecosystem Service Model
15:00-15:12	Myriam	Perschke	University of Southern Denmark	Visualizing the Interconnectedness of Ecological and Social Systems for Informed Decision-Making
15:12-15:24	Yoann	Baulaz	France Energies Marines	When Offshore Wind Reshapes MSP: How Ecosystem Service Mapping Can Question the Transition Potential of Coastal Territories?
15:24-15:36	Juliana	Socrate	Leibniz Institute for Baltic Sea Research (IOW)	Advancing Marine Spatial Planning in Areas Beyond National Jurisdiction Through a Socio-Ecological and 3D Conceptual Framework
15:36-15:48	Jonne	Kotta	University of Tartu	Marine digital twins for dynamic ecosystem-service mapping and scenario-based spatial planning
15:48-16:00	Nelson	Valdivia	Universidad Austral de Chile	Using Scale-Dependent Community Assembly Processes to Inform Marine Conservation and Restoration
16:00-16:30	Discussion session			

III. LIST OF ABSTRACTS

The first author is the presenting author unless indicated otherwise

1. Perspectives on transboundary Baltic Sea marine ecosystem services applications

***First author*:** Carolyn Faithfull
***Other author(s)*:** Lena Bergström, Francisco R. Barboza, Anda Ruskule, Kristīna Veidemane, Elina Virtanen
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Knowledge about ecosystem services is essential to sustainably manage resources. However, mapping and quantifying ecosystem services in the marine environment is still a persisting challenge due to limited data availability and a lack of understanding on how ecosystem components and ecological processes contribute to their supply and flow. This, along with a lack of clear operational approaches or practices to incorporate ecosystem services into management processes, have hindered the integration of marine ES information into regional and local decision-making. Here we present a range of perspectives on how ecosystem services' assessment outputs, methods, and data can be harmonised between Baltic Sea countries and how marine and coastal ecosystem services information can be implemented in management processes. These perspectives have been developed through collaborations with scientists and managers from Sweden, Latvia, Estonia, Finland, Lithuania, Poland and Germany during a series of workshops and discussion sessions spanning 2025-2026. Discussions have revealed the great potential of ecosystem service information in supporting maritime spatial planning, management, and to justify marine conservation and restoration measures, although so far, its practical application in decision-making has been very limited. We aimed to: (1) identify the current and potential uses of ecosystem services information for management with example use-cases, (2) investigate how ecosystem service assessment outputs, methods, and data can be aligned, (3) clarify the opportunities and benefits of ecosystem service use in policy and management at local, regional, national and international scales, and (4) develop potential future applications for ecosystem services information. These perspectives will be integrated into a roadmap for policy makers, environmental agencies, researchers, planners and NGOs to support a

shared transboundary approach in implementing ecosystem services information to reach conservation, restoration and spatial planning goals and targets.

Keywords: Sustainable-use, marine resources, marine spatial planning, management

2. Beyond Functional and Expert Zoning: The Role of Cultural Ecosystem Services in Marine Spatial Planning - Evidence from the Gulf of Gdańsk

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The functional approach in any spatial planning emphasizes flows, linkages, and relationships as a basis for spatial policy, typically through the delineation of functional areas and network structures. In marine contexts, this approach requires adaptation, as functional relationships are shaped less by human mobility and more by biological and hydro-morphological processes, alongside maritime transport and other human activities that may disrupt marine ecosystems. Marine spatial planning(MSP) therefore relies on four main zoning typologies: administrative-based, inventory-based, expert-based, and people-based zoning. The latter is the least commonly applied, as it depends on participatory approaches and engages with social values and human emotions. We argue, however, that people-based zoning is equally important, as it can stimulate dialogue among diverse MSP stakeholders. This study presents results from two research-ledparticipatory processes conducted in the Gulf of Gdańsk (in 2021 and 2025; ongoing) that used the concept of cultural ecosystem services to identify culturally significant areas, and examines how these findings can inform current maritime plans, in which, in fact, culture and cultural services have played a secondary role, overshadowed by a focus on tangible maritime heritage artifacts such as wrecks. By showing that aesthetic values, natural coastlines, and the perceived authenticity of culture and nature remain central in local social narratives, we demonstrate how people-based zoning can complement the other three approaches. Finally, we discuss key challenges to fully integrating (cultural) ecosystem services into Polish MSP practice, including their limited incorporation in legal frameworks, the minimalist implementation of existing provisions, and the constraints of current tools. These limitations highlight the need for deeper systematic inventories and more robust baseline data to support people-based zoning in future MSP cycles.

Keywords: spatial planning, functional approach, zoning, culture, participatory processes

3. Identifying valuable areas for cultural ecosystem services to support marine spatial planning: example from Finland

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Cultural ecosystem services (CES) provided by marine and coastal environments play a crucial role in human wellbeing, recreation, and coastal identity. Yet, they remain challenging to assess and integrate into marine spatial planning processes (MSP). We present a comprehensive, spatially explicit approach for identifying areas of high importance for cultural ecosystem services in Finland, with the aim of supporting evidence-based MSP.
We assessed key dimensions of CES by integrating diverse spatial datasets representing recreational activities, cultural heritage, landscapes, accessibility, and people's perceptions and values. Recreational values were mapped using indicators of outdoor activities (e.g. overnight stays, boating opportunities), citizen-science (e.g. bird observations), and user-generated data (e.g. geocaching). Cultural heritage included data on built heritage and shipwrecks, nationally significant cultural environments, and World Heritage sites. Landscape values were assessed using visual impact models based on expert evaluations of visual disturbance, explicitly accounting for the permanence and visibility of built infrastructure and human activities.
As accessibility largely defines the importance of marine areas for CES, we modelled travelling times and

modes to estimate the time cost of reaching CES locations. As peoples´ perceptions on CES eventually define their value, potentially differing from those CES locations we initially identified, we collected participatory GIS data through a nationwide Maptionnaire survey. We targeted people living by, or actively using the sea, to capture peoples´ meaningful places and perceived values in the northern Baltic Sea. Finally, we identified priority CES areas that were discussed in a stakeholder workshop, where data sources, criteria, methods, and mapped areas were evaluated. Based on stakeholder feedback, the final CES areas were delineated. The resulting datasets and mapped areas provide a practical tool for integrating CES into MSP, supporting also coastal management and conservation efforts.

Keywords: cultural ecosystem services, recreation, perceptions, PGIS, MSP

4. Social values and ecosystem services in Marine Protected Areas: Insights from the Danish Wadden Sea

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Marine Protected Areas play a crucial role in biodiversity conservation and sustainable resource use. Understanding how people value these areas is essential for better management. This study, part of the Blue4All European Horizon project, performs a socio-cultural valuation of the northern Danish Wadden Sea. It aims to (1) determine the spatial distribution of social values for ecosystem services, (2) analyse relationships between social values and natural resource conditions, and (3) compare value allocations between tourists and locals. Using participatory mapping, this study integrates mapped survey responses with environmental data (including bird habitats) to generate social-value maps, revealing how different groups perceive cultural ecosystem services. The findings provide valuable insights for improving MPA management and ensuring conservation efforts align with social values and stakeholder interests.

5. Mapping traits, functions and ecosystem services: introducing BALM - a Baltic Sea Ecosystem Service Model

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The assessment of marine ecosystem services (ES) remains underdeveloped compared to terrestrial environments, as highlighted by IPBES (2023). This imbalance stems partly from the complexity of marine ecosystems and the challenges in evaluating their ecological processes. In recent years, national and pan-Baltic research initiatives have sought to improve ES assessments in the Baltic Sea. However, a key challenge has been applying the ES cascade model (CICES, 2023), which requires integrating ecosystem functions into the calculation of final ES potential.

The Horizon Europe-funded PROTECT BALTIC project is addressing this gap by developing a regional methodology for applying the ES cascade model. This approach bridges the connection gap between ecosystems and their services through species traits, which serve as critical links between ecological functions and ES provision. By combining expert knowledge, scientific literature, and quantitative estimation rates, the project employs a matrix-based assessment covering all major species groups in the Baltic Sea.

This methodology aims to provide a more comprehensive understanding of ecological functions, enabling holistic ES assessments that can be applied across spatial scales and geographic locations. When integrated with species distribution maps, it can generate cascade 'heatmaps' illustrating trait diversity, ecosystem function, and final ES supply. Within PROTECT BALTIC, this methodology will be incorporated into a broader social and economic valuation framework, forming the basis for a decision-support tool.

This tool will aid policymakers and MPA managers in the designation and implementation of marine protected areas, contributing to the project's vision for a sustainable future for the Baltic Sea.

Keywords: Ecosystem services, Baltic Sea, species traits, cascade model, ecosystem function

6. Visualizing the Interconnectedness of Ecological and Social Systems for Informed Decision-Making

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Despite decades of progress in ecosystem service research, its operational use for local decision-making remains constrained. Building on insights from local conservation practitioners, marine conservation requires approaches that make the relationship between ecosystem functioning and services tangible for decision-makers. To address this, we adapted the ecosystem service assessment framework by Armoškaitė et al. (2020) to the Danish Wadden Sea, aiming to illustrate and communicate complex social-ecological interlinkages. Preliminary lists of components, functions, services, and pressures were developed through a literature review. These were validated and scored through structured expert elicitation following the IDEA protocol (Investigate, Discuss, Estimate, Aggregate). Experts linked pressures to components, components to functions, and functions to services. They scored sensitivity and pressure impacts and provided confidence ratings. Scores were aggregated with confidence weighting to produce sensitivity networks. The networks were visualized as interactive Sankey diagrams using a multiplicative modeling approach. These diagrams show how cumulative pressures propagate through ecological networks and alter service delivery. An interactive cloud-based interface enables scenario exploration and dynamic visualization, making the approach accessible and visually strong. Preliminary results reveal strong interdependencies and highlight how anthropogenic pressures can trigger cascading declines in ecosystem services. Scenario analyses demonstrate variable sensitivity across components. The expert elicitation process also helped identifying critical knowledge gaps. Lessons learned include the need for broader expert involvement and recognition that the process is time-intensive, emphasizing collaborative and iterative approaches. By translating complex ecological relationships into an intuitive interactive format, this method provides a practical tool for exploring trade-offs and prioritizing actions under uncertainty. It advances the integration of ecosystem functioning and services into evidence-based marine conservation and restoration strategies.

Keywords: Ecosystem services, Sensitivity assessment, Multiplicative modelling, Interactive visualization, Marine conservation

7. When Offshore Wind Reshapes MSP: How Ecosystem Service Mapping Can Question the Transition Potential of Coastal Territories?

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Marine spatial planning (MSP) is challenged by rapid offshore wind farm (OWF) expansion and the need to operationalise ecosystem functioning in spatial decisions (Foley et al., 2010; Queirós et al., 2025). Although the ecosystem services (ES) framework has strong potential to support MSP, its translation into decision-ready spatial evidence remains constrained by (i) limited process-based representations of ES supply, (ii) insufficient consideration of cumulative and long-term dynamics, and (iii) limited attention to the relational conditions through which technologies, ecosystems and collectives co-produce pathways to sustainability (Galparsoro et al., 2021; Pınarbaşı et al., 2017).

We present a spatially explicit framework to map changes in marine ES supply across OWF life cycles and

to use these maps to examine the conditions under which coastal pathways can become more sustainable. Our approach combines participatory expert elicitation, ecological modelling and scenario-based spatial analysis to explicitly link biodiversity, ecosystem functions and ES supply. It is implemented in the Bay of Seine (eastern English Channel), a region facing major OWF development. We focus on three ES: food provisioning from professional fisheries, water and substrate purification, and lifecycle maintenance. For each ES, weighted indicators are derived from expert consensus and trophic modelling outputs, then integrated within a state–transition model representing successive OWF phases (pre-construction, construction, operation) and multi-OWF cumulative scenarios up to 2050 (figure 1).

Results show pronounced spatial and temporal heterogeneity, including construction-related losses, potential operational gains linked to reef and reserve effects, and spillovers beyond OWF footprints. We argue that dynamic ES mapping can serve as an empirical entry point to qualify the transition potential (Labussière and Nadai, 2018) of coastal socio-ecosystems, understood as their situated capacity to evolve towards more sustainable trajectories beyond a purely technico-economic framing. Beyond providing maps, the approach raises a key operational question: how can we move from spatialised indicators to an integrated reading of ecological, socio-cultural and technical dynamics that shape this transition potential?

Keywords: Offshore Wind Farm, State-And-Transition Model, Cumulative Impacts, Transition Potential, Spillover effect

8. Advancing Marine Spatial Planning in Areas Beyond National Jurisdiction Through a Socio-Ecological and 3D Conceptual Framework

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Marine Spatial Planning (MSP) in Areas Beyond National Jurisdiction (ABNJ) remains a major challenge for global ocean governance, given the fragmented institutional landscape, multi-use pressures, and complex ecological interactions that characterize these vast marine commons. This study contributes to the integration of ecosystem components and services into marine policy by analyzing a socio-ecological system (SES) located in ABNJ adjacent to Argentina's Exclusive Economic Zone. The objectives were: (i) to characterize major human activities, ecosystem components, pressures, and ecosystem services in the area; (ii) to examine how multidimensional conflicts and interactions shape governance needs; and (iii) to develop a conceptual three-dimensional visualization framework to support MSP under complex vertical and horizontal dynamics.
Using a combination of socio-ecological network analysis and expert-informed evaluations of interactions, we identified system hotspots involving commercial fishing, ecological features of conservation importance, and pressures such as overfishing and pollution. Results reveal that many conflicts and compatibilities are vertically structured, emphasizing the importance of integrating water-column and seabed interactions into MSP. The 3D conceptual framework developed here illustrates vertical overlaps across uses and ecosystem components, offering a novel schematic tool for understanding multi-layered socio-ecological dynamics.
The findings highlight opportunities for operationalizing MSP in ABNJ by improving the representation of ecosystem functioning, clarifying trade-offs, and informing governance mechanisms under the emerging BBNJ Agreement. By synthesizing system interactions and illustrating them through vertically explicit schemas, this study advances practical pathways for designing, optimizing, and implementing ecosystem-based planning measures in marine areas beyond national jurisdiction.

Keywords: Marine Spatial Planning, Areas Beyond National Jurisdiction, socio-ecological systems, governance, 3D conceptual visualization

9. Marine digital twins for dynamic ecosystem-service mapping and scenario-based spatial planning

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Marine spatial planning processes increasingly require spatially explicit, mechanistic estimates of ecosystem functioning and ecosystem service delivery under alternative human-use scenarios. We outline a marine ecological digital twin (DT): a living, data assimilating system that fuses observations and models to support scenario testing for planning, conservation, and restoration. The DT couples (i) spatio temporal mapping tools including remote sensing, machine learning, and joint species distribution models that predict dynamic patterns of habitats, communities, and pressures, (ii) 3D hydrodynamic-biogeochemical models that resolve sediment pelagic exchanges, producing maps of stocks and fluxes that underpin ecosystem services and (iii) Dynamic Energy Budget models that translate environmental forcing into organism and ecosystem level budgets, including production and waste pathways associated with low trophic aquaculture infrastructure. An AI assisted impact-response knowledge base keeps pressure effect links updated as new evidence emerges. Modules connect through adaptive fidelity: high-resolution where data are rich, and transparent evidence-based or expert-informed where data are sparse. Integrated dynamically, these components calculate cumulative effects on multiple ecosystem services, forecast habitat recovery trajectories, and quantify changes in service delivery under alternative management, development, and climate scenarios. Outputs are delivered as comparable maps with uncertainty, enabling trade-off analysis and prioritization of mitigation and restoration actions. The result is an auditable decision layer that turns ecosystem services into operational planning metrics.

***Keywords*:** marine ecological digital twin, ecosystem services mapping, marine spatial planning, cumulative effects assessment, scenario based decision support

10. Using Scale-Dependent Community Assembly Processes to Inform Marine Conservation and Restoration

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Understanding how ecological processes governing community dynamics vary across spatial scales is essential for improving the predictability of ecosystem responses to disturbance in conservation and restoration contexts. Deterministic and stochastic processes control community dynamics. However, the responses of both processes to the loss of foundation species, which strongly influence community dynamics across spatial scales, are unclear. We experimentally examined how spatial extent and foundation species removal affect rocky-intertidal community dynamics over three years in eight field sites spanning ~1000 km along the southeastern Pacific. The normalised stochasticity ratio (NST), which distinguishes between stochastic (>50%) and deterministic (<50%) community dynamics, decreased with spatial extent for sessile and mobile species, with consistently lower values under foundation species removal for sessile communities. The effect of foundation species removal on NST was strongest in smaller sessile communities and diminished as spatial extent increased, while mobile communities showed no significant response to the disturbance. Our experimental results demonstrate that the loss of foundation species disrupts the scale dependency of ecological mechanisms, with implications for the predictability of community responses to disturbance. By explicitly linking spatial scale, disturbance, and community assembly processes, our study offers an operational perspective relevant to marine policy. Long-term monitoring programmes and the use of process-based indicators can support the design and spatial configuration of conservation and restoration measures by identifying scales at which community

dynamics are more predictable and management outcomes more robust, thereby contributing indirectly to the effective incorporation of ecosystem functioning concepts into marine planning and governance.

***Keywords*:** Local extinction, determinism, scale-dependency, stochasticity, metacommunities