



BOOK OF ABSTRACT

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I. SESSION DESCRIPTION

ID: B1a

Advancing methods in marine ecosystem services quantification, mapping and modelling

	Title	Name	Organisation	E-mail
Host:	Dr.	Evangelia Drakou	University of Twente	e.drakou@utwente.nl
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Abstract:

Within the last decade methods to assess marine and coastal ecosystem services (MCES) are advancing, moving from simple land-based adaptations to innovative, fit-for-purpose methods. A plurality of methods exists, leading to a rich diversity of scientific outputs ranging, for instance, from maps of ecosystem capacity to supply MCES, to hydrodynamic models simulating biophysical process and ecological functions supporting MCES, or the production of indicator sets that allow for monitoring MCES status and change. At the same time, MCES assessments should inform a broad spectrum of applications by producing knowledge for specific and targeted policy problems at the local, national and international level. Throughout this plurality of approaches and end-uses of MCES assessments, severe knowledge and methodological gaps still exist, especially when it comes to specific MCES (e.g., cultural) or to specific parts of the MCES spectrum (e.g., quantification of MCES supply is much more developed in relation to their flow, demand and use). Lastly, large gaps emerge when it comes to the actual use of such knowledge to inform decision making.



In previous years within the marine biome group we explored the uptake of MCES information from policy and decision-making and made an overview of existing mapping, modelling and quantification methods. Taking stock from these sessions, this year we aim to build on this knowledge and work together with participants from all Marine Biome working group sessions towards developing an MCES quantification guide that will match multiple end-uses and policy needs to support diverse problem solving demands. We will focus on specific applications and end-uses of MCES assessments from national assessments to nation-wide marine spatial planning and marine protected area management. We will explore various MCES assessment methods related e.g., to scale, resolution, data inputs and assess whether these match specific problem scoping and policy demands. A focus will also be given on the methods of information delivery, highlighting tools and methods of disseminating information to managers and policy makers.

Participants are welcome to submit an abstract presenting their experience with using specific MCES assessment methods, as well as an assessment of the capacity of the applied methods to match specific decision-making needs. The session will have two parts: i) an introductory part with presentations by the participants and ii) a workshop-session in which participants will work in groups according to their different expertise towards co-developing the MCES methodological guidance. All the work and the group discussions will be facilitated by the hosts.

Goals and objectives of the session:

Within this session we aim to build on participants' experiences and carry out a workshop during which we expect to:

- Develop a repository of case studies focusing on marine and coastal ES assessments;
- Use this repository to develop a guide on how-to and what-to choose when it comes to assessing marine and coastal ES for specific policy demands, application domains, and at different scales;
- Identify marine and coastal ES research and methodological needs that can constitute the future work program for the MCES group.

Planned output / Deliverables:

We will explore the option of hosting a special issue in an ESP-related journal on advancing marine ES assessment methods.

Related to ESP Working Group/National Network:

[Biome working group: BWG 1 – Marine systems](#)



II. SESSION PROGRAM

Date of session: Thursday, 24 October 2019

Time of session: 10:30 – 15:00

Timetable speakers

Time	First name	Surname	Organization	Title of presentation
10:30–10:40	Evangelia	Drakou	University of Twente, Netherlands	Introduction to the Session
10:40–10:50	Ibon	Galparsoro	AZTI, Spain	Operationalizing ecosystem services in support of ecosystem-based marine spatial planning: needs and recommendations
10:50–11:00	Alberto	González-García	Autonomous University of Madrid, Spain	Mapping marine ecosystem services at national scale: A case study in the Spanish Natura 2000 sites
11:00–11:10	Giulia	Dapueto	University of Genoa, Italy	Environmental spatial decision support system (ESDSS) for ecosystem services' management of marine-coastal areas
11:10–11:20	Aurelija	Armoskaite	Latvian Institute of Aquatic Ecology, Latvia	Establishing the links between ecosystem components, functions, values and benefits: An assessment and communication support tool
11:20–11:40	Stephen	Kankam	Martin Luther University, Halle-Wittenberg, Germany	Implications of Spatio-temporal Land Use/Land cover Changes for Regulating and Provisioning Ecosystem Services in the Coastal Landscape of South-Western Ghana, West Africa
11:40–11:50	Anda	Ruskule	Ministry of Environmental Protection and	Mapping of marine green infrastructure to support maritime spatial planning in the Baltic Sea



Time	First name	Surname	Organization	Title of presentation
			Regional Development, Latvia	
11:50–12:00	Elianne	Omena	Ecology Brazil	Mapping benefits and services of marine biotopes from Jacuípe and Sergipe Alagoas Marine Basins at Northeast Brazil
13:30–13:40	Annelies	Boerema	University of Antwerp, Belgium	Qualitative, quantitative and spatial tools for applying ecosystem services in marine and coastal management: an overview from Belgium
13:40–13:50	Sonja	Wanke	Deltares, Netherlands	Addressing Ecosystem Services within Integrated Multi-Trophic Aquaculture (IMTA) Systems and Conventional Aquaculture Systems through Bayesian Networks
13:50–14:00	Charlène	Kermagoret	Ifremer, France	A state-and-transition model to explore the responses of ES bundles regarding marine eutrophication
13:50–14:00	Miguel	Inácio	Mykolas Romeris University, Lithuania	A framework to map and assess commercial fisheries supply and demand in the Lithuanian Exclusive Economic Zone (EEZ)
14:00–14:10	Barbara	Bauer	German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Germany	Scenario modelling of food web and fisheries in the Baltic Sea as a basis of quantifying future marine ecosystem services



Time	First name	Surname	Organization	Title of presentation
14:10–15:00		Drakou		
	Evangelia	Gissi		
	Elena Ana	Ruiz–Frau		Hands–on workshop on methods to map marine and coastal ecosystem services
	Alex Sonja	Ziemba		
	Tundi	Wanke		
	Agardy			

III. ABSTRACTS

The abstracts appear in alphabetic order based on the last name of the first author. The first author is the presenting author unless indicated otherwise.

1. Type of submission: **Abstract**

B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling

Establishing the links between ecosystem components, functions, values and benefits: An assessment and communication support tool

First author: Aurelija Armoskaite

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Albeit there are many sophisticated methods for conducting Ecosystem Service assessments they are rarely applied in practice and often lack transparency to be used in decision making in maritime spatial planning. Furthermore, many approaches focus on either the left or the right side of the cascade model, or on a particular ecosystem component or a service stopping short of establishing an integrated method required for effective ecosystem–based management.

Here we introduce a new method for assessing ecosystem service provisions using the cascade model and a revised CICES typology developed during the BONUS BASMATI project. The core



of the approach is an interactive weighted linkage diagram based on an expert opinion matrix evaluating the role of ecosystem components, functions and services in the provision of benefits to human wellbeing. The results of the assessment are presented in a Sankey diagram which shares its intrinsic structure with that of the cascade model as both organize information in groups in a hierarchical order in a flow from left to right.

By using expert judgement we were able to overcome the dilemma of 'urgency and uncertainty' and semi-quantitatively measure the relative importance of ecosystem components in provision of ecosystem services.

The method provides a means for looking at how ecosystem services are impacted by changes in ecosystem components meanwhile acknowledging their connectivity to the wider ecosystem. Further, it transparently links the left side of the cascade to the right, works as an environment for interdisciplinary communication, and reduces the risk of double counting in socio-economic valuation by indicating the chain of linkages and their magnitude. The interactive version of the diagram could be used for stakeholder engagement and to promote ocean literacy.

Keywords: Cascade framework, Linkage diagram, Maritime Spatial Planning, Interdisciplinary communication, Expert opinion matrix

2. *Type of submission: Abstract*

B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling



Scenario modelling of food web and fisheries in the Baltic Sea as a basis of quantifying future marine ecosystem services

First author: Barbara Bauer

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We developed numerical simulations of potential future ecological services provided by the Baltic Sea ecosystem at the end-of-century under five scenarios. We used a spatial food web (Ecospace) model, forced by a physical–biogeochemical model. The scenarios are built on consistent storylines that describe plausible developments of climatic and socio–economic factors in the Baltic Sea region. Modelled species diversity and fish catches are driven by climate– and nutrient load–related changes in habitat quality and by fisheries management strategies. Our results suggest that a scenario including low greenhouse gas concentrations and nutrient pollution and an ecologically focused fisheries management results in high biodiversity and catch value. On the other hand, scenarios envisioning increasing societal inequality or economic growth based on fossil fuels, high greenhouse gas emissions and high nutrient loads resulted in decreased habitat quality and diminished biodiversity. Under the latter scenarios catches are high but they predominantly consist of lower–valued fish.

Keywords: integrated modelling, Ecospace, fisheries, Representative Concentration Pathways (RCP), Shared Socioeconomic Pathways (SSP)

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

B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling



Qualitative, quantitative and spatial tools for applying ecosystem services in marine and coastal management: an overview from Belgium

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Marine and coastal ecosystems and the ecosystem services (ES) they deliver are subject to increasing pressures. A sustainable management requires a thorough understanding of their functioning, how humans depend on it and what kind of management measures can be taken.

In our research we address three decision-making questions to support the development of sustainable management. The first question is “what management is needed?”. Development of sustainable management should be oriented towards solving a mismatch between demand and supply of ES. We follow a two step approach: (i) define objectives for ES (= demand for ES), and (ii) investigate which ecosystem processes and functions (= supply of ES) are needed to realise this demand. The second question is “how to study and quantify management effects in a complex environment?”. We approach this question by investigating impact-effect pathways linking management interventions with ecosystem functioning (hydrology, morphology, ecology) and ecosystem services. This reveals how the impact of management on ES occurs through changes in habitats and ecosystem processes. Challenging aspects are the complexity of the functioning of ecosystems (e.g. dune dynamics, ecological succession) and the spatial context of management effects and ES. The third question is “what are the benefits of management for society?”. We use the cost-benefit analysis and cost-effectiveness analysis to compare between management alternatives and incorporate ES benefits.

This approach and the tools needed will be documented based on research in the Belgian coast and the Scheldt estuary.

Keywords: Effect evaluation, Ecosystem processes, Ecosystem dynamics, ES quantification, Spatial explicit tools



4. *Type of submission: Abstract*

B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling

Environmental spatial decision support system (esdss) for ecosystem services' management of marine-coastal areas

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In recent decades, increasing attention has been paid to the protection of marine-coastal environment and ecosystem services.

An Environmental Spatial Decision Support System (ESDSS) was developed for the management of marine-coastal areas' ecosystem services. This allows to quantify the physical and monetary value of natural capital stocks and ecosystem services flows originating from the natural capital.

The ESDSS was applied in different Italian marine protected areas in relation to the project concerning environmental accounting in marine protected areas financed by the Ministry of the Environment starting from 2014.

The ESDSS procedure involves the evaluation of: 1) natural capital, 2) human pressure on natural capital, 3) ecosystem services (environmental benefits and costs), 4) spatial constraints within ecosystem services can be enjoyed, 5) economic costs and benefits associated with the use of the ecosystem services, 6) system environmental and economic budgeting. The ESDSS's outputs (numerical results, spatial maps) allow improving the management and overall understanding of the state of the marine protected areas and its environment. In particular, maps allow to identify and characterize areas, also in relation to synergies and trade-offs between ecosystem services.

The ESDSS can be used as tool to evaluate sustainability level at different spatial and temporal scale obtaining sustainability detailed maps.



For the ESDSS development a computerization and data management system is cardinal. Specifically, it is fundamental for collection, storing and processing alphanumeric and spatial data and for results visualization.

Thanks to the implementation of management and forecasting models the ESDSS allow the marine protected areas managers to update the data (e.g. for monitoring the natural capital value over time) and to perform simulations.

The procedure is easily and quickly iterable and as generalized as possible to be adaptable and applicable to different areas.

Keywords: Natural capital, Ecosystem service cascade, Marine protected areas, Sustainability level, Spatial analysis



5. *Type of submission: Abstract*

B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling

Operationalizing ecosystem services in support of ecosystem-based marine spatial planning: needs and recommendations

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The integration of ecosystem services framework into Marine Spatial Planning shows great potential to ensure the sustainability of marine ecosystems and the services they provide. The need of operational approaches that integrate ecosystem services into management and decision making has already been raised frequently. The adoption of such approach, requires the integration of information on relevant ecosystem components and their environmental status and detailed information of the distribution of human activities to derive a better understanding of ESs flow, analysis of pressures and impacts that human activities exert to Natural Capital, and the potential effects on the delivery of ESs. Although the integration of ES assessment in MSP has shown opportunities there is still a big lack of basic knowledge concepts to operationalization of this concept.

The present contribution analyses the critical needs for operationalizing ecosystem services in support of ecosystem-based marine spatial planning. Outputs are derived from the contributing authors at the European Ecosystem Services Partnership (EU-ESP) Conference 2018 held in San Sebastian (Spain) to a dedicated session entitled "Operationalizing ecosystem services in support of ecosystem-based marine spatial planning". This contribution will review the current status of ESs application in MSP processes according to a framework including integration phases and common concepts. Strengths, weaknesses, potential links and pathways will be identified, and recommendations and future needs will be presented.

Keywords: Management, human activities, coastal and marine ecosystem services, critical needs, recommendations



6. *Type of submission: Abstract*

B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling

Mapping marine ecosystem services at national scale: A case study in the Spanish Natura 2000 sites

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Mapping methods applied to marine ecosystem have become an important challenge to enhance the knowledge about ecosystems services. Specially, there is a lack of knowledge in the ecosystem services provided by marine and coastal natural protected areas. In this study, we mapped three different marine ecosystem services in Natura 2000 protected areas at national scale using InVEST: Fisheries production (provisioning ES), blue carbon sequestration (regulation ES) and recreation (cultural ES). We quantified and mapped the fisheries production of five representative species (*Merluccius merluccius*, *Engraulis encrasicolus*, *Thunnus thynnus*, *Micromesistius poutassou* and *Sardina pilchardus*), the carbon sequestration by marine phanerogams species (*Posidonia oceanica*, *Cymodocea nodosa*, *Zostera noltii*, *Ruppia cirrhosa*, *Halophila decipiens*), and the recreation by using the photos shared in Flickr and assessing different spatial and temporal dynamics. Then, we developed three future scenarios of the Spanish Marine Natura 2000 (Business as usual, Sustainable scenario and Non sustainable scenario) and analysed the potential future trend and its associated value in supplying these ecosystem services. Our results show that the management of protected areas are an essential component on the supply of these ecosystem services. Additionally, we provide some insights related to methodological challenges for mapping marine and coastal ecosystem services using InVEST model at national scale.

Keywords: InVEST; Marine protected areas; Coastal blue carbon, fishing, recreation



7. *Type of submission: Abstract*

B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling

A framework to map and assess commercial fisheries supply and demand in the Lithuanian Exclusive Economic Zone (EEZ)

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Commercial fisheries are one of the most important and valued ecosystem services (ES) worldwide, due to its importance in contributing to food security and human wellbeing. Nevertheless, the lack of spatial explicit information on commercial fish species distribution and catches, makes the task of map this service extremely challenging. In the Baltic Sea, fish catches are spatially represented either by The Food and Agriculture Organization (FAO) or International Council for the Exploration of the Sea (ICES) statistical squares, 40400 and 3451 km² respectively. In Lithuania, these squares occupied almost the entire Exclusive Economic Zone (EEZ) area (~ 4560 km²), and the resolution is very coarse for mapping. However, in the Baltic Sea, the Baltic Marine Environment Protection Commission – Helsinki Commission (HELCOM) collects data related to different fishing indicators, some with a good spatial resolution. The aim of the study is to map and assess the supply and demand of commercial fisheries, ES based on available spatial indicators (proxies) from national and HELCOM sources for the Lithuanian EEZ. Commercial fisheries supply was mapped and assessed using an index, which combines data from biological elements of three commercial fish species (cod, herring and eelpout), and the habitat and species distribution. To map and assess the commercial fisheries demand an index was created, which compiles information about fishing intensity on the surface, mid water and bottom, for different fishing gear types as well as extraction of commercial species. With supply and demand maps we identified the mismatches between them. The practical approach to map the supply and demand of commercial fisheries in Lithuania based on existing data, besides the possibility to be transferred to other areas of the Baltic Sea, contributes to better understand spatial contribution of coastal and marine ecosystems to human wellbeing.

Keywords: Baltic Sea, HELCOM, ecosystem services, fishing intensity, LINESAM



8. *Type of submission: Abstract*

B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling

Implications of Spatio-temporal Land Use/Land cover Changes for Regulating and Provisioning Ecosystem Services in the Coastal Landscape of South-Western Ghana, West Africa

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Coastal landscapes in South-Western Ghana face land use threats driven by oil and gas infrastructure development, agriculture expansion and artisanal mining. An assessment of two decades of land use pressures on the landscapes' capacities to supply ecosystem services was conducted using remote sensing and benefit transfer approaches. Indicators for regionally relevant provisioning and regulating ecosystem services supplied by the landscape were selected from existing literature. Using the Africover classification scheme, land cover data spanning approximately a decade before and after the commercial production of oil and gas were used to generate typical land cover classes for a representative coastal landscape. The capacities of the coastal landscapes to supply food, fish, fuelwood and sequester greenhouse gases were quantified. Results of the assessment indicate a trend towards agricultural (food and perennial tree crop) expansion with concomitant increase in the coastal landscapes' capacity to supply provisioning services over the period. However, coastal land use patterns are observed to have a net negative impact on regulating ecosystem services, such as carbon storage.

Keywords: coastal landscapes, spatio-temporal, land use/landcover, benefits transfer, ecosystem services



9. *Type of submission: Abstract*

B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling

A state-and-transition model to explore the responses of ES bundles regarding marine eutrophication

First author: Charlène Kermagoret

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Initiated in the French national ES assessment program (EFESE program), we analysed the ES bundles supplied by three coastal ecosystems (coastal lagoons, coral reefs and sandy beaches) along a gradient of eutrophication. To do that, we used a state-and-transition model. Eutrophication and management measures (e.g. nutrient flow, ecological restoration) have been seen as drivers determining the ecosystem state, i.e. specific biodiversity and functioning, at a particular time and place. The first step aimed to characterize the ecosystem dynamics under eutrophication in order to identify alternative states. For each state, ES bundles supplied have been identified. The second step aimed to describe and, if possible, to quantify ecosystem responses to eutrophication levels. Each step involved a literature review regarding ecosystem responses to eutrophication that have been supplemented with expert-knowledge.

Changes along the eutrophication gradient are essentially a shrinking of ES bundles. Indeed, for all ecosystems, nearly all ES decrease, nutrients and pathogen regulation/sequestration or the support of recreational and leisure activities being especially impacted. However, few exceptions are highlighted and explained.

The use of state-and-transition models to explore the dynamics of ecosystems and ES is slightly growing, but its application to marine and coastal ecosystems remained almost non-existent. The lessons learned from this exploratory application are multiple. Despite few obstacles to their full use, state-and-transition models can be a very powerful framework to work in an interdisciplinary perspective taking into account all functions and services delivered by the ecosystem and avoiding the conclusions focused on single service. It is also relevant to



take into account the temporal dynamics of ES which are too often ignored. Otherwise, it could help identify knowledge and data gaps. The most difficult and challenging step for experts involved in state-and-transition models is to quantify each ES based on qualitative and heterogeneous quantitative data.

Keywords: State-and-transition models, ES supply, Coastal lagoons, Coral reefs, Sandy beaches

10. Type of submission: **Abstract**

B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling

Mapping benefits and services of marine biotopes from Jacuípe and Sergipe Alagoas Marine Basins at Northeast Brazil

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Strategic planning of public policies is a requirement to develop Oil & Gas (O&G) offshore industrial activities in Brazil. Sergipe–Alagoas and Jacuípe (SEAL–J) basins are important areas of O&G offshore exploration and production in Northeastern Brazil. One of the objectives of this study is to map and assess marine ecosystem services and to promote the recognition of their economic value to help decision-making processes related to the concession of exploratory blocks and the respective environmental licensing.

Nine marine biotopes considering 12 ecosystem services, over 3034 km of northeastern Brazilian coast have been analyzed. Goods and services provided by each biotope were classified according to the European Nature Information System (UNIS, 2002) considering three major evaluation classes (High, Low, Negligible / Irrelevant / Unknown). Mangroves were the most valuable biotope, as it covers an extension of 34 % of the coastal and it has the highest number of good and services (n=11), like: food production, water quality regulation and bioremediation. With an extension of 26 % and a lower number of services (N=4), sandy beaches have an important role on conservation as they are the main breeding site of



endangered of marine turtles species along the coast. Although coral reefs cover a lower extension (12 %), it provides a high number of services (n=10), which in turns promotes high fish production and intense tourism activities. It should be noted the importance of carbonate and muddy infralittoral biotopes in the oligotrophic shelf of study area. The first one is highly biodiversity and the other contributes with food provision, especially shrimp fishing grounds, which supports many fishing communities. These preliminary results pointed out to the importance in account marine ecosystems services to support diverse problem solving demands, especially to reduce gaps of information in decision-making process regarding O&G offshore industrial activities.

Keywords: marine ecosystems services, public policies, assessment

11. Type of submission: Abstract

[B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling](#)

Mapping of marine green infrastructure to support maritime spatial planning in the Baltic Sea

First author: Anda Ruskule

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Green Infrastructure (GI) is an emerging concept helping to mainstream ecological considerations and ecosystem service quantification and mapping results into spatial planning. The EU Strategy on GI defines it as “strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services”. Thus, the emphasis of the GI concept is on multifunctionality of ecosystems in providing benefits both for humans and for nature. The strategy also highlights that GI incorporates terrestrial (including coastal) and marine areas. Although the concept is well established in terrestrial areas, its application in maritime environment is a novelty.



The Pan Baltic Scope project has taken a challenge to develop a concept for marine GI applicable in maritime spatial planning (MSP) and to test it at the Baltic Sea scale. The proposed methodology includes: i) mapping of the areas of high ecological value and ii) mapping potential supply of ecosystem services, by using spatial data sets marine on ecosystem component available from the HELCOM Maps and Data services. First more than 30 ecosystem components were assessed in relation to six ecological value criteria and ten ecosystem service classes (CICES v.5.1). The assessment results were used to produce aggregated maps on ecological value and ecosystem service supply potential. A hierarchical data aggregation method was applied to avoid domination in the results features that were represented by many data layers. Finally, the marine GI map was produced combining results of the ecological value and ecosystem service mapping.

GI mapping can enhance ecosystem-based approach in MSP by improving the knowledge base on marine ecosystem functioning as well as support development and cross-border co-ordination of spatial planning solutions.

The Pan Baltic Scope project is supported by the European Maritime and Fisheries Fund of the European Union.

Keywords: green infrastructure, maritime ecosystem services, maritime spatial planning, Baltic Sea



12. Type of submission: **Abstract**

B. Biome Working Group sessions: B1a Advancing methods in marine ecosystem services quantification, mapping and modeling

Addressing Ecosystem Services within Integrated Multi-Trophic Aquaculture (IMTA) Systems and Conventional Aquaculture Systems through Bayesian Networks

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In recent years, the Integrated Multi-Trophic Aquaculture (IMTA) approach has gained more attention as a promising solution for the sustainable development of aquaculture around the globe. The EU funded project IMPAQT looks at the design, development, and validation of tools to enable an IMTA framework for inland, coastal and offshore production systems. A selection of the IMTA tools focuses on the use of Ecosystem Services in portraying the diversity, benefits, and impacts of multi-trophic aquaculture. IMTA systems can provide valuable ecosystem services such as provisioning of aquaculture products, purification of water, or oxygen production when managed correctly. In order to understand and analyse the effects of ecosystem services of an IMTA as well as the benefits compared to standard aquaculture systems, a Bayesian Network was developed. These statistical models function on the basis of causal dependencies between system elements of interest. The developed network includes various ecosystem services relevant for IMTA and compares them to the portfolio and composition of ecosystem services provided by standard aquaculture systems. The results from such a comparative assessment for a North Sea case study will be presented and the benefits and drawbacks of such an implemented system discussed.

Keywords: Integrated Multi-Trophic Aquaculture (IMTA), Bayesian Network analysis, ecosystem services assessment, IMPAQT