

# BOOK OF ABSTRACTS

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## I. SESSION DESCRIPTION

### ID: B1

Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems

#### Hosts:

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#### Abstract:

The marine and coastal social-ecological systems host a large amount of biological, genetic, functional and ecosystem diversity while offering the space for a multitude of interactions with society. Especially the areas on the interface between land and sea, such as coastal zones and deltas, represent a major environmental governance challenge, as over 90% of the population they concentrate relies on marine resources. This population is also vulnerable to sea level rise and degradation of these marine systems.

These multi-functional systems are subject to sectoral policies and planning schemes, while being areas of social conflicts under varying financial interests. European Union (EU) has proposed a new approach towards Sustainable Blue Economy, which targets simultaneously climate change mitigation through offshore energy production, a circular economy approach on the fisheries and shipping sector, while preserving coastal biodiversity and landscapes for the benefit of tourism and the economy. This multi-objective strategy is key to ensuring that multiple goals can be achieved, but at the same time its implementation is not straightforward as the research methods available to account for those goals are designed in a sectoral manner. Marine and coastal ecosystem services assessment can be key to ensure

an integrated and inclusive assessment of the plural values of such systems and provide information to policy and decision-making in an integrated way. However changing the current approaches is a difficult process, which includes changes in current public policies, public awareness and repeatedly producing results that support decisions.

Marine and coastal ecosystem services (MCES) research has evolved towards this direction over the last decade. From land-based adaptations and a greater focus on provisioning ecosystem services, it extended to developing marine-specific models, while addressing the broader range of ecosystem services including cultural and regulating ones. At the same time, simple spatial and quantitative tools, produce clear outputs that can be used by decision makers. However, such instruments and methods are required to be tested on the ground through a continuous user involvement. Research also unbundled the quantification and accounting of marine ecosystem services targeting not only the ecosystem service supply side, but also the flow, demand, and value. Still, while the notion of ES bundles and the multiple values of marine systems are well acknowledged in scientific literature, methodological and policy approaches on how to account for these as bundles are scarce. At the same time, approaches toward the inclusion of multiple values of marine and coastal systems, extending beyond the biophysical or economic value, to account for social and relational values are lacking. The scale of existing challenges calls for further research on methods and theoretical approaches that require integration of different disciplines (ecology, engineering, planning, economy) to detect risks and weaknesses of marine and coastal ecosystems.

The goal of this session is therefore dual: to explore methods and approaches towards the inclusion of the plural values of marine and coastal ecosystems; and ways of accounting for the plural values of these systems towards a more inclusive planning and governance.

We invite research teams who have been targeting the assessment of multiple, biophysical and social values of marine and coastal ecosystem services, to present their approaches, but also methods for including and involving society in their work. This session is a continuation of the work carried out by the Marine Biome Working group of ESP in cooperation with the Interreg Central Baltic project MAREA “From marine ecosystem accounting to integrated governance for sustainable planning of marine and coastal areas” and ERASMUS+ project Mare “Marine Coastal and Delta Sustainability for Southeast Asia”.

We seek for contributions and knowledge exchange with researchers or teams that focus on:

- Methods of plural valuation within the marine and coastal environment;
- Methods integrating biophysical modelling of ecosystem services with socio-cultural quantification and assessment in marine and coastal systems;
- The development of plural marine ecosystem services accounting framework(s);
- Approaches followed for inclusion of different societal groups with a special focus on civil society organizations and citizen science;
- Methods and development of decision support tools for sustainable management of marine and coastal ecosystems;
- Examples of marine ES assessments as solutions for sectoral integration in the marine and coastal zone.

- Examples of spatial planning instruments and evaluation of trade-offs generated by different planning and management options.

### Goals and objectives of the session:

To exchange knowledge, experience and approaches on integrated and inclusive approaches for marine and coastal ecosystem services, with the ultimate goal to identify planning and management options for an inclusive and sustainable use of the marine and coastal areas.

### Planned output / Deliverables:

The session foresees two different and practical outcomes, to be decided according to the interest generated among participants.

- 1) A joint publication on the best practices for integrated and inclusive assessment of ecosystem services.
- 2) Proposal of a book with International Publisher with full contributions from the presentations.

### Session format:

A combination of presentations with discussion groups on emerging topics.

### Voluntary contributions accepted:

Yes, I allow any abstract to be submitted to my session for review

### Related to ESP Working Group/National Network:

[Biome Working Groups: BWG 1 –Marine systems](#)

## II. SESSION PROGRAM

**Date of session:** Tuesday 11 October

**Time of session:** 11:00–17:30

### Timetable speakers

Time	First name	Surname	Organization	Title of presentation
11:00–11:05	Evangelia	Drakou	Harokopio University of Athens	Introduction to the session
11:05–11:20	Jana	Schluenss	Université du Québec en Outaouais (UQO)	Only know you love her when you let her go? Assessing multiple values in

Time	First name	Surname	Organization	Title of presentation
				the context of ecosystem service loss in coastal and marine areas
11:20–11:35	Aurelija	Armoskaite	Latvian Institute of Aquatic Ecology	Ecosystem services for multi-objective maritime spatial planning
11:35–11:50	Daniele	La Rosa	University of Catania	Ecosystem Services Trade-offs in Coastal Areas (with an urban perspective)
11:50–12:05	Germain	Boussarie	Centre d'Ecologie et des Sciences de la Conservation (CESCO), Muséum National d'Histoire Naturelle, Centre National de la Recherche Scientifique, Sorbonne Université, Paris, France	Marine spatial planning to solve increasing conflicts at sea in a changing world: a framework and a Shiny app for prioritizing offshore windfarms and marine protected areas
12:05–12:20	Johanna	Schumacher	Leibniz Institute for Baltic Sea Research	Assessment of ecosystem services across the land-sea Interface: approach and applications along the German coast
12:20–12:30	Francisco	Barbosa	Estonian Marine Institute, University of Tartu	Integrative and data-driven assessment of ecosystem services under alternative human-use scenarios to inform decision-making in the Baltic Sea
Lunch break				
13:30–13:45	Agnese	Reke	Baltic Environmental Forum, Latvia	Sociocultural valuation of coastal cultural ecosystem services and their linkages to human well-being: case of Latvia and Estonia
13:45–14:00	Tin-Yu	Lai	Finnish Environment Institute	Measure multiple cultural service values and their linkage to ecosystem condition: an application of PGIS survey for ecosystem accounting
14:00–14:15	Esther	Robbe	Leibniz Institute for Baltic Sea Research Warnemuende & Klaipeda University	A scenario-based assessment and comparison of macrophyte ecosystems and their services in Southern Baltic lagoons
14:15–14:30	Solvita	Strake	Latvian Institute of Aquatic Ecology	The supply and value of nutrient regulation performed by habitats in the Latvian marine waters
14:30–14:45	Jacinto	Cunha	CIIMAR/UTAD	Assessment of key areas of Regulation and Maintenance Ecosystem Services supply along a coastal – sea gradient.

Time	First name	Surname	Organization	Title of presentation
14:45–15:00	Miriam	Montero Hidalgo	Rey Juan Carlos University	What are the current state and future perspectives of blue carbon and seagrass meadows in the Canary Islands?
15:00–15:15	Sylvie	Campagne	Sorbonne Université, CNRS, Station Biologique de Roscoff, Adaptation et Diversité en Milieu Marin – Fondation pour la Recherche sur la Biodiversité, Centre de Synthèse et d'Analyse sur la Biodiversité	Evidence on the impact of changes in marine and coastal ecosystems structure and functioning on the ecosystem services delivery
15:15–15:30	Nidhi	Nagabhatla	United Nations University, Institute on Comparative Regional Integration Studies (UNU-CRIS), Belgium and School of Geography Earth Science and Society, McMaster University, Hamilton, Canada	Can Seaweed Aquaculture Industry fit the Nature Based (& Ecosystems Based) Solutions Discourse? Insights from GlobalSeaweedSTAR (2017–2021) Initiative
Coffee break				
16:00–16:15	Charis	Chalkiadakis	University of Twente	Mapping social–ecological system flows of a small–scale fishery across scales
16:15–16:30	Miguel	Villoslada	University of Eastern Finland	An integrated monitoring scheme for coastal wetlands: Combining field ecology and remote sensing
16:30–16:45	Chengfa Benjamin	Lee	German Aerospace Center (DLR)	Spatially Explicit Seagrass Extent Mapping Across the Entire Mediterranean
16:45–17:00	Dimosthenis	Traganos	German Aerospace Agency (DLR)	National Seagrass Blue Carbon Accounting in Bahamas using Earth Observation
17:00–17:15	Justas	Kazys	Vilnius University	Effects of existing and future marine energy systems on provision ecosystem services in the South–Eastern Baltic Sea
17:15–17:30	Vincenzo	Maccarrone	IRBIM–CNR	Artificial light at night and vessel traffic: spread, measurements, assessments. Are mitigation policies needed?

### III. ABSTRACTS

*Abstracts are ordered based on the session program. The first author is the presenting author unless indicated otherwise.*

1. *Type of submission: Abstract*

B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems

Ecosystem Services Trade-offs in Coastal Areas (with an urban perspective)

*Presenting author: Daniele La Rosa*

*Other author(s):* Viviana Pappalardo, Vincenzo Maccarrone, Pietro Scandura

*Affiliation:* University of Catania, Italy

*Contact:* dlarosa@darc.unict.it

Coastal Areas are broad transitional landscapes under multiple pressure and undergoing dynamic changes driven by close and significant influence of terrestrial and marine actors. Coastal areas have high significant potential to provide ES and respond to different demands for ES, but they are also particular contexts where significant and different ES trade-offs occur. Majority of existing forms of governance are not able to deal and address such trade-offs, which thus call for more innovative and effective governance approaches and mechanisms, aimed at achieving ES synergies and reducing ES conflicts.

This contribution discusses the characteristics of coastal areas in the context of governance questions related to the management of ES trade-offs. The drivers of ES trade-offs are presented and different trade-off relationships between and within the main ES types are analyzed. A specific urban focus is reserved to the interface between urban settlements and seascapes, where the most challenging of these trade-offs can happen and where it could be prior to concentrate policy and planning efforts. Finally, this contribution proposes a way forward from the current governance state-of-the-art by providing recommendations for new governance mechanism able to address the trade-offs analyzed.

*Keywords:* Trade-offs, Spatial Planning, Urban, Governance

## *2. Type of submission: Abstract*

### **B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

The supply and value of nutrient regulation performed by habitats in the Latvian marine waters

*Presenting author: Solvita Strake*

*Other author(s): Ingrīda, Aurelija, Kristīne, Juris*

*Affiliation: Latvian Institute of Aquatic Ecology, Latvia*

*Contact: solvita.strake@lhei.lv*

The seabed of the South-eastern Baltic Sea is a mosaic of hard, mixed and sandy substrate, thus a diverse range of habitats. Hard substrate – stones and pebbles – host macroalgal communities, mussels, mobile invertebrates and fish. In the deeper waters, large areas of the seabed are formed of muddy sediments rich in infaunal invertebrate species. Different types of habitats make a different contribution to the provision of ecosystem services (ES), understanding this as well as the benefits they provide in quantitative terms and embedding these values in decision-making is essential for ensuring sustainable biodiversity conservation policies.

In this study, we conducted an integrated ecosystem service assessment with a focus on nutrient regulation to estimate the supply and value of the service in the Latvian setting and inform decision-making.

The assessment was based on primarily biophysical as well as socio-economic primary datasets, as well as literature research. The assessment included quantitative estimation of nutrient regulation service supply by the different types of habitats found in the Latvian marine waters, which informed socio-economic study of the benefits the service provides. Specifically, in-house data on habitat areas in Latvian sea waters and results of assessments for biogenic and carbon sequestration were used for calculating service supply by biogenic attraction, accumulation in biomass, deposition in sediments performed by benthic habitat types (kg/km<sup>2</sup> /year). The amount of nutrients stored in the sediments is evaluated for the calculation of the monetary value of the benefits nutrient regulation provide. The results show that the national monetary welfare benefits (value) from nutrient regulation are measured at an average of 577.2 million. EUR (311.3–843.1 million EUR) per year.

The study is funded by LIFE19 NAT/LV/000973 REEF project "Research of marine protected habitats in EEZ and determination of the necessary conservation status in Latvia".

*Keywords:* Baltic Sea, hard substrate habitats, regulating ecosystem services, nutrient storage, monetary value

### *3. Type of submission: Abstract*

#### **B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

Assessment of key areas of Regulation and Maintenance Ecosystem Services supply along a coastal – sea gradient.

*Presenting author: Jacinto Cunha*

*Other author(s):* Edna, Cabecinha, Sebastián, Villasante, Stefano, Balbi, Michael, Elliott, Sandra, Ramos,

*Affiliation:* CIIMAR/UTAD, Portugal

*Contact:* jcunha@ciimar.up.pt

Coastal and marine ecosystems provide valuable Ecosystem Services, from which we derive societal goods and benefits (SG&B). The integration of ES and SG&B assessments in regional and local management is crucial to achieve sustainability and maintain ecosystem productivity, particularly in achieving the objectives of multiple policies (e.g. EU Water Framework Directive, Marine Strategy Framework Directive, UN Sustainable Development Goals). Marine and coastal ES and SG&B assessments are often done at national levels and assume equal delivery from similar ecosystems, with a focus mainly on Production (e.g. fisheries) or Cultural benefits (e.g. tourism). However, Regulation and Maintenance ES (RMES), lack focused attention, particularly given their importance in supporting both the ecosystem ecological foundations, but also the provision of other ES and in turn leading to SG&B. This work investigated the provision potential of RMES along a coastal–sea gradient (NW Portugal), using available and spatially explicit, regional to local data. Nine classes of RMES were identified and eleven indicators were used as proxies to assess hotspots (areas with a higher supply of RMES) and coldspots (areas with a lower supply of RMES) of service supply. The data showed that 20% of the study area was classified as hotspots of RMES provision and 28% was classified as coldspots. Hotspots were mainly distributed along the coastal areas and estuaries, and the potential supply of RMES tended to decrease from coastal areas towards the open sea. It is of note that 39% of the area classified as hotspots is already protected under the National and International Classified Areas. These results provide locally based and spatially explicit information on RMES supply, fundamental to support regional environmental management decisions, but also highlight future RMES research needs in the area.

***Keywords:*** Regulation Ecosystem Services, Maintenance Ecosystem Services, Marine and Coastal Ecosystems, Environmental Management, Marine Spatial Planning



#### *4. Type of submission: Abstract*

#### **B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

Measure multiple cultural service values and their linkage to ecosystem condition: an application of PGIS survey for ecosystem accounting

*Presenting author: Tin-Yu Lai*

*Other author(s):* Tommi Tikkanen, Liisa Saikkonen

*Affiliation:* Finnish Environment Institute, Finland

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Economic research has a long history of valuing different cultural services, including recreational and landscape aesthetic value, through various methods such as contingent valuation, choice experiment, or travel cost model. However, most studies measured the value of these cultural services from the demand side of the services with weak linkages to the ecosystems, which makes the challenges remain in assessing cultural services under ecosystem services assessment and ecosystem accounting frameworks. This study designed a survey to measure and value multiple marine and coastal cultural services in Finland, Estonia, and Latvia, specifically for the purpose of ecosystem accounting. Taking the recreational survey which was used to apply the travel cost model as the basis, we also included questions on other cultural services (e.g., landscape scenery and spiritual meaning) and perceived environmental qualities on the visited site. Therefore, the survey results assessed how other cultural services are embedded into recreational services and value, as well as how perceived environmental qualities influenced these cultural services. The survey was conducted in the participatory geographic information system (PGIS) form with location information; thus, the perceived environmental qualities can link to the spatial modelled or monitored ecological indicators that are potentially usable as ecosystem condition indicators in the ecosystem accounting. With such linkage, the assessed cultural services from this survey are possible to compare and analyze the trade-off to some modelled or monitored ecological value (e.g., biodiversity) or other types of ecosystem services that are measurable by the modelled or monitored environmental data.

*Keywords:* cultural services, participatory GIS, ecosystem accounting, marine and coastal ecosystems

*5. Type of submission: Abstract*

**B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

Evidence on the impact of changes in marine and coastal ecosystems structure and functioning on the ecosystem services delivery

*Presenting author: Sylvie Campagne*

*Other author(s):* Laurie–Anne Roy, Eric Thiébaud

*Affiliation:* Netherlands

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While the current biodiversity crisis calls for an urgent need to sustainably manage human uses of nature, it is mandatory to improve our knowledge on the interactions between biodiversity and ecosystem services, especially on marine ecosystems which often receive less attention than terrestrial ecosystems. Following the Collaboration for Environmental Evidence Guidelines and a published protocol (Campagne et al. 2021), we performed a systematic map on the existing literature with the aims to highlight knowledge clusters and gaps. We searched for all evidence documenting across scientific and grey literature sources related to the impacts of spatio-temporal dynamics of marine and coastal biodiversity, and of ecosystems structure and functioning on the ecosystem services (ES) they provide.

A total of 41 884 records were found with our search string. The selection process led to 695 articles selected. We recorded many information on ES, the habitats concerned, the pressures and the quality of the data. For exemple we have seen that management impact was the most studied driver of change followed by climate change and overexploitation. Only one quarter of the studies analysed more than one ES values which confirmed the weak knowledge on the pluralities of values of marine and coastal ES. The lack of pluridisciplinary articles and social assessment of marine and coastal ES is highlighted.

A scale paradox indicating a bias in the scales of ES studies, their pressures, and the implementation of management measures is perceived. With more than 99% of the data were quantitative, only 67% of the articles presented data on the variability and around 53% where primary data. While 87% of the studies cited pressures, only 60% used data of the pressures in their analyses. This work will lead to a meta-analysis confronted with a perception analysis to highlight divergences and convergences between scientific and societal knowledge.

*Keywords:* Coastal; Biodiversity; Nature's contribution to people; Spatio-temporal dynamics

*6. Type of submission: Abstract*

**B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

A scenario-based assessment and comparison of macrophyte ecosystems and their services in Southern Baltic lagoons

*Presenting author: Esther Robbe*

*Other author(s):* Linda Rogge, Jūratė Lesutienė, Martynas Bučas, Gerald Schernewski, , ,

*Affiliation:* Leibniz Institute for Baltic Sea Research Warnemuende & Klaipeda University, Germany

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Coastal lagoons and their macrophyte habitats provide multiple ecosystem services. Historically harvested and used (e.g. building material) nowadays macrophytes lost their economic importance. However, they provide important regulating and maintenance services (e.g. nutrient filtration). Their cultural services are more controversial, sometimes seen as nuisances to tourists by blocking the view, or contrarily being pivotal for the aesthetic experience. Besides, Baltic lagoons are under high pressure. They are intensively used and impacted by humans (e.g. nutrient input). Due to eutrophication and habitat destruction, many lagoons show poor ecological states reflected by a decline in macrophytes. However, as a core indicator within the European Water Framework Directive (WFD, 2000/60/EC), macrophytes are of high political relevance for monitoring and assessing water quality.

The main objective of this study is to develop a generally applicable ecosystem services approach for the assessment of macrophytes. We select and identify relevant services differentiating between habitats according to Natura 2000 and EUNIS categories. Thereby, we compare services provided by emerged, submerged and intertidal macrophytes (i.e. charo-, halo-, helophytes). Additional to the Szczecin Lagoon (Germany) and the Curonian Lagoon (Lithuania), we apply the approach in the Southern Mediterranean (Bizerte Lagoon, Tunisia). We developed scenarios to assess current and possible future states of the lagoons, i.e. ecological states, coverage of macrophytes and pollution. We applied a holistic and indicator-based assessment integrating expert, biophysical and socio-economic data.

Results reveal the importance of services provided by macrophytes and show the impact of changing ecosystems on their provision. Our assessment approach can support sustainable coastal management (i.e. environmental impact assessment within coastal development) and policy implementation (i.e. support to achieve the EU WFD good environmental status, or Natura 2000 objectives). In the presentation we will discuss its limitations, opportunities, and the general applicability of the approach for international coastal lagoons.

*Keywords:* coastal management, impact assessment, macrophytes, eutrophication, policy implementation

*7. Type of submission: Abstract*

[B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems](#)

Effects of existing and future marine energy systems on provision ecosystem services in the South-Eastern Baltic Sea

*Presenting author: Justas Kazys*

*Other author(s):* Ieva Misiunė, Darijus Veteikis, Stefano Menegon, Daniel Depellegrin

*Affiliation:* Vilnius University, Lithuania

*Contact:* justas.kazys@gf.vu.lt

The Lithuanian sea space belongs to the smallest sea areas in Europe. Post-pandemic ambitions for ecological transition and national demands for energy independence drive needs for energy and infrastructural interconnectivity of Baltic States like Lithuania, Latvia and Estonia with other European countries. The aim of this research is to address how existing and new energy-related marine infrastructure developments are shaping the impact on marine ecological values and the interactions with Blue Economy sectors of the Lithuanian maritime space. “National Energy and Climate Action Plan for the period 2021–2030” (2019) and “Klaipėda 2030: Economic Development Strategy and Action Plan” (2018) are including these very ambitious plans of the energy-related sector development in the region. Three potential future offshore wind energy prospects in the Lithuania–Latvian sea space (one site to be operational in 2028) together with two subsea high-voltage direct current interconnections, namely the planned Harmony–Link (700 MW; Poland–Lithuania), the existing NordBalt (700 MW; Sweden–Lithuania), the Butingė offshore oil terminal and Klaipėda LNG (liquefied natural gas) terminal were characterized and analysed for their potential impacts on habitat provisioning services using a nature values coupled risk-based cumulative effects assessment technique. Results were presented in terms geospatial impacts to multiple ecological components of the study area (marine habitats, algal beds, marine mammals and fish resources) and for their implications for ecosystem services-based MSP in the region. The study is part of the IFESMAR project – Integrated Framework for Ecosystem Services based Analysis of MARitime sectors, funded by the Lithuanian Research Council.

*Keywords:* Marine spatial planning, marine renewable energy, provisioning ecosystem services, ecological transitions

*8. Type of submission: Abstract*

**B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

An integrated monitoring scheme for coastal wetlands: Combining field ecology and remote sensing

*Presenting author: Miguel Villoslada*

*Other author(s):* Thaísa F. Bergamo, Mariana Morgado, Volha Kaskevich, Ricardo Martínez Prentice, Raymond D. Ward, Kalev Sepp,

*Affiliation:* University of Eastern Finland, Finland

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The EU Biodiversity Strategy has set the aim of halting the loss of biodiversity and degradation of ecosystems within the EU Member States (MS) by 2030. By adhering to the 17 targets set by the Strategy, MS are committed to improve the state of habitats inside and outside protected areas, increase the efficiency of management of all protected areas, and increase the surface of protected areas.

In coastal ecosystems, subject to the various pressures of climate change and managements shifts, the effective implementation of these targets requires coherent monitoring strategies, able to capture the spatial character of biodiversity status and change trends in ecosystem services supply. However, current monitoring methods relying mostly on local-scale proxies do not fully account for the multiple scales that characterize ecosystems and processes of change in coastal areas. In addition, local-scale proxies do not yield an accurate representation of habitat status and the supply of ecosystem services at the regional and national level, since most of these monitoring schemes are spatially constrained. This, in turn, hinders our ability to adequately understand biodiversity change trends and ultimately renders current monitoring and conservation efforts inefficient in the long term.

Here, we present a set of standardized UAV-based tools, field ecology procedures, and experimental settings to monitor the structure, functions, changes and supply of ecosystem services in coastal meadows in Estonia. In order to enhance upscalability and transferability of the methods, we put a strong focus on the adoption of Essential Biodiversity Variables (EBVs) that are relevant to both the realms of coastal meadows and remote sensing.

The accurate results obtained during the last 4 years encourage us to move beyond the piloting phase into the Nation-wide scale.

*Keywords:* ecosystem services, monitoring, coastal wetlands, remote sensing, field ecology

*9. Type of submission: Abstract*

**B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

What are the current state and future perspectives of blue carbon and seagrass meadows in the Canary Islands?

*Presenting author: Miriam Montero Hidalgo*

*Other author(s):* Fernando Santos–Martín, Fernando Tuya, Francisco Otero, Ricardo Haroun

*Affiliation:* Rey Juan Carlos University, Spain

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Blue carbon is the carbon stored in coastal and marine ecosystems such as salt marshes, mangroves, and seagrasses. Seagrasses can store and sequester large amounts of carbon dioxide from the atmosphere, and their conservation can be a solution to adapt and mitigate climate change effects. This study focuses on mapping and assessing blue carbon storage of seagrass meadows in the Canary Islands using InVEST Coastal Blue Carbon model. Particularly, this study: (1) mapped and assessed the past and current capacity of *Cymodocea nodosa* to store and sequester blue carbon; (2) mapped and assessed blue carbon under three plausible future scenarios; and (3) valued the economic implications of these scenarios. Our results demonstrate that despite the ecological, cultural, social, and economic relevance of *C. nodosa* in this region and the multiple services it provides to human well-being at a local and global level, this species has suffered 50% loss in the last two decades. Our results from the modelled future scenarios indicate that if we continue with the current degradation rate in the year 2036 *C. nodosa* will completely disappear from the Canary Islands archipelago. The ecological, social, and economic impact of these losses in 2050 is equivalent to loss 1.43 Megatonnes of CO<sub>2</sub> equivalent (45% from current situation) and 126.3 million € (0.32% of the current Canary GDP). Finally, we highlight that this research is the first one that quantifies and spatially represents *C. nodosa* regression in the whole archipelago and their effect on carbon storage, as well as identifies the areas and pressures that need to be acted upon and studies future management scenarios. Additionally, this research proposes its potential applicability across coastal ecosystems for use as a strategic conservation planning methodology.

*Keywords:* Seagrass meadows decline, blue carbon, ecosystem services, InVEST model, future scenarios.

*10. Type of submission: Abstract*

**B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

Marine spatial planning to solve increasing conflicts at sea in a changing world: a framework and a Shiny app for prioritizing offshore windfarms and marine protected areas

*Presenting author: Germain Boussarie*

*Other author(s):* Gaël Lavialle, Dorothée Kopp, Maud Mouchet, Marie Morfin

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The sixth extinction is ongoing at an unprecedented rate. Near-future biodiversity loss is expected to skyrocket, with global warming as catalyst cumulated with other direct anthropogenic pressures. With it, the ecosystem services (ES) they provide are expected to dwindle. As an answer to climate change, renewable energies are being rapidly developed on a worldwide scale, leading to a significant increase in space use in the coming decades. Simultaneously, protected areas will be implemented as part of the Post-2020 Global Biodiversity Framework. Sharing space is an increasingly complex task, especially because of the high rate of emergence of such competitors for space. In fisheries-dominated socio-ecosystems, acceptability of offshore windfarms (OWFs) and marine protected areas (MPAs) is usually very low, partly due to an underrepresentation of fisheries in spatial plans and poor attention to equity in the spatial distribution of restrictive areas. Here we developed a framework with a marine spatial planning case study in the Bay of Biscay represented by the socio-ecosystem of the Grande Vasière, a mid-shelf mud belt spanning over 21,000 km<sup>2</sup>. We collected biological, environmental, and anthropogenic data to model the distribution of 62 benthic-demersal species, 7 regulating ES layers related to nutrient cycling, life cycle maintenance and food web functioning, as well as provisioning ES of 18 commercial species and 82 fisheries subdivisions. We used these spatial layers and a prioritization algorithm to explore siting scenarios of OWFs and two types of MPAs (benthic and total protection), aimed at conserving species, regulating and provisioning ES, while also ensuring that fisheries are equitably impacted. We emphasize the importance of exploring multiple targets with a Shiny app to visualize results and stimulate dialogue among stakeholders and policymakers. We show how our flexible, inclusive framework with particular attention to equity could be an ideal discussion tool to improve management practices.

*Keywords:* marine spatial planning, biodiversity, ecosystem services, offshore windfarms, fisheries

*11. Type of submission: Abstract*

**B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

**Sociocultural valuation of coastal cultural ecosystem services and their linkages to human well-being: case of Latvia and Estonia**

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Coastal and marine ecosystems, as well as the services they provide, are vital for human well-being. However, information on specific linkages between the various dimensions of human well-being and concrete ecosystem services, especially cultural ecosystem services, is still scarce. Identifying linkages between human well-being and cultural ecosystem services is crucial for several reasons, including better integration of social values into spatial planning and management of coastal areas, as well as filling the knowledge gaps in what we know about humans' tendency to seek connections with nature.

In the frame of Interreg MAREA project, we aimed to identify links between coastal cultural ecosystem services and human well-being in Latvia and Estonia. The study is based on the results of a social survey (n=1414) that targeted recreational users of coastal areas in both countries. The study highlights the main perceived well-being benefits people gain from their recreational coastal visits and various factors that influence it, and spatially demonstrates the use of cultural ecosystem services along coastal areas in Latvia and Estonia.

The survey results show that the main motivation for visiting coastal areas in free time is linked to the maintenance of personal health and wish to feel closer to nature. Most popular coastal activities in both countries are hiking, swimming and enjoying the landscape. Despite the different characteristics of coastline in Estonia and Latvia, results in both countries were similar.

The study is supported by the Interreg Central Baltic Programme project MAREA (#CB934).

*Keywords:* cultural ecosystem services, coastal ecosystems, human well-being, Baltic Sea



## *12. Type of submission: Abstract*

### **B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

Integrative and data-driven assessment of ecosystem services under alternative human-use scenarios to inform decision-making in the Baltic Sea

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The delivery of ecosystem services has been generally mapped through qualitative and expert-based approaches in the Baltic Sea. In the Interreg project MAREA we developed a machine learning framework considering both the structure of marine ecosystems and the intensities of key ecological and biogeochemical processes to provide realistic quantitative and spatially-defined predictions of the services supplied across the northeastern Baltic Sea. The generated maps were incorporated into PlanWise4Blue (PW4B), a novel data-driven web tool capable of evaluating in an integrative way the cumulative impacts of diverse human and environmental pressures on marine ecosystems and the services they provide. To define the sensitivity of different ecosystem components and processes responsible for the services supplied, the underlying algorithm takes advantage from existing scientific evidence on actually observed and experimentally recreated impacts and its integration through meta-analysis. This information in combination with the layers generated in MAREA and high-resolution environmental and human activity maps publicly provided by European data infrastructure, are used by PW4B to quantitatively evaluate the changes that ecosystems and services might experience under both current and future scenarios. The user-friendly and decision-making oriented interface allows users, regardless of their scientific background, to test in real-time the individual and synergistic effects of a multiplicity of usage and environmental scenarios on areas and ecosystems of interest. The PW4B capability of analyzing the complexity of marine ecosystems and plethora of pressures to which they are subjected while providing holistic and easy to understand quantitative outcomes, provides a powerful tool to bridge the gap between science and policy to effectively meet sustainable development goals in the Baltic Sea.

*Keywords:* marine ecosystems, cumulative impact assessment, decision support tool, sustainable development

### *13. Type of submission: Abstract*

#### **B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

Only know you love her when you let her go? Assessing multiple values in the context of ecosystem service loss in coastal and marine areas

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Coastal and marine ecosystems are under increasing anthropogenic pressure. This pressure is closely related to a too narrow definition of nature's values in decision making processes. Assessing plural values that encompass not only economic factors, but a variety of different value dimensions, such as socio-cultural and intrinsic values is imperative for sustainable ecosystem management. Nevertheless, the assessment and consideration of multiple values is still scarce.

To promote a perspective of plural values in environmental decision making, we aim to integrate qualitative aspects into Life Cycle Analysis (LCA). To this end, we assessed how the multiple values that people attribute to ecosystems change when they experience ES loss. We conducted semi-structured interviews with local stakeholders along a coastal to freshwater gradient in two case study areas along the St.-Lawrence River delta in Southern Quebec, Canada.

We orient our analysis along the conceptual framework on multiple value dimensions of the IPBES, which differentiates between intrinsic, instrumental, and relational values. This qualitative assessment of plural values is a first step towards the construction of a set of novel indicators in LCA to mainstream the ES concept in decision making processes. Our research is embedded in the international Cost to Coast research project (C2C) that brings together social science (qualitative assessment of plural values) and natural science approaches (biophysical modeling of ES loss).

Our preliminary results suggest natural resource accessibility; a strong sense of place; and landscape aesthetics as main factors that positively influence ES values. These factors need to be emphasized in policy making to assure an integrative management of coastal and marine areas.

*Keywords:* CMES, decision-making, plural values, ES mainstreaming, Life Cycle Analysis

#### *14. Type of submission: Abstract*

**B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

### **Spatially Explicit Seagrass Extent Mapping Across the Entire Mediterranean**

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The *Posidonia oceanica* seagrass is the foundation species of the coastal Mediterranean, whose meadows support significant ecosystem services: food security, coastal protection, biodiversity maintenance, carbon sequestration, amongst others. This endemic in the basin seagrass features the largest carbon storage among seagrasses globally, contributing substantially to global blue carbon stocks.

However, climate change, coastal development, and decreasing water quality all render this slow-growing species at risk of area loss, functional extinction, and, hence, its provided services. This risk is further complicated by the current knowledge gaps in its bioregional extent, necessitating accurate, efficient and spatially explicit mapping and accounting of its distribution and trajectories at a high spatial resolution.

Here, we leveraged recent Earth Observation advances—cloud computing, open satellite data, and machine learning—with field data via a cloud-based ecosystem accounting framework to map the spatially-explicit ecosystem extent of *P. oceanica* seagrass across the whole Mediterranean, at 10m resolution.

Employing 279,186 Sentinel-2 satellite images between 2015–2019, and a human-labelled training dataset of 62,928 pixels, we mapped 19,020 km<sup>2</sup> of *P. oceanica* seagrass area in 22 countries across 56,783 km<sup>2</sup> of mapped seabed between 0–25 m of depth. Based on 2,480 independent field-based points, we observe an overall accuracy of 72%. Using a Tier 2 assessment, we estimated the bioregional blue carbon storage of *P. oceanica* beds to be 722.2 million MgC.

As reference data collections, remote sensing technology and biophysical modelling improve and coalesce, such extent accounts could support physical and monetary accounting of seagrass condition and ecosystem services. We envisage that such holistic seagrass ecosystem accounts could enable effective policy uptake in national climate, biodiversity and protection strategies and necessary financing. This in turn could accelerate transparent natural climate solutions and coastal resilience, beyond the physical location of seagrass beds and the 21st century.

*Keywords: seagrass, optical remote sensing, Google Earth Engine, blue carbon*

*15. Type of submission: Abstract*

**B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

**Ecosystem services for multi-objective maritime spatial planning**

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The multi-objective nature of maritime spatial planning (MSP) and its ecosystem-based approach to management make MSP a promising tool for balancing the levels of ecosystem service (ES) supply and demand, thus sustaining development within ecological limits. However, national MSP experiences suggest that effective MSP needs better social-ecological knowledge for trade-off assessments and scenario analysis and consideration of social sustainability dimensions. The adoption of ES in MSP could help overcome these challenges. However, practical application of ES in the marine context is burdened by its own set of challenges, namely knowledge, data and methodology gaps. Decision support tools have a role to play in resolving these challenges, but so far few allow simultaneous analysis of multiple services and support comprehensive analysis of the different dimensions of the ES cascade.

In response, the tool “ESA4MSP” has been developed for dynamic assessment and mapping of ecosystem functioning and service supply based on expert knowledge and field data. “ESA4MSP” has been developed through a case study approach where its functionalities are demonstrated through regional (Baltic Sea) and national (Latvian marine waters) level assessments. Results illustrate the assessment process and data needs for assessments of different scales.

“ESA4MSP” is part of a multi-map toolset MYTILUS, a free, open-source software programme, which is used to explore spatial patterns and statistics of social, economic and environmental data on the go. Further, conduct and compare results of cumulative impact assessments and conflict and synergy analysis. We will discuss how the results of the ES assessment can be used in conjunction with the results of the other tools as well as inform benefit valuation studies on the road towards more evidence-driven, ecosystem-based, and socially conscious MSP.

Study funded by project "Research of marine protected habitats in EEZ and determination of the necessary conservation status in Latvia" (LIFE19 NAT/LV/000973 REEF).

*Keywords:* maritime spatial planning, ecosystem-based management, marine ecosystem services, decision support tools, integrated ecosystem service assessments

*16. Type of submission: Abstract*

[B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems](#)

Mapping social-ecological system flows of a small-scale fishery across scales

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In this research piece, we followed different modeling and mapping approaches to spatially assess the flow of marine ecosystem services related to food provision from wild fisheries within the Senegalese Exclusive Economic Zone (EEZ). Literature has analyzed ecosystem services related to fisheries usually focusing only on the supply or demand side. In rare cases, literature targets fishery Ecosystem Service (ES) flows by considering the benefits and costs or the role of intermediate activities. Our paper aims to extend current knowledge by assessing and mapping marine ES flows from small-scale fisheries while considering costs and benefits emerging across ES flow paths and by investigating the relative role and contributions of intermediaries from the point of supply to the final benefit. We combine socioeconomic and environmental variables to determine the level of ES flows and we use several distance metrics, e.g. distance of trade, to model the sardinella fishery supply chain. This approach provides multi-level information for decision-making and ensures the inclusion of multiple biophysical and social values for assessing marine systems. We identify the quantity, direction, and scale of spatial flows and analyze different types and transfer mechanisms focusing exclusively on the small-scale fisheries of Senegal. We also study the environmental impact associated with intermediate activities, i.e. carbon emissions from catching, processing, and transportation, and examine patterns of distribution and trade. The ES maps produced represent the flow of marine ES to domestic and foreign beneficiaries across different mobility patterns and trade corridors.

*Keywords:* marine, fleet, model, spatial, assessment

*17. Type of submission: Abstract*

**B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems**

**National Seagrass Blue Carbon Accounting in Bahamas using Earth Observation**

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Seagrasses are among the world's most productive ecosystems, sequestering and storing vast amounts of "blue" carbon, mitigating climate change and supporting national climate agendas like the Paris Agreement's Nationally Determined Contributions. To estimate the value of seagrasses for these agendas, countries require spatially explicit, high-confidence seagrass ecosystem assessments guided by country-specific data. The recent Earth Observation advances, including cloud computing, artificial intelligence and dense satellite data acquisitions, in combination with field data can provide a contemporary scalable technological solution to assess the blue carbon service of seagrass ecosystems. Here, we utilized a scalable Earth Observation framework within the cloud platform of the Google Earth Engine to estimate the national blue carbon stock and sequestration rate of seagrasses in The Bahamas, across 114,059 km<sup>2</sup>. We leveraged a satellite mosaic based on 18,000 Sentinel-2 images and a variety of pixel and object-based features to map the Bahamian seagrass extent at 10 m resolution. Our developed machine learning algorithm was calibrated with nationwide training data and was validated by recent field data collections. We assessed national seagrass blue carbon using region-specific in-situ seagrass blue carbon data.

The mapped Bahamian seagrass extent covers an area between 39,799–47,344 km<sup>2</sup>, only second to Australian seagrass extent, globally. This extent translates into a carbon storage of 613,607,864 to 780,541,162 Mg, and a sequestration rate of 105 to 125 Mt CO<sub>2</sub> per year. This equals 58 to 69 times the CO<sub>2</sub> emissions of The Bahamas in 2018, potentially rendering a carbon-neutral state and underlining the importance of seagrasses for Bahamian climate agendas. We envisage that the synergy between our scalable Earth Observation framework and nation-specific in-situ observations can support spatially-explicit ecosystem service accounting, and effective uptake in relevant policy making and financial investments for seagrasses in and beyond The Bahamas.

*Keywords:* Seagrass, Blue Carbon, Bahamas, Ecosystem Accounting, Earth Observation

*18. Type of submission: Abstract*

B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems

Assessment of ecosystem services across the land–sea Interface: approach and applications along the German coast

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Ecosystem services (ES) assessment for terrestrial and marine ecosystems have largely been conducted separate from each other. However, to facilitate the use of ES assessments in nature and water policy (e.g. Biodiversity Strategy and Water Framework Directive (WFD)) joint approach across the land–sea interface are urgently needed.

To address this gap, we present a habitat typology for coastal and marine ecosystems, that complements existing spatial typology for land, such as the CORINE land cover types. For this, we built upon existing typologies like the water body types of the WFD and habitat types of the Habitats Directive. In an expert–based approach, the resulting typology was used to develop the first joint ES potential matrix for terrestrial, coastal and marine habitats for Northern Germany. Furthermore, we introduced a complementary indicator–based approach to assess ES flows, which is applied in selected case studies along the Baltic Sea coast. It enables a quantification of ES potentials and flows and ensures comparability among case study sites.

Being based on elements of EU policies, we demonstrate that the approaches are expandable and transferable and could be applied to support environmental policy implementation, especially to other EU Regional seas. This is exemplarily shown for the North Sea. Further, we discuss the practical relevance of the approaches, current limitations, and future research perspectives.

*Keywords:* mapping, capacity, actual use, practical applications

*19. Type of submission: Abstract*

B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems

Artificial light at night and vessel traffic: spread, measurements, assessments. Are mitigation policies needed?

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Artificial light at night emitted from anthropized areas and pollution generated by vessel traffic are the most significant and widespread effect of the human presence on the planet. Artificial light at night is visible thousands of kilometers away from satellites, while the negative effect made by vessels in moving spread physical and chemical pollutants that strike habitat and marine species. These two little discussed pollutants sources are closely linked to economic indicators such as the gross domestic product, and for these reasons they can well resume the anthropogenic pressures on marine and coastal areas. In European coastal zone, the blue growth, the long-term strategy to support sustainable growth in the marine and maritime sectors, will have to deal with negative externalities generated by these pollutant sources that could reduce the resilience, biodiversity and behavior of coastal species and habitats.

Using heatmaps, the authors propose a method to summarize the state of the pressure from vessel traffic and artificial light at night in the European coastal zones.

In conclusion the authors hypothesize the use of vessel traffic and ALAN as proxy indicators of anthropogenic introductions of energy into the seas. Moreover, thanks to new technologies (i.e. satellites or underwater observatories), it may be possible to apply a real time monitoring system to these proxy indicators.

*Keywords:* vessel traffic; artificial light at night; marine strategy, maritime spatial planning; land sea inter-actions



20. *Type of submission: Abstract*

B. Biome Working Group sessions: B1 – Plural values of marine and coastal ecosystem services towards sustainable spatial planning and an inclusive governance of marine and coastal systems

Can Seaweed Aquaculture Industry fit the Nature Based (& –Ecosystems Based )Solutions Discourse? Insights from GlobalSeaweedSTAR (2017–2021) Initiative

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The sustainable use of ocean resources is central to Sustainable Development Goal (SDG14) and targets that cover conserving coastal and marine ecosystems as well as increasing the economic benefits from their sustainable use. The conventional aquaculture sector has been often slammed for causing disruption of key ecosystems service in settings where regulations are not enforced properly or lack them. Noting the growing concern for sustainable coastal and marine ecosystems various global governance mechanisms like SDG14, Blue Economy, and the Ocean Decade (2021–2030), the UN Decade for Ecosystem Restoration (2021–2030) position the vision of applying scientific knowledge and evidence for sustainable ocean ecosystems and ‘transformative ocean science solutions, for creating resilient communities and evidence supporting policies reforms. In this setting, we situated a collaborative and multidisciplinary science and policy project: the GlobalSeaweedSTAR (2017–2021). With the objective to outline guiding sustainability–focused principles for the rapidly emerging multi–billion–dollar Seaweed Aquaculture Industry based on the appropriate acknowledgment of ecosystems services and tying with the concepts outlined in nature–based solutions frameworks, our investigation captured the key trends and patterns of sector’s growth for past 50 years, noting that it spreads > 50 % of total global marine production, supports =6 million small–scale farmers and stakeholders in global value chains, men and women, subsistence populations and communities in coastal zones of low– and middle–income countries. Based on our learning from several reviewed publications and four Policy Briefs (2021–2022) that directly and indirectly involved > 100 global seaweed experts regional and national partners in Asia and Africa and in Global North, we will present set of policy recommendations that can serve as a reference for the sector to start harmonizing ecological benefits and economic profitability, concerns of ecosystems and human health in tandem to make a case for Seaweed Aquaculture Industry as NBS and coastal protection intervention.

*Keywords:* Sustainable Development Goal (SDG14), Seaweeds, Aquaculture, ‘transformative ocean science solutions, resilient communities

