Work Package 4: Socio-ecological management framework for MPAs and MSP integration

Deliverable 4.3: Trade-offs method for protection and restoration in MSP – ESE3

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	MSP4BIO project, aiming to improve the management of marine spaces and safeguard ecosystem services. The outcomes of this deliverable provide detailed Guidelines for applying trade-off methodology for MPA design. These scenarios aim to assess and negotiate the consequences of diverse actions and strategies regarding the spatial and strategic management of marine areas. The key element is comprehending how various human activities influence and are influenced by the ecosystem's services and exploring potential ways for negotiating solutions. The outcomes, particularly the trade-off scenarios, will be integrated into practical tools and frameworks, aiding decision-making processes related to marine resource management. This method was designed by the MSP4BIO team members and experts and developed collaboratively with stakeholders to understand the perspectives linked to protected marine areas and potential trade-offs in which specific actions may positively or negatively impact ecosystems and human well-being. It was tested by the different test sites of the MSP4BIO project, and the outcomes will be integrated into the ESE 3, more specifically by the Task 4.4 MPAs and MSP Ecological-Socio-Economic integrated management.
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HISTORY OF CHANGES		
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1.0	31/03/2024	Initial version.
2.0	31/08/2024	Missing changes: ESE4 to ESE3 (page 74). Corrections: Ecological Toolkit renamed from D3.5 to D3.4 (page 74). Hyperlinks were removed in order to make the Deliverable public. Annex 8 was deleted from the deliverable to be GDPR-compliant. Romanian test site part added from page 49.

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Acronyms

ACCOBAMS:	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area
BPNS:	Belgian part of the North Sea
CC:	Climate Change
CICES:	Common International Classification of Ecosystem Services
CoP:	Community of Practice
DAPSIR:	Drivers-Activities-Pressures-State-Impacts-Responses
DST:	Decision-Support Tools
ES:	Ecosystem Services
ESE:	Ecological-Socio-Economic
EU:	European Union
GIS:	Geographic Information System
HELCOM:	Helsinki Commission for the Marine Environmental Protection of the Baltic Sea
IMMAs:	Important Marine Mammal Areas
IUCN:	International Union for Conservation of Nature
JRC:	Joint Research Centre
MCA:	Multi-Criteria Analysis
MPA:	Marine Protected Area
MSP:	Maritime Spatial Planning
NGO:	Non-Governmental Organization
OECM:	Other effective area-based conservation measures
PSSA:	Particularly Sensitive Sea Areas
SPA:	Strictly Protected Area
SWOT:	Strengths-Weaknesses-Opportunities-Threats
UAc:	Universidade dos Açores
UNESCO	United Nations Educational, Scientific and Cultural Organization
NW-Med	North-Western Mediterranean
WP:	Work Package
WWF:	World Wildlife Funds

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Executive Summary

This report presents the participatory development of integrated trade-off scenarios within the MSP4BIO project, aiming to improve the management of marine spaces and safeguard ecosystem services.

The outcomes of this deliverable provide detailed Guidelines for applying trade-off methodology for MPA design. The developed scenarios aim to assess and negotiate the consequences of diverse actions and strategies regarding the spatial and strategic management of marine areas. The key element is understanding how various human activities influence and are influenced by the ecosystem services and exploring potential ways for negotiating solutions. The outcomes, particularly the generated trade-off scenarios, will be integrated into practical tools and frameworks, suporting decision-making processes related to marine resource management.

This method was designed by the MSP4BIO team members/experts and developed collaboratively with stakeholders to understand the perspectives linked to protected marine areas and potential trade-offs in which specific actions may positively or negatively impact ecosystems and human well-being.

It was tested by the different test sites involved in the MSP4BIO project, and the outcomes will be integrated into the ESE 3, more specifically by the Task 4.4 "*MPAs and MSP Ecological-Socio-Economic integrated management*".

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1. Introduction

MSP is an integrative approach designed to manage the growing requirements for maritime areas, encompassing both established and emerging industries while ensuring the sustainable operation of marine ecosystems. A fundamental aspect of MSP is its functionality, which involves incorporating diverse sectors, societal requirements, values, and objectives into the planning process (The European Maritime Spatial Planning Platform, n.d.). Therefore, the goal of MSP is to achieve a more sustainable and integrated approach to managing marine resources and space, considering the long-term well-being of societies and marine ecosystems.

The MSP4BIO project main goal is to develop an integrated and modular Ecological-Socio-Economic (ESE) management framework for protecting and restoring marine ecosystems within its more general objectives of promoting sustainable blue growth and integrating maritime policies. As part of task 4.3, **Guidelines for applying trade-off methodology for MPA design** (ESE3) for the “participatory-based trade-off scenarios” were developed, aiming to enhance the management of marine spaces and preserve ecosystem services (ES) through the use of scenarios. The purpose of these trade-off scenarios is to help evaluate and negotiate the impacts of various actions and strategies related to the spatial and strategic management of marine areas. The primary focus is understanding how different human activities affect and are affected by the services provided by ecosystems and possible paths to negotiate solutions. Furthermore, these guidelines aim to support the effective implementation of the "participatory-based trade-off scenarios" to support the work of local practitioners. The method has been discussed with stakeholders and tested in project pilot areas. The method was designed by the project team members, who act as experts in their scientific fields, and the active collaboration of local stakeholders. A unique aspect of the developed method is the **inclusion of participatory mapping**, which involves engaging practitioners, communities and stakeholders in the mapping process of foreseen solutions. The goal is to capture diverse perspectives on the values associated with protected marine areas and identify potential trade-offs—where certain actions may positively or negatively impact ecosystems and human well-being. The deliverable emphasises the importance of considering uncertainties and adapting actions taking into account social dynamics, economic considerations, and ecological conditions.

The present document serves as a culmination of discussions among stakeholders, incorporating insights and lessons learnt, from the outcomes of applying the guidelines to real-world scenarios. Such comprehensive approach ensures that the method is theoretically sound, practically viable, and adaptable across diverse marine environments, enhancing its utility for MSP and ES management.

The outcomes of this deliverable, particularly the trade-off scenarios method, will be used for the development of ESE management framework (Task 4.4). Furthermore, these will be used for the development of practical visualisation tools (Task 7.4) that

can help provide online visualisation of potential scenarios and inform decision-making processes related to marine resource management. The entire effort aligns with the larger goals of the MSP4BIO project, which seeks to develop sustainable and inclusive approaches to managing marine areas and protecting biodiversity.

Grant Agreement *Corrigendum*

While developing this Deliverable, it was noticed that part of Task 4.3 still contained a residue from the initial version of the project proposal: "The climate change vulnerabilities criteria and maps (produced in T3.2) will be included in the trade-off scenarios to make them climate-proof and resilient in supporting biodiversity conservation and environmental protection under multiple climate change projections". This part is not mentioned in the description of T3.2. This mismatch occurred because in the starting version of the proposal it was agreed that WP2 would have provided data to WP3 and WP4 to produce scenarios and maps. However, after WP2 clarified that their work would have been focused on data repositories and data sets rather than providing single test site data, the project proposal was re-formulated, and the main objective of T3.2 became the production of a step-by-step theoretical guideline to include Climate Change (CC) scenarios into spatial conservation plans. In the final project proposal, it was clearly stated that once completed, the guideline (D3.3) would have been included into the ecological toolkit (ESE1) and tested in test sites by WP5, using the data collected by each test site. Therefore, the production of data and maps related to CC scenarios were removed from WP2 and WP3 tasks' descriptions and objectives, and they should have been removed also in WP4 but accidentally were not. In the same line, described in the Grant Agreement was "using the set of tools made available by the toolkit in D3.5." After the modification process, there is no Deliverable D3.5 instead the content was reallocated to Deliverable D3.4 Ecological toolkit (ESE 1) for MPAs prioritisation and networking. Since D3.4 and the present deliverable are both due in month 20, it was not possible to incorporate all the results. Instead, the content will be integrated into the ESE.

Still, aiming to promote discussion during trade-offs (one of its goals), a question on "Change/Climate Change Perception" from CoP members was introduced in the exercise. Test site leading partners were advised to seek a vision of what is perceived as future changes by their CoP members, thus informing discussion and supporting decisions. While this is not precisely scientifically or methodologically sound, it is reasonable to accept that CoP's composition acts similar to a Pool of Experts. For the purpose of this exercise, that was found acceptable, and the exploration of this point was performed.

However, in the context of MSP4BIO final outcomes and the ESE model, the results of D3.3 must be used. Also, in order to make an effort to provide a standalone integrated trade-off methodology in this deliverable, a table with suggestions for further exploration of this theme is presented in Annex 6.

It should be noted that one of the objectives of Task 4.2. (Strategic and spatial measures for blue economy sectors) was not completely accomplished as it was

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supposed to integrate feedback from Task 4.3. Task 4.2 was completed in January 2024, and Task 4.3 in March 2024, making integration impossible due to time elapse. The trade-offs that would come from 4.3 are now presented in this deliverable and will further be included in ESE3 (by Task 4.4).

Finally, at the III MSP4BIO General Assembly held on 6-7 November in Split, a decision was made to integrate both Deliverables 4.2 “Guideline for the strategic and spatial measures for the nature-inclusive operation of blue economy sectors” and present Deliverable 4.3 into ESE 3 and therefore that the ESE Framework would consist of three instead of originally planned four modules. Therefore, Deliverable 4.3 represents ESE3 instead of ESE 4 (as per Grant Agreement).

1.1 Deliverable Methodological Flow

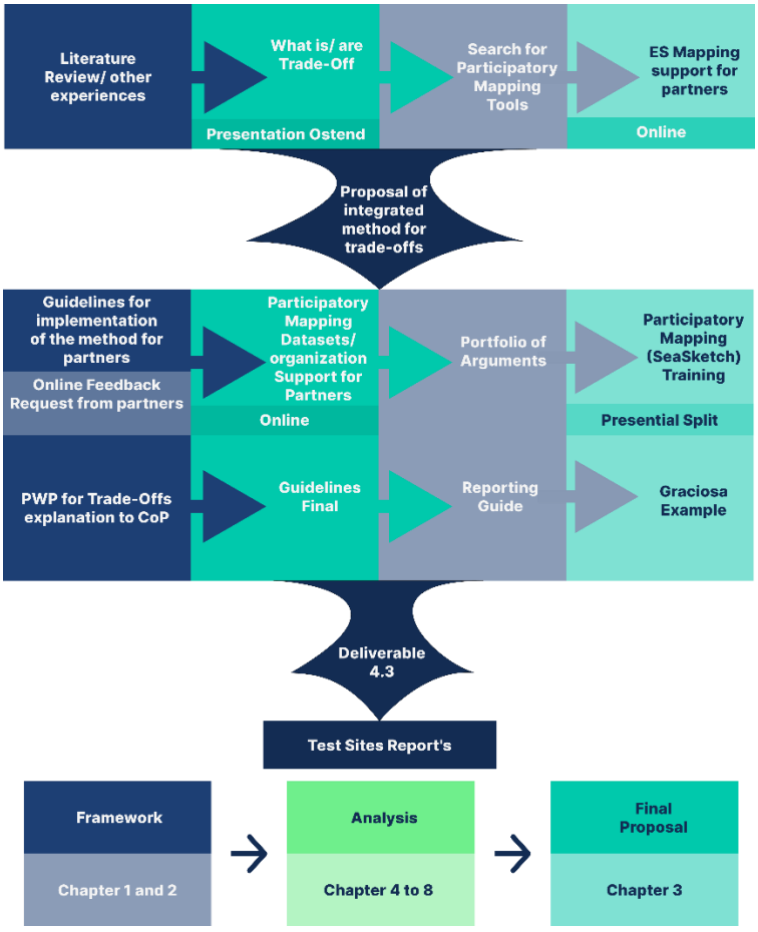

Figure 1: Methodological flow of D.4.3

The production of the present Deliverable started in the initial stages of the MSP4BIO Project, with a literature review on the subject of trade-offs (Figure 1). As the theme is almost unpublished for MSP, a wider search was performed. Also, some other experiences either on MPAs, or MSP, have been collected to propose the production

of all the materials. At first, there was the need to agree upon basic concepts such as: what are trade-offs and what types of trade-offs exist. This discussion was launched in the General Assembly (GA) in Ostend, with a presentation from the UAc Team. Inputs on these materials remained open online until compilation of the integrated step-by-step methodology and corresponding Guidelines for Partners were produced. Two supporting actions for pre-preparation of the exercise in test sites were developed: a search for participatory mapping tools options; and direct online support to partners on methods to map ES.

The draft Guidelines for Partners were made available online, to collect feedback from partners, until the GA in Split. Before that GA, direct support to partners (via Zoom) was also provided on the organisation of information and datasets for participatory mapping. Also, a Portfolio of Arguments to be used in the negotiation of trade-offs was produced, containing an organized list of reasons/motifs/arguments to support decisions. During Split GA a two-day training session for partners on the use of SeaSketch to negotiate trade-offs was provided to all test site leaders or/and other partners who expressed their willingness to participate in the training.

Along with the Portfolio of Arguments (Annex 2), a set of documents was provided to test site lead partners to support their trade-offs exercise: a presentation about trade-offs; the final Guidelines (Annex 1) (after integrating inputs and the discussion results); a reporting guide for providing feedback on the exercise (Annex 3); and examples from the Graciosa test site (Annex 4).

With the collection of all these materials, and the test site reports, the framework of the Deliverable was set; an analysis of the test site exercises performed; leading to a tailored and finetuned Proposal for Trade-offs method. In sum, this Deliverable has accomplished a mixed method exploration of Trade-Offs for MPAs by clarifying concepts, producing a theoretical framework, obtain expert insights, testing in practice, conduct the analysis, and proposal.

1.2 Communities of Practice testing

The effectiveness of the Guidelines for applying trade-off methodology for MPA design was thoroughly examined across project test sites during the interaction of Communities of Practice (CoP) (Task 5.3). The testing was performed in Cadiz Bay, Azores, North-Western Mediterranean, Baltic Sea, Black Sea, and North Sea.

Activities in Cadiz Bay pilot aim to address conflicts within the nominal Marine Protected Area (MPA) of the Bay of Cádiz. Despite strategic objectives, the MPA lacked effective implementation, leading to challenges in achieving consensus on solutions among stakeholders from various sectors. Trade-offs, such as those between marine conservation and economic development, highlighted the need for a robust governance framework. The workshop organised as part of the pilot activities emphasized the importance of examining past initiatives, enhancing surveillance, and starting with simpler issues. SeaSketch, a participatory mapping tool demonstrated during the workshop, has proved useful in the context of the growing blue economy

but faced challenges in small MPAs. The overall experience underscored the vital role of effective governance and strategic planning for successful Marine Spatial Planning in the region.

Pilot case in the Azores involved representatives from various sectors aiming to support the creation of a new protected area. Utilizing the SeaSketch tool, participants identified conflicts, potential uses, and perceptions related to climate change. Trade-offs were discussed, including conflicts between marine conservation and economic development, highlighting the importance of integrating new members into the CoP and the need for more resources for effective participatory mapping in the growing blue economy.

The Belgian test site has two objectives: proposing a marine reserve in the Belgian part of the North Sea and addressing trade-offs and considerations for pelagic biodiversity protection. The workshop successfully facilitated discussions on trade-offs, ecological protection, and coastal management. Challenges included tool applicability as this partner also has other tools available, (as reference on Annex 5) and potential stakeholder fatigue. Nevertheless, the workshop provided valuable insights and highlighted the importance of addressing uncertainties.

The Western Mediterranean test site concentrated on marine mammal conservation, aiming to extend the Strictly Protected Areas (SPAs) network. The workshop used various environmental features and ecosystem service layers, identifying challenges related to large cetacean species, maritime traffic, and collision risks. Recommendations included relying on existing initiatives, developing criteria for SPA design, and recognizing the complexity of marine mammal protection.

In the Black Sea pilot, the CoP workshops explored conflicts and potential uses in the Bulgarian test site, focusing on extended MPAs and offshore wind farm development. Trade-offs involving marine conservation, economic development, and ecological integrity were discussed. Challenges included defining clear trade-off arguments. Recommendations emphasized the need for integrated MSP, improved planning measures, and transnational/cross-border MSP.

In the Baltic Sea test site, the CoP workshops focused on identifying and analysing conflict areas for expanding MPAs in Gdansk Bay, Poland. Participatory mapping highlighted conflict areas, with tourism expansion posing challenges. Insights underscored the importance of data availability, stakeholder knowledge, and leveraging existing research for informed decision-making. Challenges included the lack of tourism impact data, suggesting a need for further research.

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2. Trade-off methodology

2.1 What is a Trade-off?

Within the realm of MSP, a trade-off entails navigating compromises or exchanges among disparate objectives, interests, or applications of marine resources and space. The decision-making process hinges on evaluating the potential benefits and costs associated with various uses or management options, considering ecological, social, and economic factors. Deliberate consideration and balance of these diverse factors and interests are imperative in addressing trade-offs in MSP.

Effective management of trade-offs involves stakeholder engagement, scientific analysis, and the utilisation of decision-support tools (DST) to pinpoint optimal solutions that minimise negative impacts while maximising overall benefits. Trade-offs manifest in close association with specific goals, interests, and activities. Various types of trade-offs can be categorised as follows:

1. **Trade-off between conservation and economic development objectives**: MSP necessitates a delicate equilibrium between safeguarding marine ecosystems and supporting economic activities such as fishing, shipping, and tourism. For instance, the designation of MPAs can restrict opportunities for fishing and tourism, affecting the monetary revenue generated from these activities.
2. **Trade-off between short-term and long-term benefits**: MSP must balance the immediate gains of specific activities and the long-term benefits of preserving marine ecosystems. For instance, permitting oil and gas exploration and drilling may offer short-term economic benefits but could produce irreversible impacts the environment and marine life.
3. **Trade-off between exclusive uses and shared uses:** Decision-making on allocating marine space may involve trade-offs between exclusive use for a specific activity or multiple shared uses. This requires considering diverse stakeholder interests and balancing activities like fishing,, recreational zones, shipping lanes and conservation activities.
4. **Trade-off between specific stakeholder interests**: Divergent priorities and objectives among stakeholders, including commercial fishermen, local communities, conservation organisations, researchers, maritime tour operators, and non-governmental organisations, necessitate trade-offs to accommodate varied perspectives.
5. **Trade-offs between local and regional interests**: While MSP can benefit local communities through economic development and job creation, it must also account for the impact of human activities on the global ocean ecosystem.

Overfishing in one region, for example, can detrimentally affect fish populations in other areas.

These trade-offs are context-specific and contingent on the unique circumstances of each MPA and/or MSP process. Identifying and managing these trade-offs is pivotal for achieving a balanced and sustainable approach to marine resource management.

2.2 Uncertainty in planning

Uncertainties in planning can be defined as "the situation in which there is not a unique and complete understanding of the system to be managed" (Brugnach et al., 2008). The great challenge of these uncertainties is that they will affect the anticipation and control of the future, two fundamental functions of spatial planning (Carneiro, 2013). Analysing these uncertainties is, therefore, essential to do spatial planning (Ansong et al., 2017).

Three kinds of uncertainty can be distinguished: incomplete knowledge, unpredictability, and ambiguity. **Incomplete knowledge** is related to the lack of available, accessible, and quality data. This point in the context of MSP4BIO was addressed in WP2 Scoping and Gap Analysis and is explored in detail in Deliverable 2.1 (Whatley et al., 2023). **Unpredictability** arises when the system being managed is complex, dynamic, and has non-linear behaviour. In MSP4BIO, this particular type of uncertainty is contained in the tasks of WP3 Systemic approach to biodiversity consideration (Deliverable 3.3 (Cambra et al., 2024) and Deliverable 3.4 (TBD)), as well as WP4 (Deliverable 4.1 (Pegorelli et al., 2023) and 4.3 (present report)). Finally, **ambiguity** is defined by the presence of multiple knowledge frames or different but (equally) sensible interpretations of the same phenomenon, problem, or situation (Ounanian et al., 2018). Ambiguity is often led by vague legal /policy formulation (Kirkfeldt et al., 2022), and MSP4BIO also addresses biodiversity policy framework in the EU context.

In particular, in maritime spatial planning, several uncertainties can be identified. As with spatial planning in general, the **definition of sustainability** is not always clear because, as highlighted by Magalhães et al. (2019), "the inclusion of sustainability factors in any process demands a complete understanding of the complexities of the scenario analysed." Options for "weak" sustainability (Frazão, 2016) are also prone to accentuate ambiguity and, thus, stress uncertainty.

Then, the marine system is a natural-economic-social system where all the components are interlinked, **which complicates the understanding of this system** (Carneiro, 2013). Indeed, in addition to the lack of or incomplete data about the marine ecosystem, the link between all the components (ecological-economic-social) of the marine system is hard to define and understand. Uncertainties about marine systems lead to a poor understanding of the causes and mechanisms of these systems and, consequently, to a poor definition of the objectives and measures required for

planning. Furthermore, the social and political uncertainties are also challenging to anticipate (Ounanian et al., 2018).

Ansong et al. (2017) highlighted that **climate change is the main uncertainty in MSP**. Indeed, the impact of climate change "might affect the dynamics of the ecosystem or any other unexpected constraints that can hinder the proper functioning of the ecosystem or the implementation of planning measures" (Ansong et al., 2017). In MSP4BIO, this particular type of uncertainty was tackled in Deliverable 3.3 Guidance for building climate change scenarios for protection strategies (Cambra et al., 2024) and in Annex 6 in this document.

Carneiro (2013), identifies the **shifting baseline syndrome + time MSP.** There he states that even if the uncertainties are inherent to complex socio-ecological systems (Ounanian et al., 2018), recognising and minimising them enables MSP to be performed more effectively. Understanding uncertainties enables us to predict the future and take precautions in spatial planning (Carneiro, 2013). Therefore, dealing with the past allows you to learn from mistakes and thus minimise uncertainties (Lester et al., 2013).

In conclusion, to address uncertainty in MSP (and the integration with MPAs), some key elements are required and must be integrated in the ESE model on Task 4.4 MPAs and MSP Ecological-Socio-Economic (ESE) integrated management framework:

- Invest in **Knowledge Expansion** and filling info/data gaps;
- **Expand Comprehension** of Socio-Ecological Systems in their individual complexity, interlinkages and processes;
- Define **clear integrative and adaptive management** strategies;
- Opt for "**Strong" Sustainability Policies**;
- Understand **past Changes, set future trends, and introduce Climate Change and its impacts on marine environments and Socio-Ecological** Systems.

2.3 Participatory Mapping

Technological advances, including those related to mapping, have progressed further in terrestrial regions than marine ones. Combining spatial data collected through participatory mapping methods with ecological data is valuable for understanding the marine environment (Seijo et al., 2021). This approach enables the identification of priority management areas, facilitates the assessment of the alignment of mapped values with planning proposals, and provides tangible evidence of conflicts among specific stakeholder groups (Seijo et al., 2021).

Participatory mapping is pivotal in MSP, particularly Marine Protected Areas (MPA), because it fosters robust stakeholder engagement (Seijo et al., 2021). This inclusive approach empowers local communities and stakeholders to actively share their insights, values, and preferences, enriching the planning and management processes (Loerzel et al., 2017). Through collaborative map-based exercises, participants can

pinpoint areas of high ecological or cultural significance, identify potential conflicts, and collectively envision sustainable solutions. These mapped insights provide the foundation for constructing scenarios reflecting various trade-offs and synergies among land uses and marine activities. The engagement of stakeholders not only enhances the effectiveness of MSP and MPA initiatives but also promotes local understanding, support, and legitimacy.

The development of scenarios, driven by participatory mapping, provides a structured framework to assess potential impacts, balance conflicting objectives, and make informed decisions that prioritise sustainable resource management (Calado et al., 2021). This integration of stakeholder input ensures that the resulting scenarios are accurate and align with the diverse values and priorities of the local communities involved. By actively involving stakeholders in mapping exercises, diverse perspectives and local knowledge are incorporated, enriching the scenario-creation process. By incorporating diverse perspectives, participatory mapping becomes a powerful tool for creating more inclusive and sustainable marine resource management strategies (Loerzel et al., 2017).

Through participatory mapping (Figure 2), resource managers can gain improved decision-making capabilities to assess whether to monitor marine quality, implement measures to mitigate or reduce threats, initiate restoration activities, or strategically redirect management efforts to alternative areas (Loerzel et al., 2017). By including climate change perception, it is possible to get some impressions on the area and support leaders on decisions for adaptive management.

A variety of tools are available for participatory mapping. Burnett's (2023) book, "Evaluating Participatory Mapping Software," provides a comprehensive list of tools and their strategies for efficient data collection tailored to different needs. The compiled material and additional tools are presented in Annex 5 of this document. It is crucial to emphasise that the solutions outlined there should not restrict the methodologies for each test study. The test site leaders can select the most appropriate methods for their projects based on the general outline and process steps. Additionally, the table in Annex 5 serves as an initial overview of the theme and does not provide an exhaustive list of all available tools.

Integrating participatory mapping into MSP facilitates a comprehensive understanding and representation of ES. Local knowledge and preferences related to cultural, provisioning, regulating, and supporting services are captured spatially by engaging stakeholders in mapping exercises. This participatory approach identifies key areas of ecological and social significance and visualises trade-offs and synergies among services. The spatial representation of ES through participatory mapping becomes a crucial tool for decision-makers, allowing them to align conservation and development goals with the sustainable use of marine resources. The collaborative mapping process ensures that the diverse perspectives of stakeholders are considered, promoting a holistic and inclusive approach to managing marine ecosystems and their associated services within the MSP framework.

Figure 2: Participatory Mapping representation.

2.4 Ecosystem Services and Trade-off analysis in MSP

The ES and trade-offs concepts are closely related within the field of environmental management.

2.4.1 What are Ecosystem services?

Ecosystem services (ES) refer to the numerous tangible and intangible benefits that ecosystems provide to humanity. These services are vital for our well-being and survival. They result from the complex interactions between an ecosystem's biotic and abiotic elements, encompassing a variety of natural processes that contribute to the maintenance of life on Earth (von Thenen et al., 2020).

The ES can be divided into four categories: provisioning services (such as food, and freshwater), regulation and maintenance services (such as climate regulation, and water regulation), supporting services (such as nutrient cycling, and primary production), and cultural services (such as recreation, tourism) (Neugarten et al., 2018; Potschin-Young et al., 2018); These services are not independent of one another, and have often complex interactions. Maximising the flow of ES is impossible and, therefore, conflicting interests and trade-offs will inevitably raise (Lester et al., 2013).

Unfortunately, human activities often negatively impact ecosystems, compromising the flow of these essential services. Deforestation, pollution, climate change, and the

overexploitation of natural resources threaten the delicate balance between humans and nature. Awareness of the importance of ES is crucial to guiding our actions toward sustainable resource management and preserving biodiversity, ensuring a sustainable future for generations to come (Barbier, 2017).

2.4.2 Marine ecosystem services

Marine ecosystems represent some of the most heavily exploited ecosystems throughout the world. According to Barbier (2017), “due to coastal development, population growth, pollution and other human activities, 50% of salt marshes, 35% of mangroves, 30% of coral reefs, and 29% of seagrasses have already been lost or degraded worldwide over several decades”. This widespread degradation poses a significant threat not only to biodiversity but also to the essential ecosystem services provided by these habitats, which are crucial for human well-being.

For instance, salt marshes serve as critical habitats for various marine species and act as natural buffers against coastal erosion and storm surges. Their loss not only diminishes the nursery and breeding grounds for many commercially important fish species but also exposes coastal communities to heightened risks of flooding and other natural disasters (zu Ermgassen et al., 2021). Mangroves, another vital coastal ecosystem, play a crucial role in carbon sequestration and provide a natural barrier against tropical storms (Vegh et al., 2014). Their decline not only affects the rich biodiversity they support but also leaves coastal areas more vulnerable to the impacts of climate change.

Coral reefs are a hotspot of biodiversity and offer valuable ecosystem services such as tourism revenue, shoreline protection, and fishery resources. The degradation of coral reefs not only results in the loss of countless marine species but also has direct economic implications for communities dependent on these services (Barbier, 2017).

Seagrasses contribute to stabilizing sediments and maintaining water clarity. They provide crucial habitat for many marine organisms and play a significant role in carbon sequestration (Montero-Hidalgo et al., 2023). The decline of seagrasses not only jeopardizes the health of marine ecosystems but also disrupts the intricate balance of carbon cycling.

In summary, the loss or degradation of these marine habitats not only harms biodiversity but also undermines the diverse ecosystem services they provide, including food provision, carbon sequestration, and coastal protection. Understanding the interconnectedness between human activities, the health of marine ecosystems, and the services they offer is crucial for promoting sustainable management practices and safeguarding these invaluable resources for future generations.

2.4.3 Trade off in ecosystem services

Trade-offs occur when pursuing one objective or maximising the use of a particular ecosystem service comes at the expense of other services or priorities. Trade-offs arise when managing ecosystem services and deciding how to allocate multiple resources. For example, converting a natural coastal ecosystem into a tourism enterprise may lead to habitat and species loss and reduced water filtration capacity, affecting other services such as coastal protection and water quality.

The relation between trade-offs and ecosystem services regularly requires **assigning values to these services**. The valuation can be done by economic measures (e.g., monetary valuation) as well as non-monetary approaches that consider social and cultural values (e.g., importance/ relevance for the community). These can help quantify the benefits and costs associated with different services, comparing and assessing trade-offs easier.

Trade-offs in ecosystem services are central to decision-making processes. In these processes, stakeholders and decision-makers evaluate the potential impacts of different management options and consider the trade-offs involved. Recognising and managing trade-offs is essential for integrated ecosystem management and sustainable development. Decision-makers can aim for a more holistic and balanced approach to resource management, striving to optimise the overall benefits while minimising negative impacts.

These integrated approaches help identify win-win solutions or strategies for synergies among ecosystem services. To achieve more sustainable and equitable outcomes, trade-offs can be managed by considering the interdependencies among ecosystem services.

Understanding the relationship between ecosystem services and trade-offs can help the decision-making process, ensuring that trade-offs are carefully evaluated, and sustainable management strategies are pursued.

2.5 How to Develop a Trade-Off Exercise in the context of MSP4BIO?

Navigating the intricate landscape of MSP should be based on understanding trade-offs, the delicate compromises between diverse objectives, interests, and resource utilisation. This methodology is a comprehensive guide for planners and practitioners engaged in MSP, outlining the systematic approach to conducting trade-off analysis. By previously preparing spatial data, prioritising criteria and ES, and employing participatory mapping surveys, this methodology lays the grounds for a strategic decision-making process (Figure 3). Stakeholders may explore tools, engage in scenario mapping, and delve into complexities of change, as for e.g. climate change analysis, all aimed at achieving a harmonious balance between ecological preservation and socio-economic development in marine environments.

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Trade-offs are performed almost at a subconscious level in daily life. Our personal choices require an analysis of “gains and losses” and should search for alternatives that assure the maximum of “gains” and minimum of “losses” in the given framework. Thus, accomplishing informed decisions.

This section presents an organisation of the decision-making process applied to MPA Conservation, Protection and Restauration. Trade-off preparation also takes place in other management stages apart from Decision Making. Magalhães et al. (2019), summarize these considerations in Table 1 bellow. Although in the context of MSP4BIO, the focus is on “Group 3. Decision-making process support”, all other Groups should be considered. A summary is presented in the section dedicated to Chapter 6: ESE Framework 3.

Table 1: Guidelines for trade-off management (extracted from Magalhães et al., 2019)

	be evaluated to minimize the occurrence of complex trade-offs	
	1.3 The sustainability trade-offs management of a project must occur systematically and not one by one individually	Morrison-Saunders and Pope (2013)
	1.4 Between two conflicting objectives, the one which does not transfer potential negative impacts to the future should be prioritized	Gibson (2006)
	1.5 The early decisions should consider the views of different actors involved in the process	Gibson (2006)
2. Acceptable and Negotiable Aspects	2.1 Initially, unacceptable aspects of the sustainability project should be defined, and the degree of flexibility to changes for unacceptable aspects should be established	Morrison-Saunders and Pope (2013)
	2.2 The offsets should be defined - project aspects that are considered negotiable, among the unacceptable ones	Morrison-Saunders and Pope (2013)
	2.3 The alternatives selection for the project should be carried out within the established limits for acceptable and negotiable sustainability aspects	Morrison-Saunders and Pope (2013)
3. Decision-making process support	3.1 It is mandatory to comply with the minimum requirements of standards and legislation	Byggeth and Hochschorner (2006); Morrison-Saunders and Pope (2013)
	3.2 All decisions should be aligned with the organization's strategic objectives	Byggeth and Hochschorner (2006)
	3.3 Decisions on project trade-offs should be guided by the expected results defined in the pre-development stages	Morrison-Saunders and Pope (2013)
	3.4 Decisions must be based on minimizing or accommodating process variability, which can scarcely be eliminated	Gibson (2006)

The decision-making process based on trade-offs is the core of this Deliverable, which aims to provide a detailed explanation of the building blocks leading to participated and engaged solutions on management and options for MPAs. Figure 3 captures the integration of the process applied to the context of MSP4BIO by figuring out the decision-making flow and identifying the related products of MSP4BIO (deliverables/milestones). Although the building blocks are in an indicative order, meaning that it can be changed, it is not advisable to do so, as they are framed in a logical sequence. The construction of the building blocks involves translating the decision-making process within the MSP4Bio project into practical frameworks for implementation in relevant sectors.

Know and prepare is a building block from where all others are building upon. The three identified blocks are not exhaustive, and resources outside MSP4BIO are also advisable to seek. Inside this block, the goals definition drives the scope of the other blocks to be pursued, by setting the framework to identify specific needs, data,

ecological settings, conservation status, socioeconomic dimension, engagement processes, maritime users, etc.

Set Options tries to create different alternatives and/or solutions to reach a specific goal. Those can be created by using Ecological models/tools (in the toolkit on D3.4 Ecological toolkit (ESE 1) for MPAs prioritisation and networking (TBD)); introducing Climate Change (D 3.3 Guidance for building climate change scenarios for protection strategies (Cambra et al., 2024); Annex 6); considering uncertainty on planning or other resources available to promote discussion and find solutions.

Trade-off Negotiation is explained in this Deliverable and consists of the presentation of diverse alternatives generated in the previous block or accomplished by participatory mapping, followed by the negotiation of those. The negotiation with stakeholders and government/ management agencies might require the inspiration of already used “arguments” and successful stories (Annex 2; Deliverable D2.3 State of the art overview of the current protection and restoration measures in place (Bocci et al., 2023)).

Assume, Implement and Mainstream building block involves translating the methodology into actionable stages for implementation in the police sector. This process requires assuming ownership of the methodology, adapting it to suit the specific needs and challenges of policing, and integrating it into routine practices and procedures. This building block will be further developed by the other MSP4Bio Tasks.

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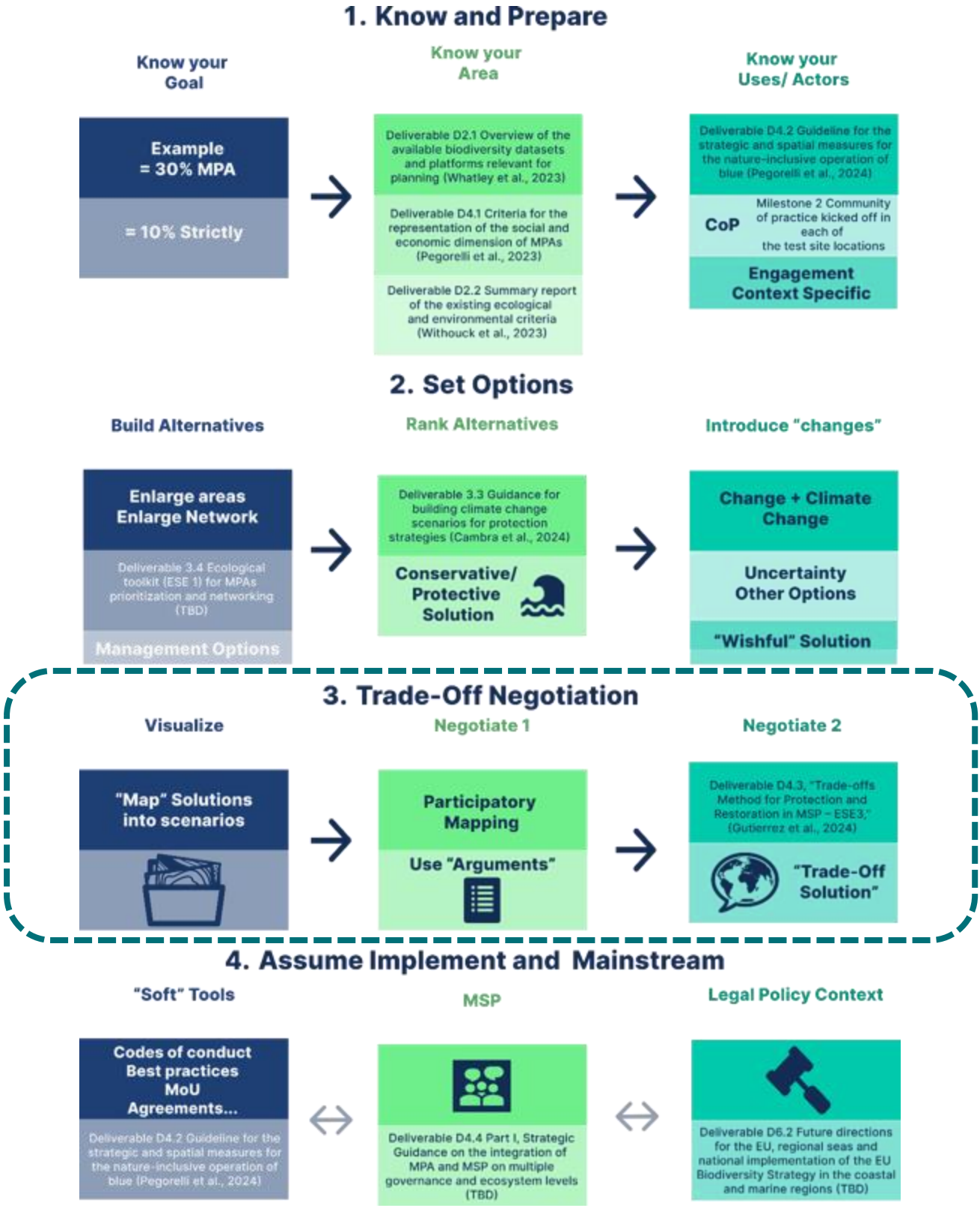

Figure 3: Decision-Making Process building blocks in MSP4BIO

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3. Guidelines for applying trade-off methodology for MPA Design

The following Guidelines for applying trade-off methodology for MPA design (Figure 4) outlines a participatory approach to create integrated scenarios, offering a valuable tool for assessing and negotiating the consequences of diverse actions and strategies for marine areas. The methodology, developed in consultation with experts and stakeholders, explained in the introduction and guided by Annex 01, addresses the complex interplay between human activities and ecosystem services, fostering a deeper understanding and facilitating informed decision-making. Successfully evaluated across different test sites within the MSP4BIO project, the outcomes of this methodology are to be seamlessly integrated into the ESE 3, specifically contributing to Task 4.4 on the Ecological-Socio-Economic integrated management of Marine Protected Areas (MPAs) and Marine Spatial Planning (MSP).

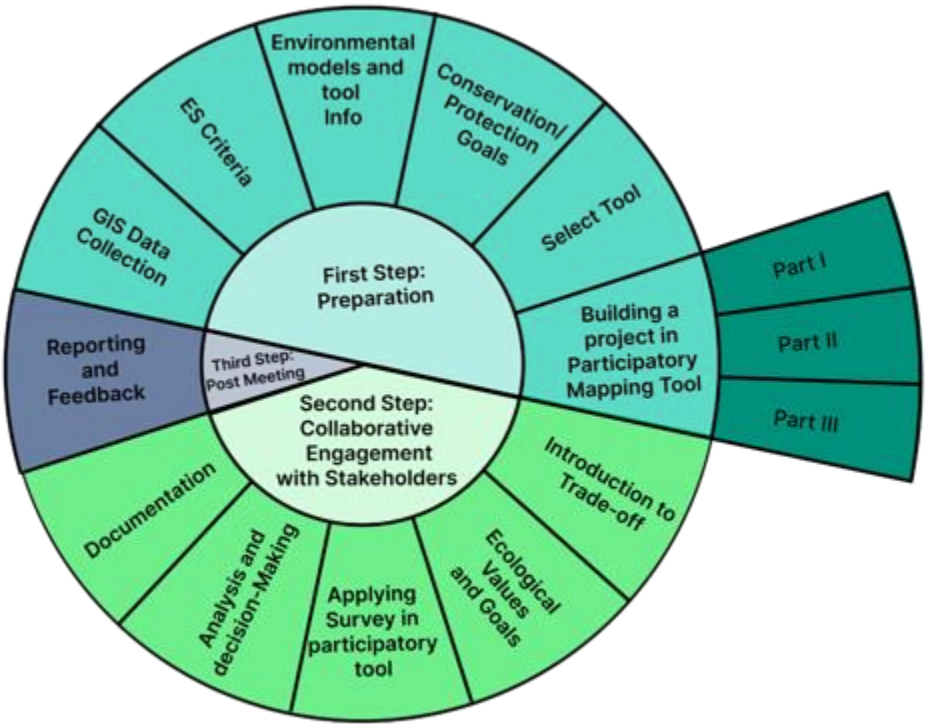

Figure 4: Guidelines for applying trade-off methodology for MPA design.

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3.1 First Step: Preparation

a) Geographic Information System (GIS) Data Collection:

The first action is to identify and list all available information sources and spatial data relevant to the area. Detailed information is found in Deliverable D2.1 Overview of the available biodiversity datasets and platforms relevant for planning (Whatley et al., 2023). Plus, a screening of the available biodiversity datasets and platforms relevant for planning is advisable. If possible, A GIS folder with all georeferenced materials should be compiled.

b) Ecosystem Services Criteria and Prioritization:

A comprehensive list of criteria and ES should be compiled and prioritised as a result of the participatory approach. In this Deliverable two suggestions for ES mapping methods are presented. Deliverable D4.1 Criteria for representing the social and economic dimension of MPAs (Pegorelli et al., 2023) refers to the representation of the social and economic dimension of MPAs and its usefulness for more guidance.

c) Environmental Models and Tool Information Summary:

All environmental information available should be structured and summarised for a clearer understanding. For detailed insights, refer to Deliverable 3.3 Guidance for building climate change scenarios for protection strategies (Cambra et al., 2024).

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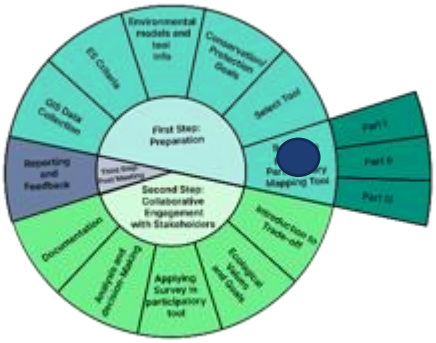
d) Conservation and Protection Goals Identification:

Specific, important natural values or areas (e.g., Dark Coral) should be identified, as well as conservation goals, such as protecting a defined percentage (e.g., 20% of Dark Coral). Goals should follow the SMART formulation.

e) Tool Selection:

An appropriate tool for developing participatory mapping and analysis should be selected. The Annex 5 can be consulted for tool suggestions.

f) Building a project in Participatory Mapping Tool:



A "participatory mapping survey" design tailored to the test site should be developed by the individual or the official entity in charge of conducting the process. This survey covers guiding questions and incorporates prioritised ES. The survey should be divided into three parts for a more comprehensive approach.

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Part I - Data Collection and Perception:

Aim to collect spatial information from Stakeholders/CoP members about current and potential uses, conflict areas, and areas suitable for trade-offs.

Examples of questions:

- Map known/ licensed existing uses in your area.
- How do you use the area?
- Map areas of conflict.
- Areas with potential for expansion or relocation of your activity?
- What are the priority areas for conservation?

Part II - Data Analysis and Validation:

This section relates to data analysis and validates findings. Scenarios based on uses, conflicts, and ES criteria should be drawn with the help of the participatory mapping tool in Part I. These are now discussed and agreed upon during part 2 of the interaction with the support of the Annex 2 Portfolio of arguments. Figure 5 shows an example of the interactive results from the Graciosa Island test site results.

Figure 5: Results Graciosa Island

https://aldebruyn.github.io/graciosa.github.io/

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Part III - Perception of Change:

Exploring changes, for example, in the context of Climate Change (CC) projections/scenarios, questions on perceptions and validation should be conducted with the stakeholders/CoP members.

The impact analysis using the participatory mapping tool is based on a survey where additional questions can be included.

Examples of questions:

- How likely the actual situation will change with CC
- How does CC affect the use of ecosystem services?
- How will CC affect your use?
- What would be the Climate Change impact (-5 = negative impact; 5 = positive impact)?
- How can we adapt to Climate Change in the area?
- How can we spatially address Climate Change in order to achieve the Goals?

3.2 Second step: Collaborative Engagement with Stakeholders

a) Introduction Trade-Offs:

- The trade-offs should be explained;
- The spatial data collected should be presented;
- Stakeholders should be reminded of the criteria/ecosystem services prioritised above.

b) Ecological Values and Goals:

- MPAs, OECM (Other effective area-based conservation measures) and other important ecological features in the area should be identified;
- The ES in the area should be mapped and discussed;
- For other key features, the protection objectives (e.g., 20%, 30%) should be clearly identified, drawn on the map, and map ES.

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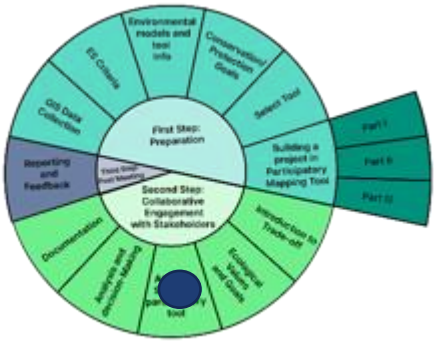
c) Applying Survey in participatory tool and results:



- Apply Part I and III of the survey and collect stakeholder perceptions;.
- Scenarios based on uses, conflicts, and ES criteria (Part II) should be drawn;
- A GIS tech should download the data and work on the results to perform the analysis that might be needed. An example of different scenarios and the methodology developed in Graciosa Island is available in Annex 4;
- Building scenarios takes time, so knowing this before starting the survey and letting Stakeholders/CoP members be aware of it;
- Present the results of participatory mapping.

d) Analysis and Decision-Making:

- The scenarios based on priority criteria/rank of ES' Importance will be analysed and discussed;
- A “Voting" or “Consensus” method should be organised to decide relevant agreements for the area(s);
- Structure prioritisation criteria and negotiate solutions using the "Arguments Portfolio" in Annex 2.

e) Documentation:

- Main discussion points (a template is available in Annex 3) are recorded;
- The imagining through Photos/print screens/recordings are made to capture the meeting through Photos/print screens/recordings are made to capture the meeting.

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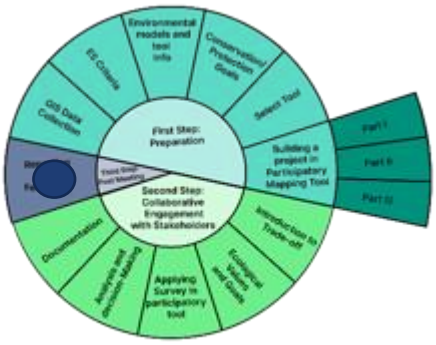
3.3 Post-Meeting:

Feedback to Stakeholders:



- A meeting report should be prepared;
- Feedback to Stakeholders on how their opinions are considered in the MSP implementation process should be provided;
- If Consensus is achieved a document stating it should be prepared (any of the “soft” tools suggested as MoU; Codes of Conduct; etc)

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4. Trade-Offs Results in the Context of MSP4BIO

In this section the results from test sites exercises are presented.

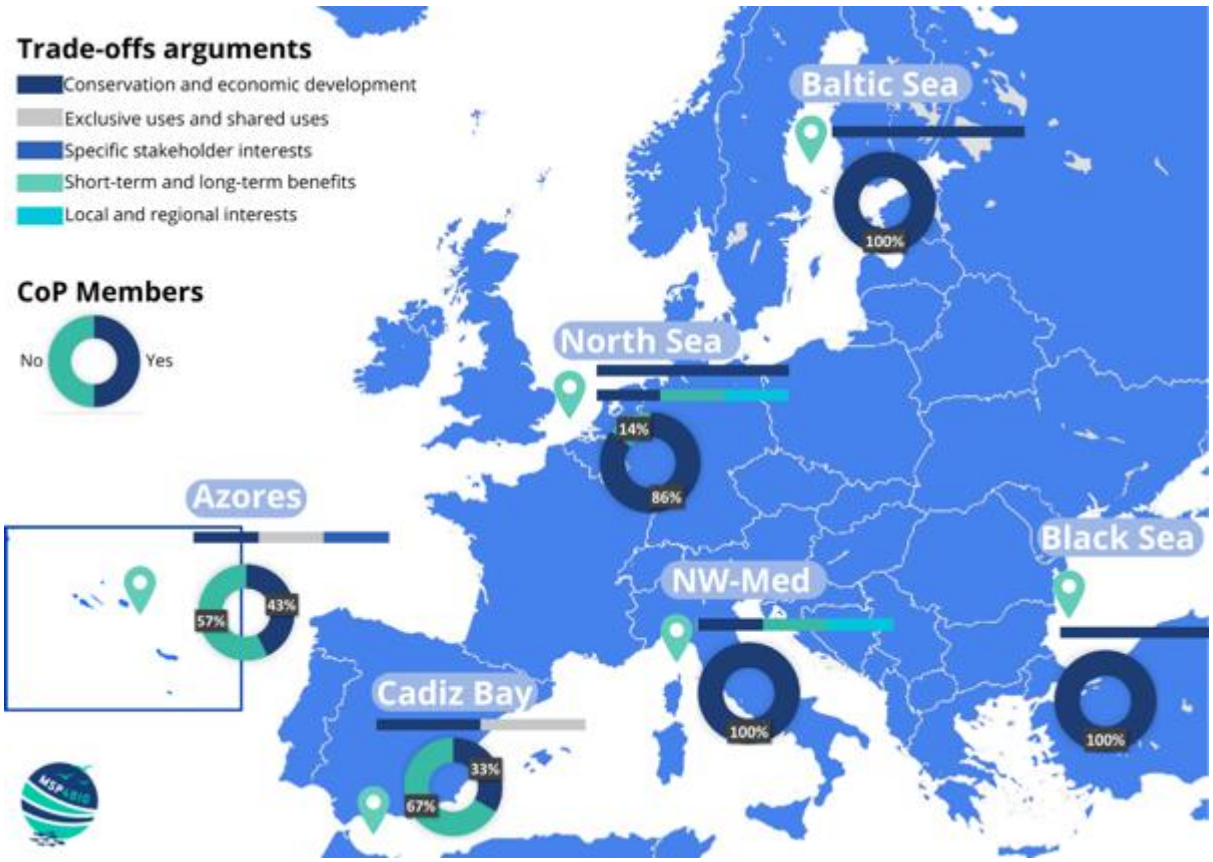

Figure 6: Use of Trade-offs arguments and constitution of the discussion group for each test site, in MSP4BIO trade-offs exercise.

Cadiz Bay

In the Cadiz Bay test site, a workshop was conducted to explore conflict areas within the nominal MPA of the Bay of Cádiz. The workshop involved stakeholders from various sectors, including one NGO (Non-Governmental Organization) representative, two persons from regional administration, and one person from a company (environmental consultancy). Additionally, three stakeholders participated in the workshop but were not part of the Communities of Practice (CoP) (Figure 6).

The MPA has a nominal designation without effective implementation (“paper park”). Therefore, the objectives of Cadiz Bay are more strategic than operational. The workshop had three goals: placing MPA on the political agenda; gathering information about the marine area of the Bay of Cádiz (uses, locations of activities, areas of significance for various sectors, areas of conflict); and resolving the main conflicts.

Stakeholders identified priority work areas based on current scenarios, but consensus on solutions was challenging due to the lack of minimum conditions related to the governance structure not well established in the area. Climate change vulnerabilities in the Bay were discussed, focusing on risks to the population, infrastructure, sector activities, and environmental conservation aspects.

Trade-off arguments faced difficulties due to culturally accepted, even illegal, activities. For instance, the practice of traditional shellfish or fishermen (often engaging in illegal activities) selling their catch at the market entrance without any regulation is viewed positively. It is recognised as a source of fresh seafood and is culturally accepted. As shown in Figure 6, the key trade-offs included marine conservation vs. economic development and ecological vs. cultural values. Proposals lacked consensus, and the main conclusion highlighted the need to enhance the governance framework for better planning initiatives.

Recommendations emphasised examining past initiative results to avoid repeating mistakes, enhancing surveillance, planning for military areas, and starting with simpler issues. SeaSketch, a participatory mapping tool, was considered useful but might pose challenges in confined areas. Indeed, working in very small MPAs requires a higher level of detail, which seems to make the SeaSketch tool slower. The tool's value lies in gathering spatial information, organising discussions, and facilitating remote or in-person collaborative work.

Challenges included using SeaSketch in small MPAs and identifying its role at different management stages. Despite challenges, SeaSketch presented opportunities for systematic planning in the Bay's growing blue economy. However, the tool's effectiveness depends on political will and administrative action. Overall, the Cadiz Bay experience emphasised the importance and need for effective governance and strategic planning for a successful MSP.

Applicability of Guidelines:

- Lack of effective implementation in nominal MPA hindered operational objectives.
- Poorly established governance structure posed challenges for consensus and trade-offs.
- Need to enhance governance framework; guidelines may face obstacles in areas with unclear governance.

Working with Stakeholders on Trade-offs:

- Stakeholder engagement revealed challenges in consensus on trade-offs.
- Lack of governance structure and cultural acceptance of illegal activities complicated decision-making.
- Highlighted complexity in conflict resolution and emphasised addressing governance issues for better planning.

Usefulness of the Tool:

- The tool provided means gathering spatial information, organising discussions, and facilitating collaborative work.
- Applicability was questioned in very small MPAs; slower performance indicated a need for greater detail, potentially limiting efficiency.
- Despite challenges, recognised value in supporting remote or in-person collaborative work.
- Suggested usefulness in broader MSP initiatives with considerations for specific spatial contexts.

Azores

In the Azores test site, representatives from the Regional Government, NGOs, Fishermen Association, and Tourism participated in the 3rd CoP workshop. 43% of the workshop members were from the CoP, and 57 % participated for the first time at the CoP workshop.

The primary goal was to support the creation of a new protected area with IUCN (International Union for Conservation of Nature) categorisation VI and map conflicts, potential uses, and perceptions related to climate change. The new proposed area is around an existing MPA. The Praia Islet has been protected since March 1990 through the Natura 2000 initiative and is recognised as an Important Bird Area by BirdLife International. Indeed, this island hosts endemic birds and plants. This area has also been part of the Natura Park of Graciosa, one of the protected areas of the Azores since 2008. A discussion space/forum dedicated to Praia Islet was proposed for

strengthened joint management, and innovative proposals, such as integrated monitoring, emerged.

The workshop concluded that integrating new members into the CoP is essential for enriching perspectives or using a more flexible working group. The SeaSketch participatory tool was utilised to identify potential priority areas for conservation features.

To address climate change, participants were asked questions regarding the likelihood of area changes, the impact of global warming, and how it affects ES. Trade-offs were identified, including conflicts between marine conservation and economic development, ecological integrity and human use, and exclusive versus shared uses.

Several arguments and trade-off scenarios were discussed, such as the impact of marine reserves on tourism-related businesses and the trade-off between ecological integrity and human use. Balancing exclusive and shared uses, as well as addressing specific stakeholder interests, were crucial aspects of the trade-off discussions.

Feedback on the workshop highlighted that in-person events are preferable for better engagement and discussion. SeaSketch was considered an excellent tool for participatory mapping, but more resources (time and money) are needed to develop reports aligned with the participants' needs. Suggestions were made for improving CoP interactions, including dividing the workshop into two days for better visualisation and discussion.

Stakeholders expressed conditions for supporting a new MPA (IUCN VI), including participatory monitoring, increasing ocean literacy, proposing alternative schedules for residents, providing scientific data supporting MPA needs, and creating special conservation areas for sustainable use.

The methodology was deemed effective, promoting discussions and allowing new stakeholders to join. However, challenges were noted, such as the need for more time to discuss SeaSketch results and the difficulty of organising online/hybrid events due to low digital skills among CoP members.

Recommendations for improvement included conducting meetings in fishermen's places, involving stakeholders more in surveillance, and addressing stakeholder fatigue. Challenges included difficulties finding a gathering company on the island, time and cost constraints for in-person meetings, and stakeholder fatigue.

Key themes emerging from the workshop were participation, discussions on ocean literacy, and the importance of effective communication and engagement among stakeholders.

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Applicability of Guidelines:

- Effective application of guidelines, promoting discussions and enabling the inclusion of new stakeholders.
- Challenges identified, including the need for more inclusive approaches and addressing digital skills gaps.
- Suggestions for potential improvements to enhance adaptability.

Working with Stakeholders on Trade-offs:

- Useful engagement with stakeholders on trade-offs, navigating conflicts between conservation and development.
- Emphasis on integrating new members and adopting a flexible working group structure.
- Showcase of guidelines' support for addressing diverse interests in marine spatial planning.

Usefulness of the Tool:

- SeaSketch proved valuable for participatory mapping in the Azores, identifying priority areas for conservation.
- Challenges noted, including resource constraints and difficulties in discussing results.
- Recognition of the tool's usefulness, with suggested refinements to enhance practical application in specific contexts.

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North Sea

Trade-Off 1

In the North Sea 1 test site, the focus was on the busy sea space in the Belgian part of the North Sea (BPNS). The 4Sea coalition has proposed a marine reserve in the next version of the MSP to strengthen the protection of ecological features and contribute to the EU Biodiversity Strategy's goal of 10% strictly protected areas (SPAs) in European Seas.

The workshop involved stakeholders and covered topics such as biological valuation maps, proposed areas for a marine reserve, and the spatial distribution of human activities. The workshop aimed to address the trade-offs between different scales of action, coastal protection, and biodiversity protection. The discussion also explored potential habitat areas, climate change perceptions, and the impacts of activities near the marine reserve.

Trade-off arguments included the necessity of a marine reserve for protecting and restoring gravel bed features, while others argued that removing pressures may not guarantee improved ecological features. Concerns were raised about external pressures on features outside the proposed reserve, especially for mobile features affected by activities like offshore wind farms.

Climate change perceptions highlighted risks such as temperature change and ocean acidification. The SeaSketch tool received technical feedback, with participants suggesting its suitability for data collection on smaller scales. Another software, MSP Challenge, was also mentioned as a relevant tool for discussing trade-offs.

The workshop successfully facilitated discussions on trade-offs, bringing together diverse viewpoints. However, challenges were noted, including the inappropriateness of SeaSketch for the BPNS because it is a relatively data-rich environment, and technical issues experienced during utilisation of the tool. Stakeholder fatigue and the risk of duplicate work in a busy sea space were also acknowledged.

In conclusion, the North Sea 1 experience emphasised the importance of addressing trade-offs in MSP discussions, leveraging the BPNS data-rich environment for future analyses. The workshop provided instant feedback, diverse viewpoints, and a shared vision despite some challenges in tool applicability and potential stakeholder fatigue.

Applicability of Guidelines:

- Successful facilitation of discussions during the workshop, providing instant feedback and incorporating diverse viewpoints.

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Working with Stakeholders on Trade-offs:

- Effective addressing of trade-offs, including those between coastal protection, biodiversity protection, and different scales of action.
- Inclusion of diverse viewpoints, discussing the necessity of a marine reserve for ecological features and acknowledging potential uncertainties in removing pressures.
- Highlighting complexities in stakeholder trade-offs, particularly external pressures on features outside the proposed reserve, impacted by activities like offshore wind farms.

Usefulness of the Tool:

- SeaSketch tool received technical feedback, suggested suitability for smaller-scale data collection.
- Challenges identified, indicating the tool's inappropriateness for the data-rich BPNS environment.
- Mention of another tool, MSP Challenge, as relevant for discussing trade-offs.

Trade-Off 2

The North Sea 2 test site focused on the pelagic ecosystems in the BPNS. Pelagic habitats in the BPNS were under pressure from eutrophication, hydrodynamic changes, and the input of pollutants. The protection of marine habitats, including pelagic habitats, called for integrative approaches, and the workshop explored frameworks such as DAPSIR (Drivers-Activities-Pressures-State-Impacts-Responses) to link economic and social needs to environmental quality.

The workshop addressed questions related to integrating pelagic habitats and communities in MSP, prioritising areas for protecting pelagic biodiversity, and identifying data and tools for implementing spatial protection. Discussions also delved

into how climate change would affect pelagic biodiversity and the marine ecosystem's functioning.

The workshop utilised biological valuation maps, proposed areas for a marine reserve, and maps of the spatial distribution of human activities. Key considerations included benthic-pelagic coupling mechanisms, pressures on pelagic habitats, and improved spatial delineation of pelagic habitats.

Trade-off discussions focused on the importance of pelagic diversity, particularly plankton communities, for ES in the BPNS. Participants rated the relative importance of current and future pressures on pelagic diversity, recognising healthy pelagic habitats' crucial role in delivering ES.

Challenges identified for the spatial protection of pelagic habitats included knowledge gaps, the need for monitoring, determining the appropriate spatial scale, and the highly dynamic nature of the system. The importance of considering connectivity, larval dispersal, and food web interactions beyond national approaches was emphasised.

The participatory tool facilitated discussions on the spatial scale needed for pelagic habitat protection and identified important areas for ecosystem functioning. While recognising the limitations of 2D mapping for capturing the complexity of the pelagic system, suggestions for using virtual reality setups like 'The Reef' were made. The tool was seen as valuable for incorporating transboundary information on activities and ecological features, highlighting data gaps, and addressing the complexity of climate change and plankton dynamics.

Applicability of Guidelines:

- Successful application of MSP guidelines in North Sea 2, focusing on pelagic ecosystems in the BPNS.
- 4Sea coalition proposed a marine reserve aligning with the EU Biodiversity Strategy's goal of 10% SPAs.
- Utilization of the DAPSIR framework explored integrative approaches linking economic and social needs to environmental quality.
- Workshop addressed questions on integrating pelagic habitats, prioritising areas for protection, and identifying data and tools for spatial protection.

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Working with Stakeholders on Trade-offs:

- Trade-off discussions focused on the significance of pelagic diversity, especially plankton communities, for ecosystem services in the BPNS.
- Participants rated the importance of current and future pressures on pelagic diversity, recognising the crucial role of healthy pelagic habitats in delivering ecosystem services.
- Challenges identified included knowledge gaps, the need for monitoring, determining the appropriate spatial scale, and the highly dynamic nature of the system.

Usefulness of the Tool:

- The participatory tool facilitated discussions on the spatial scale needed for protecting pelagic habitats and identified crucial areas for ecosystem functioning.
- Acknowledging 2D mapping limitations in capturing the complexity of the pelagic system, suggestions were made to explore virtual reality setups like 'The Reef.'
- The tool was considered valuable for integrating transboundary information on activities and ecological features, addressing data gaps, and navigating complex aspects of climate change and plankton dynamics.

North-Western Mediterranean (NW-Med)

The Western Mediterranean test site focused on the conservation of marine mammals, specifically addressing the ecosystem service of "Lifecycle maintenance, habitat, and gene pool protection." Representatives from ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area), WWF, and Pelagos participated in the workshop.

The ecosystem service was mapped through the distribution of cetaceans in the study area, linking it to socio-economic aspects such as the importance of the area for local communities and shipping. The primary goal was to extend the SPAs network in

alignment with national targets and international initiatives such as Particularly Sensitive Sea Areas (PSSA), ACCOBAMS, Pelagos, and Important Marine Mammal Areas (IMMAs).

The trade-offs exercise aimed to frame the SPA design approach for marine mammals, particularly focusing on biocentric processes targeting species conservation. IMMAs were identified as starting points for designing scenarios, considering their correlation with high-density areas for resident populations of Mediterranean Cuvier's beaked whales and other vulnerable species.

The workshop utilised various environmental features and ecosystem service layers, including IMMAs, marine mammals' distribution and functional areas, sea surface temperature, chlorophyll concentration, maritime traffic, and fishery layers. The proposed area was extensive, suggesting the need for more specific areas based on IMMA criteria to enhance the effectiveness of the trade-off exercise.

Prediction models for foraging areas for whales based on chlorophyll concentration were employed to refine proposed areas. Actions were identified and prioritised based on threats affecting cetacean species, using information from conservation management plans, ACCOBAMs, IUCN reassessment, and PSSA materials.

Management options for potential MPAs included traffic deviation, speed limitation, boat vigil, mariner broadcast, and pollution reduction. The arguments in favour of implementing such measures highlighted benefits such as ensuring the survival of endangered marine mammals, reducing energy costs for maritime transporters, improving the industry's image, and reducing pollution.

Challenges were acknowledged, especially concerning large cetacean species with high mobility, making it difficult to locate stable areas of interest. The main threat identified was maritime traffic and collision risks, with proposed mitigation measures such as traffic deviation or speed limitation. Economic impacts and the need for transnational cooperation were emphasised.

Several scenarios were addressed, accepting uncertainty but clearly explaining it. Key questions included knowledge gaps on species location and collision risks, making mapping trade-off scenarios challenging. The recommendation was to rely on existing initiatives, make scenarios, and develop criteria for SPA design. Challenges included overlapping with ongoing initiatives, relevance only at the basin scale, and limited knowledge of climate change impacts on cetaceans. The complexity of marine mammal protection was recognised, suggesting a larger-scale approach to address uncertainties.

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Applicability of Guidelines:

- MSP guidelines effectively applied in the Western Mediterranean, focusing on marine mammal conservation.
- Utilizing various environmental features and ecosystem service layers for mapping, highlighting the extensive proposed area's need for specificity based on IMMA criteria.

Working with Stakeholders on Trade-offs:

- Stakeholder engagement instrumental in addressing trade-offs for marine mammal conservation.
- Emphasis on economic impacts and the necessity for transnational cooperation.

Usefulness of the Tool:

- Utilization of various environmental features and ecosystem service layers.
- Actions identified and prioritised based on threats affecting cetacean species, incorporating information from conservation management plans.
- Proposed management options for potential MPAs included traffic deviation, speed limitation, boat vigil, mariner broadcast, and pollution reduction.
- Challenges recognised, including knowledge gaps on species location and collision risks.
- Recommendations emphasised reliance on existing initiatives, scenario development, and criteria for SPA design.
- Challenges acknowledged, such as overlapping with ongoing initiatives, relevance only at the basin scale, and limited knowledge of climate change impacts on cetaceans.
- Recognition of the complexity of marine mammal protection, suggesting a larger-scale approach to address uncertainties.

Black Sea

In the Black Sea test site, a diverse group, including the Regional Government, NGOs, Tourism representatives, representatives of local fisheries and scientists, participated in the CoP workshops. Key data sources included maps of natural values and the spatial distribution of human activities.

The primary objective was to explore conflicts and potential uses in the Bulgarian test site, focusing on extended MPAs and offshore wind farm development. Climate change considerations were incorporated using the SeaSketch tool, which aided in identifying priority areas and assessing trade-offs.

The Romanian objectives for the Trade-Off exercise are to identify conflicts and synergies among marine activities, assess stakeholder perceptions of climate change and adaptive strategies, protect high-value marine habitats through strict protection zones, explore the feasibility of a transboundary marine protected area for marine mammals, and evaluate potential conflicts between Blue Economy activities and current uses.

Environmental features and maritime uses, such as Natura2000 areas, fishery layers, recreational activities and maritime traffic, were considered. Proposed activities included MPAs enlargement and a new offshore wind farm. Challenges included defining clear trade-off arguments and addressing limited sea space for existing and emerging sectors.

Trade-offs discussed encompassed marine conservation vs. economic development, ecological integrity vs. human use, and exclusive vs. shared uses. Arguments highlighted challenges related to MPAs overlapping with fishery activities, military training impacting economic sectors, and offshore wind farm development conflicting with migration birds.

Conclusions emphasised the need for integrated MSP and MPAs management, improved planning measures, and transnational/cross-border MSP. SeaSketch feedback indicated its value for planning MPAs and wind farms, but challenges included the lack of high-quality spatial data and flexibility in visualising layers. The Romanian Western Black Sea faces increasing socio-economic pressures and conflicts due to inadequate stakeholder consultation and monitoring in MPA designation, necessitating better policy coherence and adaptive responses to climate change.

There is a lack of research and dedicated models on climate change in the Black Sea, making it difficult to predict its impacts on ecosystems and services, and although stakeholders are aware of these negative impacts, assessing adaptation strategies has been challenging. Recommendations included integrating socio-economic and ecological criteria, systematic planning, and addressing knowledge gaps, particularly regarding marine mammals and climate change in the Black Sea. Participatory mapping, ideally conducted face-to-face, aids stakeholder understanding and consultation, highlighting the need for comprehensive questionnaires and the integration of new MPAs into the MSP process to meet EU

Biodiversity Strategy recommendations. The approach was praised for promoting discussions and stakeholder involvement, but challenges included insufficient digital skills and the need for more detailed studies.

Applicability of Guidelines:

- The workshops aimed to explore conflicts and potential uses, particularly focusing on extended Marine Protected Areas (MPAs) and offshore wind farm development in the Bulgarian test site. While the approach proved
- Effective in identifying trade-offs and proposing activities, but challenges such as defining clear trade-off arguments and addressing limited sea space for emerging sectors were noted.
- The recommendations emphasised the importance of integrated MSP and MPAs management, highlighting the guidelines' applicability but also suggesting areas for enhancement.

Working with Stakeholders on Trade-offs:

- Working with stakeholders on trade-offs in the Black Sea test site was essential, with discussions encompassing marine conservation vs. economic development, ecological integrity vs. human use, and exclusive vs. shared uses.
- The challenges identified, such as conflicts between MPAs and fishery activities or offshore wind farm development impacting migration birds, showcased the complexity of trade-off considerations.
- The need for integrated MSP and transnational/cross-border planning emerged as key conclusions, indicating the guidelines' effectiveness in fostering discussions on conflicting interests and potential solutions.

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Usefulness of the Tool:

- The SeaSketch tool played a crucial role in incorporating climate change considerations, identifying priority areas, and assessing trade-offs in the Black Sea test site.
- Value for planning MPAs and wind farms. However,
- The lack of high-quality spatial data and limitations in visualizing layers point to potential improvements in the tool's adaptability and data integration.
- The recommendations emphasised the importance of addressing knowledge gaps, integrating socio-economic and ecological criteria, and adopting systematic planning approaches, indicating potential refinements for both SeaSketch and the broader MSP guidelines.

Baltic Sea

In the Baltic Sea test site, eight research and administrative stakeholders participated in the CoP workshops. The focus was identifying and analysing conflict areas that might arise with expanding MPAs in Gdansk Bay, Poland.

Key questions were posed to participants using environmentally valuable areas from the Polish Maritime Spatial Planning (https://sipam.gov.pl/english/maritime-spatial-planning) and HELCOM HOLAS 3 Ecosystem Services assessment (HELCOM, 2023). These questions aimed to pinpoint sector/activity areas, critical zones for various activities, potential areas for future MPAs, and areas of conflict between maritime uses and marine protection.

Data sources included ecological valuation and ecosystem service maps, the Baltic Sea impact index, bottom trawling and coastal fishery data, and shipping density layers.

Guiding questions for the Baltic Sea were established, focusing on climate change adaptation, monitoring strategies for MPAs, the intersection of MPA policies with MSP, and balancing economic interests with environmental protection in MPAs.

The participatory mapping in Gdansk Bay highlighted conflict areas, with tourism expansion posing a significant challenge, while the impact on coastal fishery decreased. Key observations were shipping and the spatial separation of bottom trawling from proposed MPAs. New MPA proposals emerged, emphasising unique ecological attributes and trade-off considerations.

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The concluding insights underscored the importance of data availability, stakeholder knowledge, familiarity with the local area, and leveraging existing research for informed decision-making. Challenges included the lack of tourism impact data, suggesting a need for research on tourism effects. However, the potential to meet EU conservation goals and enhance ecological sustainability through collaborative efforts was recognised.

Applicability of Guidelines:

- MSP guidelines effectively applied in Baltic Sea's Gdansk Bay test site.
- CoP workshops identified conflict areas in expanding MPAs, guided by key questions and diverse data sources.
- Challenges noted: need for tourism impact data, indicating potential improvements in data availability and research integration.

Working with Stakeholders on Trade-offs:

- Working with stakeholders valuable in Gdansk Bay for trade-offs, notably in tourism expansion.
- Participatory mapping highlighted conflict areas, fostering new MPA proposals.
- Challenges included a lack of tourism impact data, suggesting areas for further research.

Usefulness of the Tool:

- Participatory mapping is instrumental in Gdansk Bay for conflict identification and the proposal of MPAs.
- Data availability and leveraging existing research critical in decision-making.
- Need for adaptable tools in marine spatial planning processes emphasised.

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5. Comparative Analysis from Test Sites Results

In this section a comparative analysis of test site exercises is presented.

5.1 Word Cloud

Figure 7, a word cloud crafted from the partners' responses, vividly encapsulates the key themes and focal points that emerged during the interactions. The visually striking representation offers a condensed, yet comprehensive snapshot of the collective insights shared by the Community of Practice. By highlighting the most frequently used terms and prominent concepts, the word cloud serves as a visual guide to the overarching themes that resonate across diverse perspectives. This innovative presentation not only synthesises complex information but also provides a quick and accessible reference, facilitating a nuanced understanding of the core elements that shaped the collaborative discussions within the CoPs.

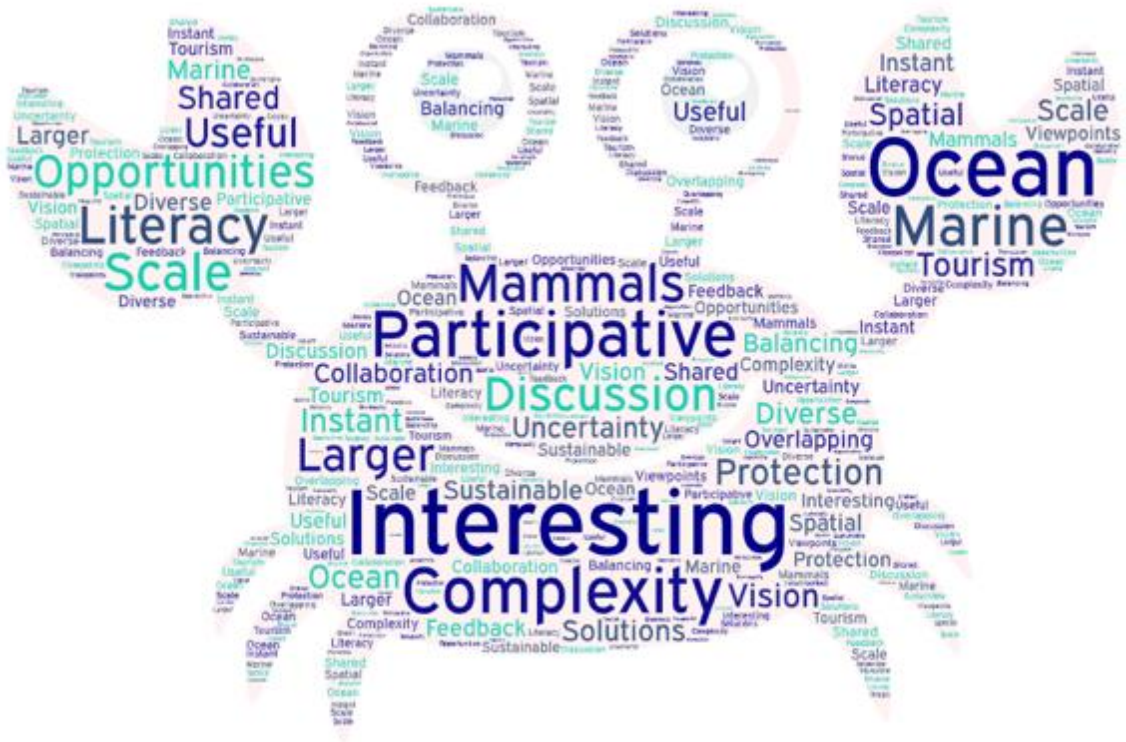

Figure 7: Word Cloud Crab from CoP interactions experiences.

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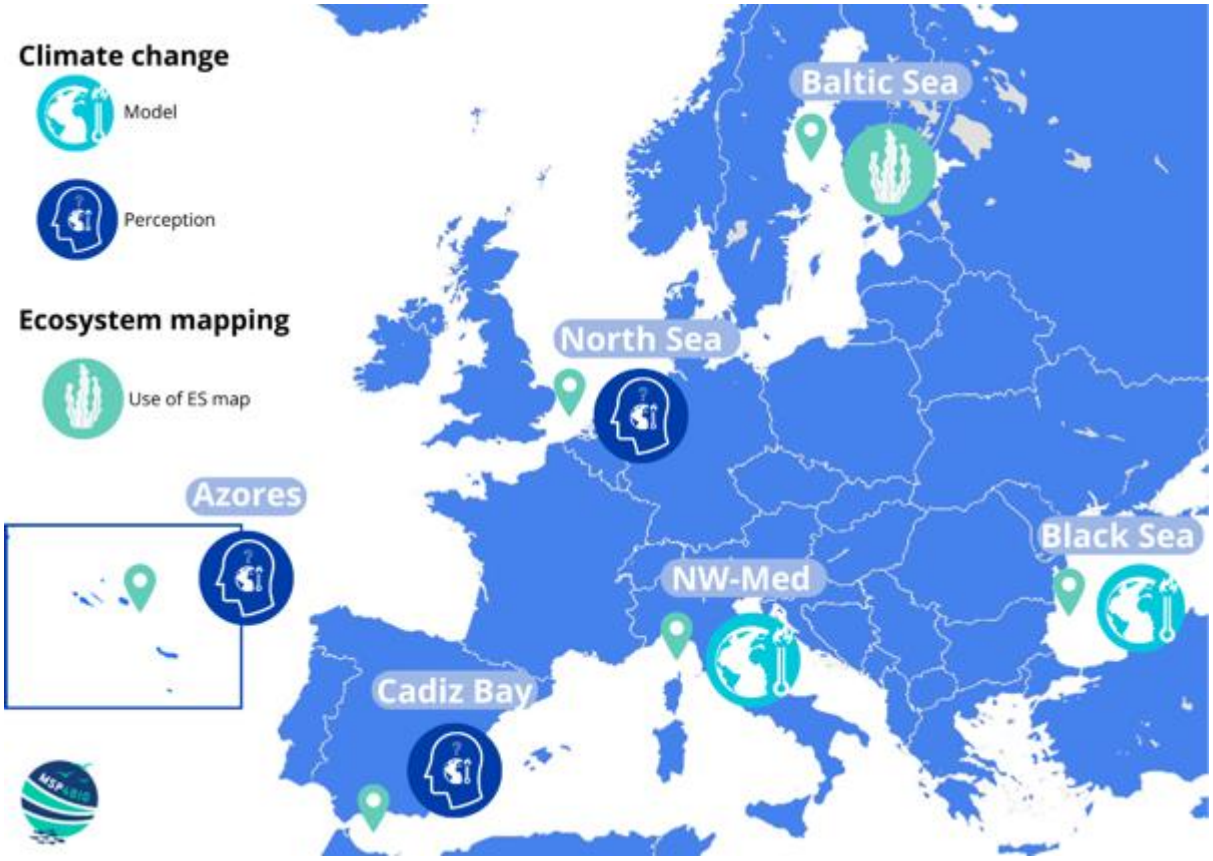

Figure 8: Climate Change Consideration (Perceptions or Models) and the use of Ecosystem mapping for MSP4BIO test sites.

5.2 Stakeholders (only CoP members or non-CoP members)

The participants taking part in the testing exercise were mostly members of the established CoPs. Some test sites took a broader approach, such as Cadiz, which opened its interaction to other stakeholders interested in the region. This was mainly because Cadiz aimed at basic information gathering and focused on establishing a framework. In the Azores and North Sea, new members were included in the CoP in the discussion. The other test sites primarily had CoP members with a few absences in the meeting. The proposed methodology has the potential to enhance stakeholder interest and engagement, fostering co-development of the ESE.

5.3 ES Mapping

Only one test site, the Baltic Sea (Figure 8), opted to use ecosystem service mapping because it already had a study with geo-referenced data. The criteria and indicators were the basis for discussion and information gathering in the Western Mediterranean.

One reason for this choice was the available time. Since the assistance for ecosystem service mapping was not initially included in the project's scope, but it was found

helpful to be considered, UAc Team decide to prepare a set of guidance (Annex 7) and provide support with online meetings. However, datasets needed were scarce or difficult to obtain in most test sites, and the support provided by UAc became available in October, thus leaving a shorter period to perform a suitable analysis.

Furthermore, some needs of trained skills in the different test sites can also explain why the ES map was not used. Indeed, ES mapping requires advanced geomatic skills, manipulation of spatial data, use of GIS, understanding mapping methods, etc.

Another aspect is the lack of data available to build an ES map. Indeed, obtaining accurate data is more difficult in marine environments, and it is clear that available datasets do not have full coverage of the test site areas either in specific scales or detailed Bio Physical data.

5.4 Goals

The different testing locations share similar goals, although there may be some variations.

Similarities:

Conflict Mapping: All test sites share a common concern for mapping conflicts, aiming to identify areas were human activities conflict with marine conservation objectives.

Involvement of Diverse Stakeholders: Each site involves a diversity of stakeholders, ranging from regional governments and NGOs to industry representatives, fishers, and tourism. This inclusive approach seeks to integrate a variety of perspectives into decision-making.

Marine Conservation Goals: Most sites have goals related to marine conservation, whether through the creation of new protected areas, extension of existing networks, or resolution of conflicts to ensure sustainable ecosystem management.

Differences:

Strategic Goals in Cadiz: In Cadiz, the emphasis is on strategic goals, such as placing the MPA on the political agenda, while other sites focus more on operational goals of creating or extending protected areas.

Focus on Marine Mammals in the Western Mediterranean: The Western Mediterranean region stands out with its specific focus on the conservation of marine mammals and their interactions with maritime traffic.

Climate Issues in the Azores: The Azores give particular attention to perceptions of climate change, illustrating a specific concern for long-term environmental impacts.

Offshore Wind Development in the Black Sea: The Black Sea (Bulgarian) site distinguishes itself by examining potential conflicts related to offshore wind farm development, highlighting specific considerations related to renewable energy.

Pelagic Prioritization in the North Sea: Both parts of the Belgian North Sea focus on distinct aspects, with one emphasising the creation of marine reserves and the other prioritising pelagic biodiversity and marine habitat management.

In summary, while all sites share common concerns for marine conservation and conflict resolution, each project tailors its approach specifically to its region's unique characteristics and challenges, reflecting a personalised and contextual approach to sustainable marine management.

5.5 Layers

Each test site had to describe the layers used for the actual area, the proposed area, and climate change.

Regarding the layers used for the actual area, three approaches can be distinguished: one using a participatory method; other using environmental/ecosystem features; and the uses of the marine space via existing layers. Cadiz Bay and Azores use the first approach. Cadiz Bay asked the sectors to identify the areas that were most crucial for developing their activities. The Azores asked the present users to identify the central area of their uses and the conflict areas. The other test sites use the second approach. Nevertheless, the North Sea used only layers of existing MPA for the actual area layers.

Each test site analysed the areas of conflict proposed by stakeholders for the proposed area. The NW-Med proposes to have a more specific area via the analysed data through IMMA criteria.

Finally, regarding the climate change layers, two approaches can be distinguished: one using the perception of climate change; and the other using the climate model. Cadiz Bay, the Azores, and the North Sea asked CoP members their perception of climate change on the marine environment. Baltic Sea did not include this type of layer in their exercise as the use of ES required also attention in that CoP meeting.

The Cadiz Bay asked to highlight the most sensitive areas to climate change based on the risks to the population, to infrastructure, the impact of the activities of the sectors operating there, and the impact on the conservation of the natural environment in various aspects. The Azores were asked to evaluate the issue of climate change via three questions: “How likely is it that the area will change as a result of Global Warming?”, “What would be the impact of Global Warming?” “How does Global Warming affect Ecosystem services?”. The North Sea asked CoP members to spatialise the impact of climate change.

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5.6 Climate Change

Different test sites adopted distinct approaches to the methodology, tailoring their strategies to local contexts and specific objectives, as illustrated in Figure 5. In most of the test sites, the focus was understanding perceptions related to climate change, as shown in Figure 8.

Table 2 below resumes how Climate Change was discussed/ included in the test site's discussions. SeaSketch was the most used participatory tool, facilitating discussions, identifying perceptions of change and showcasing layers from Climate models across diverse marine environments.

Table 2: Discussion on about Climate Change

Test Site	Climate Change	
	CC	Method
Cadiz Bay	The actors identified the **most sensitive areas to climate change** in the Bay based on four characteristics: ● Vulnerable due to risks to the population ● Vulnerable due to risks to infrastructure ● Vulnerable because they impact the activities of the sectors operating there ● Vulnerable because they affect the conservation of the natural environment in various aspects (impact on habitats or species of interest).	perception
Azores	Questions were also asked to encompass the issue of climate change, asking users three questions: ● How likely is it that the area will change as a result of Global Warming? ● What would be the impact of Global Warming? (-5= negative impact; 5= positive impact)? ● How does Global Warming affect Ecosystem services? ○ Permanent ○ Periodic ○ Occasional ● How can Global Warming be prevented in the area? ○ Relocate the area ○ Enlarge the area ○ Reduce the area	perception
NW-Med	– prediction **models** for foraging areas for whales based on chlorophyll concentration (Joint Research Centre (JRC))	model
Baltic	Do not provide a climate change scenario in T4.3 due to lack of data as highlighted in D2.1 and efforts were focus on the use of ES	none

Black Sea	New knowledge and dedicated **models** are needed to forecast the magnitude, extent, and spatial distribution of marine mammals' areas and their impacts on ecosystem components and services.	model
North Sea 1	This was a **spatial question** asked to workshop participants	perception
North Sea 2	CoP members were asked about their **perception** of the effects of climate change and other potential pressures on pelagic communities. No data layers were used, as this was not a spatial question.	perception

5.7 Trade-off Arguments

To complete the exercise, each test site had to describe the arguments used to get into trade-offs. Annex 2 provides a portfolio of different arguments in support of trade-offs. This argument portfolio was used to provide the different arguments and a common definition so that each test site would have the same frame of reference.

Figure 9: Trade-off arguments for each test sites

Figure 9 shows that every test site has one argument in common: conservation and economic development. This trade-off means finding the right balance between sustainable practices and allowing economic growth while minimising environmental harm.

The management of the trade-offs begins when it is not possible to deal with the aspects considered acceptable. These aspects are grouped into different dimensions, such as economic, social, and environmental, etc. Trades-offs occur between these different dimensions but also inside the dimensions themselves (Magalhães, et al., 2019).

The NW-Med and North Sea 1 highlighted these two arguments: trade-offs between short-term and long-term benefits and trade-offs between local and regional interests. Opting for short-term benefits can provide immediate gratification or economic advantages but may come at the expense of long-term consequences. Concerning the second argument, the two test sites agree with the fact that it may be more interesting to think on a larger scale, on a transnational scale, to be efficient.

About the trade-off between exclusive uses and shared uses, Cadiz Bay and the Azores highlighted this argument. The trade-off between exclusive uses and shared uses relates to the allocation of resources or spaces and the choice between restricting access to a select few or opening them up for the broader group. The challenge is to create policies that harmonise exclusive and shared use, serving the interests of diverse stakeholders.

The Azores put the argument specific to stakeholders. Each stakeholder has specific interests and needs in marine spaces, and managing these competing interests requires careful consideration and trade-offs. Indeed, the interests of recreational boaters and tourists can enter conflict with the conservation interest. Manage this access by conditioning how they do it, making it less devastating for the marine ecosystem.

The Bay of Cadiz highlighted the difficulty of this exercise as it also includes illegal activities, because even if they are not authorised, they are accepted and, therefore, don't give the impression that there are any conflicts.

5.8 SWOT (Strengths-Weaknesses-Opportunities-Threats)

The SWOT analysis was conducted to evaluate the entire methodology, highlighting its strengths, weaknesses, opportunities, and threats. Some test sites opted to focus their review specifically on the selected participatory mapping tool, examining its potential benefits and limitations in the context of their respective marine planning projects. This approach allowed for a targeted assessment of the tool's applicability and effectiveness within different geographic and socio-economic contexts.

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STRENGTHS

- SeaSketch is a robust tool for gathering specific **spatial information** and structuring discussions on effective area management.
- The tool guides discussions toward **actionable outcomes**, minimising circular debates related to area diagnostics.
- The tool facilitates discussions on **local and cross-border spatial scales**, emphasising the need to expand MPAs networks and integrate them into MSP.
- Its flexibility caters to remote and in-person formats, overcoming challenges in fragmented territories. **Hybrid approaches, boost collaboration** by integrating remote surveys and individual in-person interviews, showcasing effectiveness in remote survey formats, thereby improving accessibility and engagement.
- **The methodology**, supported by SeaSketch, **fosters effective discussions**, especially during in-person events.
- Clear methodology contributes to **informed decision-making**, posing questions on data availability, stakeholder knowledge, and local area familiarity.
- The central theme of trade-offs in workshops sparks **meaningful discussions**, capturing diverse viewpoints within the Cop and **fostering engagement** in marine area management.

WEAKNESSES

- SeaSketch excels in extensive marine plans but faces **challenges in small, detailed MPAs**. Challenges arise when dealing with intricate spaces, potentially slowing down processes.
- CoP members express the need for **more time to prepare and discuss results**, citing low digital skills and difficulties organising online or hybrid events.
- **Spatial data knowledge gaps/ availability** (including socio-ecological) challenges for mapping trade-off scenarios.
- Unresolved questions surround the implementation of strong **protection measures for cetaceans** and determining appropriate protection area sizes.
- The tool's inflexibility, such as challenges in **visualising all layers during the survey**, highlights the need for a more adaptable platform or more **time/knowledge to develop the base maps** accordingly.
- A comprehensive **framework with scenarios and ecological and socio-economic criteria** is crucial for effective trade-off analyses.
- **Limitations of 2D mapping** in capturing the complexity of the pelagic system suggest the need for alternative tools, emphasising the call for advanced technological solutions.

OPPORTUNITIES

- SeaSketch proves **valuable for strategic planning** in maritime regions.
- Facilitates **systematic addressing of potential new uses** and activities.
- **Stakeholders** in various regions express **commitment to the blue economy**.
- Enables discussions and meetings in local fishermen's places for **increased stakeholder involvement**.
- Use SeaSketch in the Maritime Spatial Planning (MSP) **implementation and evaluation phase** in a timely manner.
- Integrates **socio-economic and ecological criteria** for effective MSP and MPA management.
- **Fosters collaboration among MSP and MPA** managers and stakeholders.
- Adaptable to incorporate **transboundary information** and address data gaps.
- Instrumental in comprehensive trade-off analyses, **supporting informed decision-making** in maritime planning.

THREATS

- **Weak governance and political inaction** present challenges for effective planning initiatives.
- Careful consideration of **SeaSketch's role is crucial to avoid misuse** and ensure effectiveness.
- The tool can support political decisions by highlighting **areas of opportunity or conflict**.
- Logistical challenges include difficulty finding gathering companies, **time constraints, and stakeholder fatigue**.
- SeaSketch's implementation may vary at **different stages of the management cycle**.
- **Overlapping with ongoing initiatives** and relevance is limited to a basin-scale in some regions.
- **Limited knowledge of climate change** impacts on cetaceans poses challenges.
- **Uncertainty** about the future impact of tourism and the economic consequences of declining activities.
- Onshore **sea space faces challenges of overcrowding**, limited alternatives, and a scarcity of trained human resources.
- **Stakeholder fatigue and duplicate work risk** due to multiple ongoing projects complicate planning efforts.

5.8.1 Strengths

SeaSketch has proven highly valuable as a crucial tool for gathering specific spatial information and structuring discussions on effective area management. It plays a key role in guiding discussions toward actionable outcomes, minimising circular debates related to area diagnostics. The tool's flexibility allows for both remote and in-person formats, addressing the challenges of fragmented territories. Moreover, it supports hybrid approaches, enabling remote surveys or individual in-person interviews, with collaborative work presented in subsequent in-person workshops for further discussion and planning.

The methodology employed, supported by SeaSketch, has been effective in fostering discussions among participants, particularly during in-person events that facilitated the inclusion of new stakeholders. The methodology's clarity in posing questions has contributed to informed decision-making. Factors such as data availability, leveraging stakeholder knowledge, local area familiarity, and building upon existing research have played crucial roles in the success of the approach.

Conducting SeaSketch participatory mapping surveys for trade-off analysis has emerged as a robust platform, leading to important discussions and diverse feedback from the CoP members. The tool's contribution extends to facilitating discussions on both local and cross-border spatial scales, emphasising the need to expand MPAs networks and their improved integration into MSP. The tool's effectiveness in remote survey formats, demonstrated in the Bulgarian test site, underscores its utility in accommodating online options and enhancing accessibility and engagement.

Having trade-offs as a central theme for workshops has been instrumental in sparking discussions and capturing diverse viewpoints within the CoP. The organic emergence of trade-offs during discussions reflects the ability to bring together a diverse group of participants. The live presentation of survey results directly with participants, even in hybrid formats, has proven effective in fostering meaningful discussions.

In specific applications, the participatory tool has played a crucial role in discussions related to pelagic habitat protection, allowing for the identification of important areas for ecosystem functioning, particularly those related to the water column, such as nursery and feeding areas. Overall, SeaSketch has demonstrated its versatility and effectiveness as a collaborative tool in the complex landscape of marine area management and trade-off analysis.

5.8.2 Weakness

While SeaSketch proves highly effective for extensive marine plans, challenges arise when dealing with very small MPAs that demand a high level of detail. The tool may appear better suited for planning larger areas, potentially slowing down processes in smaller, intricate spaces. CoP members express the need for more time to discuss SeaSketch results, highlighting low digital skills among participants and difficulties organising online or hybrid events in specific locations.

In addressing knowledge gaps on species location and collision risks, particularly for cetaceans, mapping trade-off scenarios becomes challenging. Questions about implementing strong protection measures for cetaceans and determining the appropriate size for areas with robust protection remain unresolved.

Several issues were identified during the survey process, such as the inability to consult spatial allocations and the lack of high-quality spatial data in the Bulgarian part of the Black Sea. The tool's inflexibility, including difficulties in visualising all layers during the survey and challenges for CoP members with limited digital knowledge, underscores the need for a more adaptable platform. A comprehensive framework involving scenarios and ecological and socio-economic criteria is essential for effective trade-off analyses.

In the BPNS, participants found SeaSketch less appropriate due to existing spatial designations and the difficulty visualising it during the survey. The survey's filling process resulted in silent periods during workshops, impacting group dynamics. Technical questions, particularly for those with socio-economic backgrounds, posed challenges, revealing the need for a more user-friendly interface. The tool's lack of flexibility, including difficulties incorporating uploaded data as base maps, further emphasises the need for enhanced adaptability.

Moreover, the limitation of 2D mapping in capturing the complexity of the pelagic system led to suggestions for alternative tools like 'The Reef´ (Annex 5), a virtual reality setup used for marine training in Ostend, indicating the need for more advanced technological solutions in certain contexts.

In general, some weaknesses could be strengthened or resolved with more time and technical proficiency in using the tool, both in preparing the survey and analysing and presenting the results. Additionally, the proposed exercise could be divided over more than one day, facilitating information gathering, which could be conducted online in cases where the group is digitally literate. In a subsequent phase, with a time interval for data analysis, the discussion of trade-offs could be based on the obtained results, gaining more strength and influence in decision-making processes.

5.8.3 Opportunities

SeaSketch serves as a valuable tool for strategic planning in maritime regions, offering opportunities to address evolving activities and uses systematically. In one region, stakeholders express support for potential activities like aquaculture, sailing competitions, and increased ship traffic, highlighting the commitment to a blue economy. In the Azores, the meetings in fishermen's places enhance stakeholder involvement, emphasising surveillance and garnering unanimous support for a proposed MPA at level VI (IUCN).

One of SeaSketch's strengths lies in its ability to integrate socio-economic and ecological criteria, enhancing the effectiveness of MSP and MPA management. The tool fosters collaboration among MSP and MPA managers and various stakeholders,

creating a conducive environment for information exchange and joint decision-making. Furthermore, SeaSketch proves adaptable, allowing for incorporating transboundary information and addressing data gaps, which is crucial for comprehensive trade-off analyses.

In Belgium, a smaller country with a data-rich maritime area, SeaSketch was utilised for trade-off analyses in MSP, benefiting from stakeholder awareness and easy identification. The tool's capability to incorporate transboundary information and highlight data gaps contributes to informed decision-making, making SeaSketch an instrumental asset in fostering proactive planning and collaboration in diverse maritime environments.

In summary, SeaSketch stands as an instrumental platform in the maritime planning landscape, supporting informed decision-making, promoting stakeholder engagement, and contributing to the successful implementation of MSP and MPA initiatives. It can be used in different phases of the political cycle, like planning, implementing, and evaluating.

5.8.4 Threats

The challenges of weak governance, political inertia, and illegal situations create a complex framework for effective planning initiatives. The role of SeaSketch in this context needs careful consideration to avoid potential misuse and ensure effectiveness. It could serve at different stages of the management cycle, either supporting initial political decisions by highlighting opportunities or conflicts or being employed later in the planning stage. Difficulties in finding a gathering company, time constraints, and stakeholder fatigue pose logistical challenges in implementing in-person meetings.

SeaSketch overlaps with ongoing initiatives in some regions and may only be relevant at a basin scale. Limited knowledge about climate change impacts on cetaceans and uncertainties regarding the future impact of tourism and the economic consequences of declining activities add complexity to planning. The Bulgarian onshore sea space faces overcrowding limited offshore alternatives, a scarcity of trained human resources, and gaps in data and climate change considerations in MSP plans and MPAs. Stakeholder fatigue and the risk of duplicate work due to multiple ongoing projects complicate the situation. Additionally, the complex nature of climate change and plankton dynamics is often overlooked due to perceived complexity and knowledge gaps.

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6. ESE Framework 3

The trade-off analysis will undergo a seamless transition into the ESE3 (Ecological-Socio-Economic) framework through a carefully adapted methodology designed for replication. This conversion process will draw upon comprehensive guidance embedded in the responses to specific guiding questions, ensuring clarity and coherence in the argumentation. All necessary materials, including annexes, will be thoroughly reviewed and incorporated to provide a holistic view of the trade-off analysis within the ESE framework.

The methodology will be adapted to replicate the successful trade-off analysis, aligning it with the nuances and requirements of the ESE3 framework. The guidance derived from the guiding questions will serve as a roadmap, directing the integration of trade-off analysis outcomes into the broader context of ES. This structured approach ensures a systematic and transparent transition, allowing for a seamless incorporation of trade-off insights.

In addition to the primary trade-off analysis, supplementary materials such as the bibliography folder, ES (Ecosystem Service) mapping methodology, and illustrative examples will be leveraged to enrich the ESE3 framework. These resources will enhance the depth and breadth of the evaluation, providing a robust foundation for understanding the interplay between trade-offs and ES.

In essence, the conversion process will draw upon the adapted methodology, guidance from guiding questions, and a wealth of supplementary materials. This ensures a comprehensive and well-informed integration of the trade-off analysis into the ESE framework, fostering a nuanced understanding of ES within the broader context of the study.

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7. Recommendations

Table 3 contains recommendations from the CoP from MSP4BIO trade-off exercises structured according to Table 1 from Magalhães et al., 2019.

Table 3: Recommendations from MSP4BIO

Stage	Recommendations from MSP4BIO trade-off exercises
1. Early Decisions	Before beginning the process, examine the past initiatives. This is important to avoid past mistakes and highlight the best practices for better results. Furthermore, the socio-cultural and jurisdictional challenges must also be examined.
	Starting with simpler issues that fall within the existing framework, can set oneself up for success. This approach allows for identifying opportunity areas that can be quickly and efficiently capitalised on.
	It is crucial to carefully choose the stakeholder engagement format more appropriate to context. For e.g. workshops, working Groups, NGOs (as not all regions may find CoP format suitable).
	Finding the right tool to use for participatory mapping is essential before starting the process. SeaSketch proved to be valuable for participatory mapping, but other tools are available. Comprehensive reporting is essential to communicate results effectively. More resources are needed to produce comprehensive reports.
	SeaSketch is good for data collection or smaller scales, as it may not be suitable for exploring larger areas.
	Before the process, basemaps must be prepared for participatory mapping. Despite its complexity, simplifying the preparation of basemaps on Mapbox is recommended.
	Exploring alternative software like MSP Challenge for discussing trade-offs in specific test sites.

	The visualisation of results is important, thinking of a two-day format for CoP interactions could help improve this visualisation.
	Before organising the workshops, it should be noted that in-person workshops are preferred for better engagement and discussion of opportunities in some cases.
2. Acceptable and Negotiable Aspects	Illegal activities are also part of the negotiable aspects, but as it is difficult to have data about them, intensifying surveillance in sensitive zones could indirectly deter illegal activities.
	Thinking about the future of military zones helps to avoid future complications and conflicts.
	The support of a new MPA by the stakeholders with some conditions, therefore negotiations should happen between the stakeholders. Participatory monitoring should be suggested.
	The uncertainties are inherent to complex socio-ecological systems, so accepting them and addressing multiple scenarios while explaining them could be useful in defining the acceptable and negotiable aspects.
	Having crowded onshore areas and MPAs could be a source of conflict, as the two are incompatible. Exploring opportunities for compatibility is therefore needed.
3. Decision-making process support	To support the decision-making process, improving policy coherence between the MSFD and MSP Directives for better MPA integration is needed.
	As one of the challenges of MSP is the lack or the gap in the data, conducting offshore studies on marine mammals, implementing automated detection, and tracking their food chains should be useful to complete these data to support the decision-making process with more arguments.
	One of the biggest uncertainties in MSP is Climate change, and therefore Climate Change scenarios are still challenging to address, their comprehension should be expanded.
	Visualising all preliminary layers during participatory mapping allows us to understand the workshop results quickly and easily and, therefore, to support the decision-making process with more arguments.

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8. Test Sites Analysis and Conclusion

In the culmination of Deliverable 4.3, the Trade-offs Method for Protection and Restoration in Maritime Spatial Planning (MSP) based on the Ecological-Socio-Economic (ESE3) framework emerges as a multifaceted and adaptable approach.

In reflecting on the timeline for implementing the CoP interactions from November to January, it is commendable to note the exemplary work carried out by all CoPs. Undertaking activities of this nature demands dedicated time for execution, and while the methodology was introduced in July and thoroughly discussed, the commitment shown during the latter months has been instrumental in its refinement.

The feedback received underscores the following:

The efficacy of SeaSketch as a valuable tool for participatory mapping. However, it is essential to acknowledge the resource constraints encountered by the CoPs, emphasising the need for more time and financial support. This recognition aligns with the understanding that comprehensive reporting aligned with participants' needs requires a substantial investment of resources, both in terms of time and funding;

The insights provide valuable considerations for refining and optimising the application of SeaSketch and the overall ESE3 framework. Balancing the ambitious goals of the methodology with the practical constraints faced by the CoPs will be crucial in ensuring its sustained success and meaningful contributions to Maritime Spatial Planning and marine conservation efforts;

The acknowledgement of SeaSketch's utility, coupled with the awareness of its potential constraints, forms a cornerstone for refining its application;

The emphasis on in-person workshops, technical feedback, and the need for additional resources for comprehensive reporting underscores the dynamic nature of the proposed methodology;

The integration of socio-economic and ecological criteria in MSP and MPA management, as evidenced in various regions, highlights the versatility of the ESE3 framework. The methodological adaptability to incorporate transboundary information, address data gaps, and conduct comprehensive trade-off analyses stands out as a valuable aspect. The need for continuous research, especially in areas like marine mammal behaviour and climate change impacts, underscores the evolving nature of MSP.

In conclusion, the present Deliverable 4.3 not only presents a trade-offs methodology grounded in the ESE3 framework but also encapsulates the collaborative spirit of stakeholders and the dynamic challenges in diverse maritime contexts. As we navigate the complexities of MSP, the Guidelines for applying trade-off methodology provides a structured yet flexible approach, paving the way for informed decision-making, sustainable practices, and the effective protection and restoration of marine ecosystems.

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Final note

The annexes in this document provide detailed supplementary explanations of the content found in this Deliverable. They should be consulted alongside the main document for a comprehensive understanding of the material.

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10. Annexes

1. **Guidelines for partners**
2. **Portfolio of Arguments**
3. **Reporting guide**
4. **Example of data Analysis in the Graciosa Island Trade-off**
5. **Table Participatory Mapping Tool**
6. **Table Climate Vulnerability Tools**
7. **Ecosystem Services mapping**
8. **Partners Answers**

1. Guidelines for partners

30/07/2023

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Introduction

Welcome to this guide for carrying out the Trade-Off exercise as part of the MSP4BIO task T4.3 – Participatory development of integrated trade-off scenarios (ESE 3).
To perform it, methodological guidelines were developed for participatory-based trade-off scenarios, to weigh the impacts of the multi-objective spatial and strategic management measures (i.e., uses impact on ecosystem services) in close interaction with T4.2 - Strategic and Spatial measures for blue economy sectors (ESE3). Using the set of tools provided by the toolkit in D3.4, the trade-off scenario methodology will also integrate a participatory mapping approach, thus providing an insight into the different perceived values of Marine Protected Areas (MPAs) and their trade-offs (i.e., if spatial fishery restriction is to be imposed what is the social feedback?). Apart from looking for the best ways to mitigate conflicts among user groups, these guidelines will also focus on positive trade-offs or synergies between Ecosystem Services (ES), marine and coastal uses and human well-being.
Close interaction with the community of practice CoP is crucial since measures might change the local 'willingness to protect'. Participatory mapping will also be used to provide feedback to the Ecological Toolkit (D3.4), thus helping to structure prioritisation criteria by presenting maps of alternatives with high social acceptance. The climate change vulnerabilities criteria and maps (produced in T3.2) will be included in the trade-off scenarios to make them climate-proof and resilient in supporting biodiversity conservation and environmental protection or restoration of the ecosystem within a Marine Spatial Planning (MSP) framework and to identify internal and external social, economic, and ecological factors to achieve adequate protection and restoration.
The trade-off scenarios will be applied in the test sites (T5.3) and fed into an online scenario visualisation tool (T7.4) and the ESE framework (T4.4). The compilation of trade-offs in the case study sites will be provided in the frame of deliverable 4.3.

Marine Spatial Planning

Maritime spatial planning (MSP) is a process that involves the planning and management of human activities in marine areas to achieve ecological, economic, and social objectives that are usually specified through a political/public process. The MSP processes face the issue of finding solutions for multiple trade-offs between different human activities and conservation needs to guarantee the flow of ecosystem services that support human well-being while ensuring the healthy functioning of marine ecosystems.
Overall, MSPs must navigate these trade-offs to promote marine protection and resilience while also supporting sustainable economic development.

The ultimate goal of addressing trade-offs in MSP is to achieve a more sustainable and integrated approach to managing marine resources and space, considering the long-term well-being of both societies and marine ecosystems.

Concepts

In the context of MSP, a trade-off refers to the compromise or exchange between different objectives, interests, or uses of marine resources and space. The decision-making process must weigh the potential benefits and costs associated with various uses or management options, considering ecological, social, and economical factors. Trade-offs in MSP require careful consideration and balancing of these different factors and interests.
Trade-offs can be addressed through stakeholder engagement, scientific analysis, and the use of decision-support tools (DST) to help identify optimal solutions that minimise negative impacts while maximising overall benefits. Trade-offs can arise in strict connection to specific goals, interests, and activities involved.
Different types of trade-offs might be found and organised as follows:

Trade-off between conservation and economic development objectives. MSP must balance the need to protect marine ecosystems while supporting economic activities such as fishing, shipping, and tourism. For example, designating MPAs can limit opportunities for fishing and tourism industries and thus the monetary revenue generated from those activities.

Trade-off between short-term and long-term benefits. MSP must balance the immediate benefits of certain activities with the long-term benefits of protecting marine ecosystems (e.g., allowing oil and gas exploration and drilling can provide short-term economic benefits but can also have long-term negative impacts on the environment and marine life).

Trade-off between exclusive uses and shared uses. When decisions about the allocation of marine space may involve trade-offs between exclusive use for a specific activity or multiple shared uses, on the same space or resource. Requires considering different stakeholder interests for that area and balancing between various uses, like fishing, marine protected areas, recreational zones, shipping lanes, etc.

Trade-off between specific stakeholder interests. Since different stakeholders may have different priorities and objectives. To advocate the interests of commercial fishermen, local communities, conservation organisations, researchers, maritime tour operators, and non-governmental organisations requires trade-offs to accommodate diverse perspectives.
Trade-offs between local and regional interests. While MSP can benefit local communities through economic development and job creation, it must also consider

the impact of human activities on the global ocean ecosystem. For example, overfishing in one region can negatively impact fish populations in other regions.

These trade-offs are context-specific and depend on the particular circumstances of each MSP process. Identifying and managing these trade-offs effectively is important to achieve a balance and sustainable approach to marine resource management.

Ecosystem Services and Trade-off Analysis in MSP

The ES and trade-offs concepts are closely related within the field of environmental management.
Four main groups of ES can be identified based on the nature of the benefits humans received from healthy ecosystems, including tangible and intangible dimensions. These can be **provisioning services** such as food, fresh water, biochemicals, and genetic resources; **regulating services** such as climate regulation, disease regulation, water regulation, water purification, and pollination; **cultural services** such as recreation and tourism, as well as spiritual and religious, aesthetic, inspirational, and educational benefits; and **supporting services** such as soil formation, nutrient cycling, and primary production.
Trade-offs occur when pursuing one objective or maximising the use of a particular ecosystem service comes at the expense of other services or priorities. Trade-offs arise when managing ecosystem services and deciding how to allocate multiple resources. For example, converting a natural coastal ecosystem into a tourism enterprise may lead to habitat and species loss and reduced water filtration capacity, affecting other services such as coastal protection and water quality.
The relation between trade-offs and ecosystem services regularly requires **assigning values to these services**. The valuation can be done by economic measures (e.g., monetary valuation) as well as non-monetary approaches that consider social and cultural values (e.g., importance/ relevance for the community). These can help quantify the benefits and costs associated with different services, comparing and assessing trade-offs easier.
Trade-offs in ecosystem services are central to decision-making processes. In these processes, stakeholders and decision-makers evaluate the potential impacts of different management options and consider the trade-offs involved. Recognising and managing trade-offs is essential for integrated ecosystem management and sustainable development. Decision-makers can aim for a more holistic and balanced approach to resource management, striving to optimise the overall benefits while minimising negative impacts.
These integrated approaches help identify win-win solutions or strategies for synergies among ecosystem services. To achieve more sustainable and equitable outcomes,

trade-offs can be managed by considering the interdependencies among ecosystem services.
Understanding the relationship between ecosystem services and trade-offs can help the decision-making process, ensuring that trade-offs are carefully evaluated, and sustainable management strategies are pursued.

Methodology to map Ecosystem services

What exists – This step is supported/performed by UAc Team

The first step is to explore existing geographical information supporting ecosystem services in each study case. With the results of T4.1, the three most important ecosystem services for each study site are able to be highlight. To select these three most important ES, the ranking of each ecosystem service and the percentage of answers possible must be checked, the higher the percentage, the more reliable the ranking of ecosystem services.
Then, explore each criterion related to the three most important ecosystem services in order to know which criteria are useful to map in each pilot's sites. The task 4.1 linked the various criteria to each ecosystem services.
Finally, to map each criterion, check all the useful data on T 2.2.

Methods to map ES

In order to map each criterion, two methods were chosen: criteria overlay and hotspot of information/Bio layers. They are explained in the following points.
This involves mapping the biophysical characteristics of ecosystems that contribute to the provision of ecosystem services.
Criteria overlay (Azores proposal)
The first method identified for mapping ecosystem services is to overlay each criteria related to the ecosystem services. The Multi-Criteria Decision Analysis is a method to structure and formalize decision-making process, but it would require expert judgement.
The positive aspects of this method are that it is robust but requires time and human resources.

Hotspot of information

To create this type of map, an overlay all information about the ecosystem component layers must be produced. This method will aggregate the binary assessment of the contribution of the ecosystem services for each ecosystem component. This method will therefore highlight the areas with the most ecosystem services suport.
This method has the advantage of being simple to use and requires limited human and time resources. However, the disadvantage is that it is not as robust. Indeed, it only considers the presence or the absence of information about the ecosystem to produce the map. Moreover, each component of the map is considered equal. This

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implies a reduction in the accuracy of the information we want to represent (HELCOM, 2023).

Participatory Mapping

There are various tools available for participatory mapping. Burnett (2023) edited a book titled "Evaluating Participatory Mapping Software," which lists tools and their respective strategies for efficient data collection suited to different needs. The compiled material, along with other tools, is presented in Table 1 at the end of this document. However, it is important to note that the solutions presented in the table should not limit the choice of methodologies for each case study. Case site leaders are free to choose the most appropriate methodology for their project according to the general outline and process steps.
For those partners who prefer using SeaSketch software (SeaSketch, 2023), training is arranged with project developer Will McClintock. The training will take place after the next GA Meeting on the 8th and 9th of November 2023 in a hybrid format. We recommend that case study leaders have the GIS information for their area beforehand in preparation for the training.

Step-by-step methodology:

Remember that this methodology will be used along with:
Annex 01 – Portfolio of arguments to support trade-offs.
Annex 02 – Example of Survey for Graciosa Island (in SeaSketch).
Annex 03 – Example of Graciosa Scenarios.
Annex 04 – PowerPoint – What is a trade-off.
Annex 05 – Layout/guidelines for reporting.

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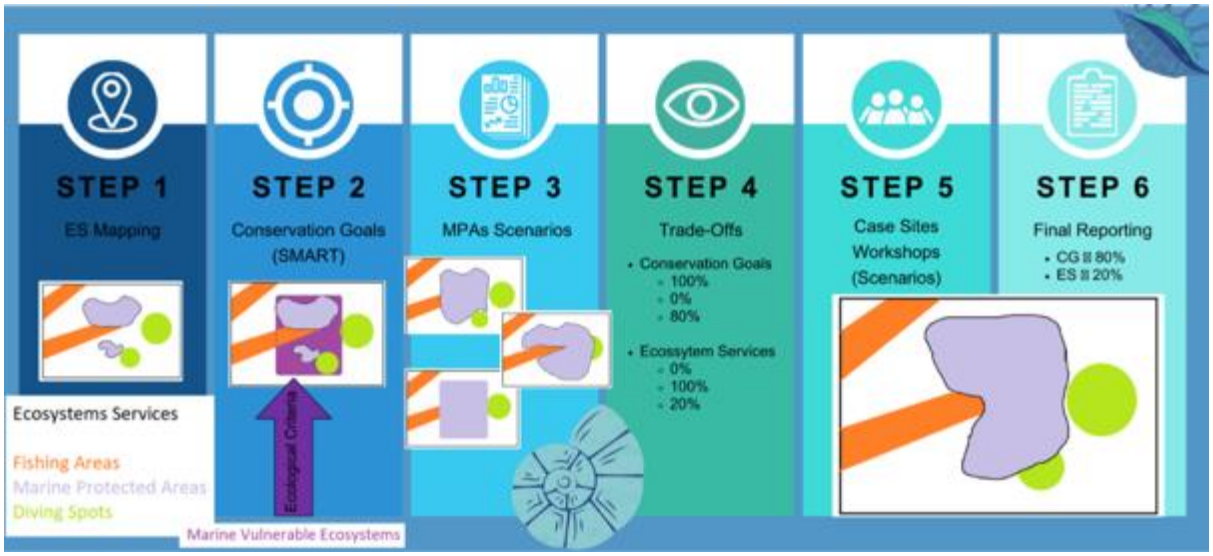

A. Before III CoP interaction (planned for November/December)

1. Based on the geographic information (identified in Task 5.1 and Task 2.1), make a folder exclusive of your case study with the download of all GIS and include it in a working folder (can be here).

2. Make a list of criteria/ecosystem services listed and ordered by priority (identified in Tasks 4.1) for your case site (UAc Team is supporting this step).

3. Identify a natural value to be protected. (e.g. Dark Coral) and Define Conservation Goal (e.g. protect 20% of Dark Coral).

4. Choose a tool to develop the work (See table 01 for suggestions). For those who choose SeaSketch, face-to-face/online training will be conducted on the 8th and 9th in Split, after the GA Meeting with the tool developer Will McClintock. **If you bring all your materials organised, you can directly develop the survey tool there.**

    1. Include the spatial data in the tool to be used (you should have this done before the SeaSketch training if you want to use this tool i.e before 7/8 November);
    2. Create a "participatory mapping survey" for your case study that can bring CoP to answer the guiding questions (Task 5.3) and consider the prioritised criteria (A.2). Remember to include open questions for collaborative mapping on important areas for specific activities, areas of conflict, and areas of synergy;

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The questionnaire will be in three Parts I, II and III; The Graciosa survey can be used to inspire your questionnaire (Graciosa example);

1. "Participatory Mapping Survey" Part I – Data Collection and perception;

For those using SeaSketch, you can use the training to start designing the survey; the goal is to collect spatial information about uses (existing and potential), conflict areas and possible valuation of areas for trade-offs. Those using other participatory mapping tools (PPMT) will have to adapt to their tool.

Examples of questions:

- Map known/ licensed existing uses in your area.
- How is your use in the area?
- Map areas of conflict.
- Areas with potential for expansion or relocation of your activity?
- What are the priority areas for conservation?

2. "Participatory Mapping Survey" Part II – Showcase the data analysis and validate; Draw scenario examples based on the uses, conflicts and services criteria (which you can learn to develop during the workshop with Will in Split); these are to be discussed on part 2 of the interaction and agreed upon the consensual solution. (See 2.1.7).

Examples of possible analysis will be delivered by the SeaSketch team.

3. "Climate Change Perception Analysis" Part III – Explain the Climate Change (CC) projections/ scenarios for your area. Do a perception of impacts analysis with the participatory mapping tool.

Examples of questions:

- How likely it will change with CC
- How does CC affect the use of Ecosystems services?
- How does CC will affect your use?
- What would be the Climate Change impact (-5 = negative impact; 5 = positive impact)?
- How can we adapt to Climate Change in the area?

At least 3 hours of a face-to-face workshop is recommended (to be adjusted by each case study leader).

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B. During the meeting

1. Making the participatory trade-offs.

    1. Explain what trade-offs are (2/3 slides provided by UAc Team in the annexe 04);
    2. Based on what was identified in 5.1 (guiding questions), present issues to be discussed/ addressed at the meeting (optional);
    3. Remind the criteria/ ecosystem services ranked during II CoP interaction (Task 4.1);
    4. Present the ecological values of your case study (WP3 results to be confirmed VME or any natural value or specie);

a. For the case sites where it has been decided to create a new MPA in the last CoP interaction: 1. point it out 2. **draw the new protected area** 3. Identify Ecosystem Services in the Area

b. **or** other important feature to protect and 1. what extent of protection you are aiming (20%, 30%...); **Establish a clear objective for the discussion and 2. draw it on the map;** 3. Identify Ecosystem Services in the Area.

    5. Pass out the questionnaire (A.4.2.1 – Part I) for CoP members to interact on (remember to map important areas for specific activities, areas of conflict, and areas of synergy); à The intention is to pass part I in a morning event and Part B in the afternoon;

    6. Develop Scenarios mapping (A.4.2.2 – Part II);

    7. Develop Climate Change analysis (A.4.2.3 – Part III)

    8. Make the analysis together with the CoP members. Create possible scenarios based on the priority criteria/ rank of Ecosystem Services Importance of your case study (example of Graciosa in annexe 03);
    9. "Vote" to decide which agreements may be relevant for the region according to the specific needs of your case study. Structure prioritisation criteria by presenting maps of alternatives with high social acceptance. Use the “Arguments Portfolio” in annex 02 to negotiate your solution;

2. Write down the main points of discussion (as per the template that will be provided).

3. Registration of the meeting (photo/print screen/recording).

4. Download the maps into your GIS folder (allocated in WP4 – 4.3 in SharePoint).

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C. After the meeting

1. **Deliver activity reports to UAc by 31/12.**

2. Send feedback to CoP members (D4.3) by March/2024, after the Deliverable 4.3 approval (optional).

Complementary literature

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2. Portfolio of Arguments

Authors: Débora Gutierrez, Helena Calado, Raquel Reis Coimbra

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Introduction

Trade-offs are addressed through stakeholder engagement, scientific analysis, and the use of decision-support tools to help identify optimal solutions that minimize negative impacts while maximizing overall benefits. And they can arise depending on the specific goals, interests, and activities involved.

Trade-offs are context-specific and depend on the particular circumstances of each marine spatial planning process. Identifying and managing these trade-offs effectively is important to achieve a balanced and sustainable approach to marine resource management. There are common types of trade-offs that occur:

Trade-off between marine conservation and economic development

The trade-off between marine conservation and economic development is a complex and delicate balance that societies and governments must navigate. On one hand, the conservation of marine ecosystems is crucial to preserve biodiversity, protect iconic species, and ensure the long-term health of our oceans. On the other hand, coastal communities often rely on economic activities such as fishing and tourism, which can pressure these fragile ecosystems. **Striking the right balance involves sustainable practices allowing economic growth while minimizing environmental harm**. It also requires innovative solutions, such as **creating marine reserves and responsible resource management, to ensure that conservation and economic development coexist harmoniously** to benefit present and future generations.

Marine reserves hold a special allure for divers, promising remarkable conservation benefits. These underwater sanctuaries often **witness an upsurge in fish abundance, species diversity, and the flourishing of iconic marine life**, along with improved coral reef conditions. Beyond their ecological significance, **marine reserves have the potential to enhance the economic value of all associated businesses in the tourism sector**, including hotels and restaurants, particularly those reliant on underwater activities like dive centres. However, the extent of these advantages hinges on factors such as the reserve's location and fish biomass within its boundaries. In contrast, marine reserves situated in areas devoid of other coastal attractions may primarily attract experienced divers enticed by abundant fish biomass and diversity. Such locations might need a strategic marketing approach to compete with diverse global diving options. From a tourism perspective, it becomes evident that the economic feasibility of marine reserves must not be underestimated. Additionally, using **revenues generated through user fees** to offset potential costs associated

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with reserve creation **can be crucial to gaining the support of local stakeholders and increasing conservation effectiveness** (Viana et al., 2017).

MSP must balance protecting marine ecosystems with supporting economic activities such as fishing, shipping, and tourism.

- Designating marine protected areas (MPAs) can limit economic opportunities for fishing and tourism industries.
- Creating a reserve near a port can cut costs for tourism and enforcement but might raise expenses for fishermen who have to travel farther to their fishing spots (Viana et al., 2017).
- **Marine Reserves can potentially boost the value of tourism-related businesses**, particularly those reliant on underwater activities like dive centers, as they attract more visitors (Viana et al., 2017).
- Impact assessment: Defining which human activity has the most direct impact and measuring the indirect impacts on marine habitats depends on good and reliable data on marine ecosystems (D2.3, page 199).
- Lack of introduction of real protection measures, or their minimal spatial extent, or even the lack of control has been recognised as the reason for easy acceptance of new designations by stakeholders (*e.g. Eastern IFCA and the Wash and North Norfolk Coast in UK, Vlaamse Banken in BE, Lapas - Limpets - Areas de Restrição de apanha in PT)* (D2.3 - page 84).
- Emphasize that stakeholder involvement significantly enhances the effectiveness of governance practices within Marine Protected Areas (MPAs). Involving stakeholders through inclusiveness, transparency, and accountability not only boosts the legitimacy and support for conservation efforts but also fosters a sense of ownership (D2.3; Bennet et al., 2019). These practices ensure that the voices of those who may be disproportionately affected by environmental degradation or conservation measures are heard. Additionally, they help identify strategies for livelihood support and other measures aimed at mitigating negative impacts and maximising conservation benefits (D2.3 - page 92).

Examples of management measures:

- In regions where tourism significantly outweighs the value of fisheries, closing the entire area to fishing is the optimal choice (Viana et al., 2017).
- Evaluating in terms of economic impact, there could be a potential shipping lane displacement or traffic report due to speed limitation measures (North-western Mediterranean PSSA, D2.3, page 88).
- Compensation measure to compensate stakeholders (e.g. fishermen or other restricted activity).

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Table 1. Specific events of trade-offs between marine conservation and economic development

Sea-Basin	Site name	
Baltic Sea	Signilskär-Märket Islands MPA (D2.3 - page 83)	fishing (both commercial and recreational) and hunting are still allowed and the National Natural Marine Reserve Cerbère-Banyuls where negotiations were undertaken for spatial allocation of protected areas, fishing areas and areas where scuba diving and anchoring of boats are allowed
Northwestern	North Sea Sandeel Fishery Closure case (D2.3 - page 83)	stakeholders, including fishers, have recognised the existence of impacts on ecosystems and natural resources and the need for protection.
North-East Atlantic	Archipel des Glénan (France) (D2.3 - page 87)	Different MPAs overlap in this area. Although there are more regulations and longer consultation processes, the MPAs are complementary, enhancing communication and coordination between stakeholders.

Trade-off between ecological and cultural values

The trade-off between ecological and cultural values represents a complex interplay between environmental conservation and the preservation of cultural heritage. Development projects or resource use can often clash with protecting ecosystems that hold cultural significance. Striking a balance necessitates thoughtful consideration of respecting and preserving both aspects. Indigenous communities, for instance, often have deep connections to their natural surroundings, and their cultural practices may revolve around sustainable interactions with the environment. **Balancing ecological conservation with cultural values requires engagement, collaboration, and integrating traditional knowledge into conservation efforts**. It's a dynamic process that aims to honour the rich tapestry of cultural traditions while safeguarding the natural world for future generations.

- It could involve debates over the construction of coastal infrastructures, between preserving the natural coastal environment and the cultural values of safeguarding heritage and communities.
    - Environmentalists argue against constructing coastal infrastructures like seawalls or breakwaters because they impact the ecological integrity of coastal processes and habitats to benefit wildlife and the marine environment's overall health.
    - Local communities and cultural groups may argue in favour of these instructions as a means to protect their homes, historical sites, and cultural heritage from coastal erosion and storm damage. Prioritising the immediate protection of their communities and cultural sites over ecological concerns

- Underwater Cultural Heritage - Table 2.

Table 2. Specific events of trade-offs between ecological and cultural values.

Site name	
Protected shipwreck sites in the Belgian sea	Measures addressing fishing and prohibiting trawling, exert a double effect on the conservation of both natural and cultural values (D2.3 page 92)
Dori underwater archaeological park in the Azores	
The Kaliakra Natural Reserve/protected area in Bulgaria	
Protected shipwreck sites (Belgium, North Sea) (D3.2, page 173)	Recreational diving and protection of maritime archaeological heritage can go hand in hand. An example is the initiative taken on two protected wreck sites Westhinder and the Kilmore. In 2021, they were cleaned from litter (fishing nets, fishing lead, fishing baskets, dredge anchors from divers, etc.) by recreational divers. An important trade-off must be noted. Removing marine litter may be beneficial for the natural fauna and flora, at the same time, it may make the wreck more susceptible to degradation.

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Trade-off between short-term and long-term benefits

The trade-off between short-term and long-term benefits is a fundamental consideration in decision-making across various domains, from economics to environmental conservation. It involves the challenge of choosing between immediate gains and sustainable, lasting outcomes. Opting for **short-term benefits can provide immediate gratification or economic advantages but may come at the expense of long-term consequences**, such as resource depletion or environmental degradation. Conversely, prioritizing long-term benefits often requires patience, planning, and investments that may not yield immediate rewards but can lead to more enduring and resilient outcomes. Striking the **right balance between short-term and long-term considerations is essential for informed and responsible decision-making, as it shapes the trajectory of individual and societal progress**.

MSP must balance the immediate economic benefits of certain activities with the long-term benefits of protecting marine ecosystems.

- For example, allowing oil and gas exploration and drilling can provide short-term economic benefits, but can also have long-term negative impacts on the environment and marine life.
- The trade-off debate often centres on whether prioritising local interests for short-term gains may lead to long-term global costs, such as environmental degradation or resource depletion.
- Arguments illustrating the trade-off between short-term economic benefits (higher catches and profits) and long-term ecological and economic benefits (sustainable fishery and healthy marine ecosystems)
    - Prioritizing short-term economic gains: Fishermen can argue for higher catch quotas and less restrictive fishing regulations in the short term since it will lead to increased profits and more jobs in the fishing industry immediately.
    - In long-term benefits: Scientists emphasise the importance of maintaining healthy fish populations and preserving the marine ecosystem by protecting fish stocks now, arguing that it will ensure a stable and sustainable fishery for future generations and maintain the marine environment's overall health.

Trade-off between ecological integrity and human uses

The trade-off between ecological integrity and human uses is a central challenge in managing natural resources and landscapes. It revolves around **finding a sustainable equilibrium between the conservation of ecosystems and the fulfilment of human needs and desires**. Human activities, such as agriculture, urbanization, and industry, often pressure natural environments, leading to habitat

destruction and biodiversity loss. Balancing ecological integrity involves making thoughtful decisions about resource utilization, land development, and conservation efforts. Achieving this equilibrium **requires a commitment to responsible stewardship, acknowledging that the well-being of both ecosystems and human communities is interconnected**. Striking the right balance is crucial to ensure that future generations can continue to benefit from the services and resources provided by healthy ecosystems while meeting the evolving needs of society.

This trade-off can occur when a marine space has activities like fishing, tourism or recreational practices and there's a need to preserve that specific area, maintaining ecological integrity and species habitats.

- Arguments illustrating the tension between preserving the ecological integrity of marine environments and accommodating various human uses, including fishing, tourism, and cultural practices. This could implicate a debate over the establishment of MPAs.
    - Conservationists contend that healthy ecosystems can lead to increased fish stocks and improved resilience to climate change in the long term, emphasising the importance of protecting biodiversity, conserving critical habitats, and allowing fish populations to recover within these designated areas.
    - On the other hand, different stakeholders such as commercial fishermen, tourism operators, and local communities may argue that the creation of MPAs restricts their access to marine resources and economic opportunities. It can result in job losses, reduced income, and disruptions to traditional livelihood.

Examples of management measures:

- Stakeholders advocate for more permissive regulations in MPAs, in a way that management practices can achieve ecological goals without completely excluding human activities.

- Creation of a no-take zone or a marine protected area.
- Natural restoration strategies - longer recovery time and vigilance costs
- Active restoration strategies - material and labour costs
- Passive restoration implies the natural or unassisted ecosystem recovery after removing a source of disturbance: (D2.3, page 52)
    - Regulation and removal of pollution sources (e.g. wastewater treatment);
    - Remediation of contaminated sites (e.g. dredging of contaminated sediments);
    - Fisheries management measures (e.g. restrictions on bottom trawling and dredging).

Table 3. Specific events of trade-offs between ecological integrity and human uses.

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Site name	Present practices
The protected area of Signilskär-Märket Islands (Baltic Sea)	• Hunting, but within the constraints of the area's designation as a SPA area (N2000); • Dredging for the purposes of cables, but it requires permission. This would require an environmental impact assessment by the Provincial Government of Åland); • Fishing (both recreational and commercial) And certain activities are allowed, although in a restricted capacity, e.g. temporal restrictions.
Golfe du Morbihan (France, North-Eastern Atlantic)	Special Area of Conservation (SAC) Difficulties in assessing the good ecological and conservation status of habitats; also the impact assessment • The MPA governance can be challenging because it is sometimes based on political perspectives rather than technical and scientific discussions. From an environmental point of view, strategies adopted are not always adequate. • There is a significant diversification of the types of human activities at sea or on the coastline (e.g. wing foil, coastal walks), as well as an augmentation of people participating in these activities. • There are human and financial means to enhance the natural and cultural heritage of the park, although not enough to effectively manage the MPA. • Awareness-raising measures and prevention campaigns with sea users have been fruitful. The RNP team trains maritime professionals annually and educates tourists to share and promote environmentally sustainable practices. Feedback shows that most sea users would adapt their activities to reduce their impacts on marine habitats. • There is an efficient collaboration between environmental policing, the RNP, and governing bodies. Being part of projects (Life Marha and VALMER) that allow information

	sharing and best practices exchange to meet sustainable development objectives.
Ilhas Selvagens (Portugal) (D2.3, page 189)	The access of people to the land area, diving, interpretive visits, bird watching and listening and overnight stays are allowed in the context of awareness and educational activities with the authorisation of the Institute of Forests and Nature Conservation; The exercise of any fishing activities is forbidden in this entire area.
Vlaamse Banken Belgium	The Vlaamse Banken MPA was established through a Royal Decree in 2012. The authors indicated the success factors of a successful designation to be the appointment of a minister of the North Sea, awareness of the need for conservation through the different EU Directives and the level of engagement and transparency during the process. However, it was indicated that no real conflicts arose due to the lack of restrictions imposed within the MPA for the fisheries and shipping sectors, raising questions about this MPA's effectiveness.

Trade-off between exclusive uses and shared uses

The trade-off between exclusive uses and shared uses relates to the allocation of resources or spaces and the choice between restricting access to a select few or opening them up for broader group. Exclusive uses may offer advantages like focused control or preservation of resources but can limit accessibility and exclude others from benefiting. Shared uses, on the other hand, promote inclusivity and collaboration but might raise concerns about resource sustainability and equitable distribution. **Striking the right balance between these two approaches depends on context and objectives**.

Balancing the use of ocean resources involves managing various sectors, including fishing, conservation, transportation, energy generation, among other uses. The challenge is to **create policies that harmonize exclusive and shared use, serving the interests of diverse stakeholders**. This requires sustainable practices,

environmental protection, and collaborative efforts to optimize benefits while preserving marine ecosystems.

When decisions about the allocation of marine space may involve trade-offs between exclusive use for a specific activity or multiple, shared uses.

- This trade-off can highlight the tension between granting exclusive access and rights to specific industries or company users versus promoting shared access and multiple uses of a marine environment:
    - Some arguments for the exclusive access and use of a particular marine area for a specific activity such as shipping, offshore drilling, or aquaculture. Maximising the economic benefits for the industry, allowing for efficient operations and reducing conflicts, would also be essential for safety and security reasons.
    - Environmental organisations or even recreational users may argue for shared marine area use. They contend that shared-use policies can lead to more sustainable and equitable management of marine resources and promote coexistence among different stakeholders.

- Underwater Cultural Heritage (UCH) – Fisheries management and wreck management should be increasingly integrated, to drive collaborative management that can mitigate conflicts between the **fishing industry** and **maritime archaeologists** (D2.3, page 93)
    - Management measures could include the synergy between marine biodiversity to support sustainable tourism and livelihoods: artificial reef wrecks (vessels “sunk intentionally as a recreational resource”, innovative technologies, such
    - as ‘virtual dive trails’, which can increase visitation from non-divers; Knowledge Awareness Centers can also be used to inform visitors of the importance of both marine biodiversity and UCH.

Examples of management measures:

- A potential good practice associated with this MPA is the development of fishing gear restrictions for defined subzones within the MPA - in the process of being approved by the EU. (D2.3, page 173)

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Table 4. Specific events of trade-offs between exclusive uses and shared uses.

Sea-Basin	Site name	Coexistence and multi-use of the sea: present good practices
Mediterranean	Natural Marine Park of the Gulf of Lion and National Natural Marine Reserve Cerbère Banyuls (France D2.3 page 89)	• Negotiations between professional and recreational fishers do discuss the space and resource use in the area. • A compromise was sought to anchor the boats in an area where Posidonia would not be impacted. Colour code buoys were introduced. Professional fishers were allowed to continue fishing in the area if they complied with good practices, such as keeping their distance from the dive boats.
Gulf of Lion, Mediterranean Sea	Natural Marine Park of the Gulf of Lion (Parc naturel marin du Golfe du Lion, NMPGL) and the National Natural Marine Reserve Cerbère-Banyuls (Réserve Naturelle Nationale (RNN) Marine de Cerbère-Banyuls; RNMCB) (France)	Pesca, tourism is present in both the Gulf of Lion's marine reserve and marine park, with some professional fishermen and their close family members offering camping opportunities for tourists to supplement their income. These fishing tourism operators also work with authorities to educate visitors about the reserve's attributes, although only a few guides operate within the reserve itself. The reserve provides tangible benefits to fishermen, as some travel long distances to fish near the no-take area's boundaries, believing in spillover effects. Fishermen adhere to guidelines specifying catchable species and best practices, including flashcards outlining area regulations. Within the marine park, fishing guides participate in discussions on topics like creating new marine reserves and training fishermen to follow best practice guidelines, enhancing their marketing potential. Professional fishermen establish

		cooperatives for ecotourism, although administrative challenges persist. Navivoile, a prominent activity in the marine park, revolves around observing cetaceans. Although the marine reserve and the marine park don't offer guided whale-watching tours, they are engaged in all activities within the area. Meetings involving representatives of various user groups ensure awareness of regulations, and agreements with whale watchers allow the park authority to present information about the marine reserve or park. Park staff actively promote awareness in the region. Educational programs targeting school children are also in place.
Western Ligurian Sea, Mediterranean Sea	Important Marine Mammal Area (IMMA) Western Ligurian Sea and Genoa Canyon Italy	Despite the challenges of safeguarding cetaceans in this heavily exploited and vast area, the Pelagos Sanctuary's initiatives have achieved several notable milestones: ● increased public awareness, the development, and implementation of a vital management plan (a rarity for the region), ● the adoption of environmental measures by three governments to reduce impacts, ● The use of 'umbrella' species to safeguard entire ecological communities. The Sanctuary also serves as a model for large-scale, high-seas Marine Protected Areas (MPAs) that promote ecosystem-based management and regional sea agreements. Financial resources have been allocated to marine conservation, with Italy alone providing substantial funds of half a million euros annually to support the goals of the Pelagos Sanctuary Agreement. Some institutions have voluntarily gone beyond legal requirements, such as: ● the Italian Navy refraining from naval exercises involving ordnance or sonar within the Sanctuary.

		• Italian Ministry of the Environment abstaining from discharging toxic dredged mud from harbours into the Sanctuary's waters. Notably, the Parties of the Agreement have resisted adding zoning measures to the management plan, which could help define activities in specific areas, aid in conflict resolution, and be tested initially with low-conflict activities like whale watching.
North-Eastern Atlantic	Golfe du Morbihan (France)	• 2006 local maritime planning tool leading to an efficient multi-use of the sea and marine protection management. • Despite an update of the plan in 2020 and successful outcomes in terms of the co-existence of activities in the past, consultations with stakeholders to implement the strategies have been on hold.
	Archipel des Glénan (Glenan Islands) France (D2.3 page 195)	• Changes of certain socio-economic activities that compromise(d) birds' protection. • The different stakeholders' perspectives in relation to conservation means, who are involved in the site's protection. • Time in decision-making due to a relatively high amount of consultations with all the stakeholders. • Public visibility regarding the site's objectives and regulations due to the multiplicity of stakeholders and protection measures.
North Atlantic	Marine Park Professor Luis Saldanha / Arrabida Natural Park (Portugal)	However, inside the zoning scheme of the Spatial Management Plan outside the no-take area, only local small-scale traditional fisheries can operate.

North Sea	Vlaamse Banken SAC (Belgium)	The identification of gear restriction zones was informed by a combination of data on ecological features and fisheries data, which was fed into a Marxan model to identify suitable options. Preliminary analysis for zone identification demonstrates the use of a trade-off tool (Marxan) in practice
	Multi-use combination of offshore wind, flat oyster aquaculture & restoration and seaweed cultivation (Belgium)	Production of energy: Renewable energy generation (wind power), including infrastructure + The possibility of cultivating flat oysters and seaweed (aquaculture) within the windfarm site has been investigated through this project. Within the project, different strains of seaweed are tested for cultivation.
	SSMO Closed Areas (UK, Scotland)	Closing these areas was initiated by the shellfish management organisation with a grassroots approach. This approach allowed them to have control over planning, designating, and managing the closed areas. Conversations about which areas to designate were inclusive, with fishers participating in decisions about buffer sizes around the features. The fishers' proposal to define reefs/beds instead of individual organism locations aligned with OSPAR specifications, which set the minimum threshold for a reef/bed at 25m². A benefit of this bottom-up approach was that it allowed the process to proceed at a pace that suited the fishers and their representatives, unlike government-imposed deadlines. By doing so, they felt empowered to be part of the decision-making process, rather than being excluded. Compromises were also more readily reached. For example, when scallop fishers were sceptical of outdated ecological feature locations, they

		voluntarily closed areas until the locations were verified. Looking ahead, maintaining a positive perception among fishers may be challenging, especially when asked to give up more fishing grounds through top-down initiatives. Another challenge is ensuring that measures are equally applied to other activities, such as aquaculture and cable trenching, to avoid fishers feeling disadvantaged.
	North-western North Sea Sandeel Fishery Closure (UK, Scotland)	The sandeel fishery closure shows a good practice of clear and well-established objectives. Relevant stakeholders were involved from the beginning (sandeel fishery, coastal communities, and environmental NGOs). It shows the adoption of a precautionary approach by both the EU and the UK government that acted on ICES recommendations.
	UK (England)	EIFCA succeeds in engaging with key stakeholders, particularly fishers, for biodiversity conservation. By working together with them on the development of regulations, EIFCA increases acceptance, and thus efficiency, of such regulations. Strict measures protect key habitats and compliance is regularly monitored. However, it should be noted that only a small percentage of the total SAC is covered by EIFCA's restricted areas, leaving large areas unprotected. There is no overall protection of the marine environment within the SAC.
	Protected shipwreck sites (Belgium)	- Recreational diving and research activities also go hand in hand. - An example is the provision of underwater footage by recreational divers, providing information for biodiversity research on and near the wrecks, to be used for recommendations on protection measures by experts.

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		- Collaborations can also do general research on the wrecks with recreational divers.
Baltic Sea	Signilskär- Märket Islands (Finland)	Fishing (both recreational and commercial) is allowed with the permission of the provincial government of Åland.

Trade-offs between local and global interests

The trade-offs between local and global interests underscore the complexity of decision-making in an interconnected world. Local interests are often rooted in immediate community needs and concerns, while global interests encompass broader issues such as international cooperation and agreements, environmental conservation, and global economic stability. Balancing these interests requires careful consideration and sometimes involves sacrifices at the local level for the greater global good or vice versa. Striking a harmonious equilibrium between local and global interests necessitates thoughtful policies and diplomacy, acknowledging that both are interdependent facets of a complex global landscape. **Effective governance and cooperation between local communities, nations, and international bodies are crucial in addressing the challenges arising from these trade-offs** and fostering sustainable solutions that benefit both local communities and the global community.

While MSP can benefit local communities through economic development and job creation, it must also consider the impact of human activities on the global ocean ecosystem.

- In a globalised world, actions at the local level can have far-reaching consequences. Finding equitable and sustainable solutions that balance local needs with global imperatives in various policy domains, including environmental conservation, economic development, and resource management is important.
- The central argument involves balancing addressing local needs and recognising the shared responsibility for global challenges. It's a question of how to meet local objectives without compromising the broader global good.
- Equity and Justice: Ethical considerations as local communities may argue that they should not disproportionately bear the burden of addressing global challenges like climate change.
- Collaboration and Cooperation: Advocates for finding common ground stress the importance of collaboration, where local and global interests can align and mutually benefit from shared solutions. (D5.1 UNESCO/IOC and European Commission, 2021).

Local Interests:

- Immediate Benefits: Local stakeholders prioritise their immediate needs and interests, such as economic growth, job creation, or resource utilisation, which can directly impact their communities.
- Autonomy or Self Determination: Local decision-making process is based on the best suit for their specific circumstances, and sometimes they could even resist external interference.
- Resource Exploitation: Communities that rely on exploiting natural resources or industries with localised benefits but potentially negative global consequences, such as mining or overfishing.

Global interests:

- Long-term Sustainability: Global interests consider the long-term consequences of local action, in the context of climate change mitigation and environmental sustainability.
- Ecosystem services: Protecting ecosystem health and benefiting people worldwide, such as biodiversity conservation, clean air, carbon sequestration).
- International Agreements and treaties: International agreements and conventions, such as climate accords and biodiversity pacts, seek to harmonize local actions with global goals, which can lead to tensions when local interests clash with these commitments. (D5.1; Secretariat of the United Nations Convention on Biological Diversity, 2021; Conf. of the Parties to the Convention on Biological Diversity, 2022).

Table 5. Specific events of trade-offs between local and global interests.

Site name	
Pelagos Sanctuary of Cetaceans (France, Italy and Monaco)	Negotiation processes have understandably been longer when requiring collaboration amongst different countries, however the case studies shed light on how regular cooperation and communication amongst scientists from different authorities and countries, in addition to the involvement of key stakeholders such as fishermen, underpins the decision-making process of furthering conservation efforts. (D2.3 page 92)
Fishery Restricted area of Jabuka-Pomo Pit between Croatia and Italy under GFCM,	

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The specific stakeholder interests

Since different stakeholders may have different priorities and objectives. Advocating commercial fishermen's interests, local communities, conservation organisations, researchers, maritime tour operators, and non-governmental organisations requires trade-offs to accommodate diverse perspectives.

Trade-offs in marine spatial management often revolve around balancing the interests of various stakeholders vested in these critical and often fragile ecosystems. These stakeholders can range from commercial fishermen and recreational boaters to environmental conservationists and indigenous communities. **Each group has specific interests and needs in marine spaces, and managing these competing interests requires careful consideration and trade-offs.**

Fishermen vs. Conservationists:

Fishermen's Interests: Commercial fishermen rely on marine spaces for their livelihoods. They seek access to abundant fish stocks, which may require the use of certain fishing techniques that conservationists oppose.

Conservationists' Interests: Environmentalists aim to protect marine ecosystems and vulnerable species. They often advocate for strict regulations, such as no-fishing zones or seasonal closures, which can limit fishermen's access and catch.

Trade-off: Balancing sustainable fishing practices with conservation efforts often involves compromise. Finding areas where fishing can occur sustainably while protecting sensitive habitats or species is a constant trade-off.

Recreational Boaters vs. Conservationists:

Recreational Boaters' Interests: Boaters and tourists often seek access to pristine coastal areas for activities like boating, snorkelling, and diving.

Conservationists' Interests: These groups prioritize protecting coastal ecosystems, including coral reefs and seagrass beds, which can be impacted by boat traffic and anchoring.

Trade-off: Managing access for recreational boaters while preserving marine environments can involve zoning and restricted access to sensitive areas. This can lead to conflicts over where and how recreational activities are allowed.

Indigenous Communities vs. Commercial Interests:

Indigenous Communities' Interests: Indigenous communities often have deep cultural and subsistence ties to marine resources. They seek to protect their traditional practices and rights.

Commercial Interests' Interests: Large-scale commercial activities like shipping or aquaculture may compete for the same marine spaces, potentially impacting indigenous communities' way of life.

Trade-off: Balancing the rights of indigenous communities with commercial interests may involve recognizing traditional fishing territories, co-management agreements, and ensuring that indigenous voices are heard in decision-making processes.

Tourism vs. Conservation:

Tourism Interests: The tourism industry relies heavily on pristine marine environments, from beach resorts to wildlife tourism (e.g., whale watching). This can sometimes put pressure on these ecosystems.

Conservation Interests: Protecting marine biodiversity often requires limiting the negative impacts of tourism, such as habitat destruction or disturbance to wildlife.

Trade-off: Sustainable tourism practices that generate income while minimizing ecological harm are essential. Regulations on visitor numbers, responsible wildlife viewing, and waste management are examples of trade-offs in this context.

Examples of human uses and different activities happening in marine environments:

- Extraction of living resources.
- Fish and shellfish harvesting (table 6).
- Cultivation of living resources.
- Aquaculture.
- Marine Tourism and leisure.
- Tourism and leisure infrastructure.
- Tourism and leisure activities.
- Transport – shipping.
- Security/defence – Military operations.

Examples of management measures:

- No access zone for fishing activities/ regulated fishing gears: Line fishing prohibited.
- Fishing with trawling nets is prohibited.
- Anchoring regulation: Anchoring prohibited.
- Diving related anchoring can be allowed under strict circumstances and if electronic notifications are taking place.
- Dredging regulation: dredging prohibited.

- Construction works: no activities or works may be carried out that may alter the in situ protected heritage.
- Diving regulation: The diver must report any dive to in situ protected heritage to the administration via an electronic form at least 4 hours in advance.

Table 6. Specific events of trade-offs of the specific stakeholder interests.

Sea-Basin	Site name	
Mediterranean	Jabuka/Promo Pit Croatia/Italy	Only fishing zone so far.

In conclusion, managing marine spaces involves a complex web of trade-offs among various stakeholders with competing interests. Effective marine spatial planning and governance require a delicate balance considering ecological sustainability, economic prosperity, and social equity. Finding compromises and seeking win-win solutions are key to ensuring our oceans' and coastal areas' long-term health and viability.

FINANCING MARINE CONSERVATION

The guide on Financing Marine Conservation from Spergel & Moye, 2004 provides a comprehensive **overview of various financing mechanisms for marine conservation projects** (Table 7). It covers topics such as government revenue allocations, private-sector financing, and innovative financing mechanisms. The guide emphasizes the importance of feasibility analysis in determining the viability of a marine conservation project and provides examples of successful conservation financing initiatives. It also highlights the benefits and drawbacks of using government bonds and earmarked taxes for conservation. Overall, the guide aims to provide a menu of options for building conservation capital for the future (Spergel & Moye, 2004).

Table 7. Overview of various financing mechanisms adapted from the Financing Marine Conservation Guide (Spergel & Moye, 2004).

Mecanism	Resume	Source of revenue
Government Revenue Allocations		
Direct Allocations from Government Budgets	Direct Allocations from Government Budgets is a financing mechanism for marine conservation that involves allocating funds from government budgets to support	Government budget revenues

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	conservation and sustainable management of marine ecosystems.	
Government Bonds and Taxes Earmarked for Conservation	It is a financing mechanism for conservation that involves raising revenues for conservation by imposing earmarked taxes or selling interest-bearing government bonds. The money raised is used exclusively to fund conservation programs.	Investors, Tax payers
Lottery Revenues	Using revenues generated from lotteries to fund socially beneficial purposes such as education, health, historic preservation, and nature conservation. Lotteries are a government-sanctioned form of gambling and are regarded by some people as morally and socially objectionable.	Gamblers
Premium-Priced Motor Vehicle License Plates	Selling special vehicle license plates at a premium price to raise money and awareness for conservation causes. The plates are usually decorated with pictures of wildlife, scenic areas, and environmental slogans.	Vehicle owners
Wildlife Stamps	Wildlife stamps are postage stamps issued by some countries, with some intended for conservation purposes. These stamps may raise funds for conservation programs or benefit nature preservation efforts.	Postal Customers, Hunters, Fishers
Debt Relief	Enabled developing countries to spend money on environmental activities, which they would otherwise have used to repay their foreign debt. Four types of debt relief mechanisms have provided funding for the environment: commercial debt-for-nature swaps, secondary market sales of commercial debt donated by commercial banks to NGOs, bilateral debt reduction programs, and Heavily Indebted Poor Country (HIPC) debt relief.	Donors, Government, NGOs
Grants and Donations		

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Bilateral and Multilateral Donors	Bilateral and Multilateral Donors are the largest funding sources for marine conservation in developing countries. This includes multilateral agencies such as the European Union (EU), U.N. Food and Agricultural Organization (FAO), Global Environment Facility (GEF), United Nations Development Programme (UNDP), United Nations Educational, Science and Culture Organization (UNESCO), and the World Bank	Donor agencies
Foundations	Foundations, such as the Gordon and Betty Moore Foundation and the MacArthur Foundation, from developed countries like the United States, offer substantial financial support for biodiversity conservation in developing nations through grants to NGOs and academic institutions. These foundations may also fund initiatives like environmental programs or land purchases to further conservation efforts.	Individuals, Corporations
Nongovernmental Organizations	Nongovernmental Organizations (NGOs) in the field of marine conservation, such as WWF and TNC, mobilize substantial funding for projects in developing nations. They employ various fundraising techniques, including membership drives, adoption programs for marine species, and partnerships with aquariums, to support initiatives and raise awareness about marine conservation issues.	NGO members and supporters
Private Sector	In many developing countries, the private sector, including individuals and corporations, plays a limited role in financing marine conservation due to factors such as the absence of tax incentives for charitable donations and a lack of tradition in cause-related giving. However, specific examples highlight private companies in industries like tourism (e.g., Lindblad Expeditions), seafood (e.g., EcoFish), energy (e.g., Shell Foundation), and financial services (e.g.,	Investors

	WWF partnerships) contributing to marine conservation efforts.	
Conservation Trust Funds	Including those supporting marine conservation and offering sustainable funding for conservation projects. They operate nationally, primarily as grant-making institutions, with legal structures like trusts, foundations, or associations. These funds manage various types of funds, including endowments, sinking funds, and revolving funds, to support protected areas, species preservation, and local community and NGO initiatives.	Multi-source
Tourism Revenues		
Protected Area Entry Fees	Primarily paid by visitors, can cover a substantial part of operating costs, especially with higher fees for tourists. In developing countries, fees are often lower than what international visitors would pay. Efficient fee collection and allocating revenues to park operations improve management and conservation. Outsourcing fee management can also enhance effectiveness.	Visitors to parks
Diving and Yachting Fees	Countries use diving and yachting fees to fund coral reef and marine biodiversity conservation. Scuba divers, who often have substantial incomes, are willing to pay extra (typically $20 to $30 per trip) to protect marine habitats. Their willingness to pay is higher when they know the fees support the specific marine protected area (MPA). Establishing an independent management body is the most effective way to manage these fees.	Divers, Boaters

Tourism-Related Operations of Protected Area Agencies	Protected area agencies often manage visitor services like lodges, restaurants, and stores within protected areas. However, their ability to run these commercial operations effectively can be limited due to a lack of business expertise or political pressures. Leasing concessions to private operators is a potential solution. In some cases, the incentive for park agencies to generate more revenue may be hindered, especially when they are not allowed to retain additional funds or face reduced budget allocations for increasing revenue.	Tourism operators, Tourists
Airport Passenger Fees and Cruise Ship Fees, Taxes and Fines	Certain countries impose a conservation fee on all foreign tourists, not just specific groups like scuba divers or park visitors, upon entry or exit. Additionally, passenger head taxes have been considered to address environmental impacts caused by cruise ships and to fund port services and infrastructure	Tourists, Cruise lines
Hotel Taxes	Government authorities often impose hotel taxes in many countries, and some of these revenues are directed toward coastal conservation efforts. Additionally, some hotel companies voluntarily contribute to conservation by collecting surcharges on hotel bills or providing in-kind donations, like radios, to nearby marine protected areas (MPAs).	Hotel clients
Voluntary Contributions by Tourists and Tourism Operators	Voluntary contributions by tourists and tourism operators involve private donations made directly by operators, collected from tourists, or solicited by charitable organizations in tourist destinations. Tourism operators often see the value of supporting marine resource preservation, and tourists are more inclined to contribute when they believe the funds will be transparently managed and used for the conservation of the visited area.	Tourism operators, Tourists
Real Estate and Development Rights		

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Purchases or Donations of Land and/or Underwater Property	Buying land and underwater property can be a cost-effective conservation approach, especially when land prices are low, and there's donor support and local backing. However, it may involve challenges like relocating residents or businesses. Effective protection involves ongoing management and planning, as shown by organizations like The Nature Conservancy in the USA and Latin America.	Property owners, Donors
Conservation Easements	Conservation easements are voluntary agreements allowing landowners to restrict development to preserve biodiversity. They can be given or sold to organizations or agencies, sometimes with tax benefits. These easements are mainly used for land conservation but can extend to marine areas if local laws permit.	Property owners, Donors
Real Estate Tax Surcharges for Conservation	Adding a small percentage to real estate taxes in coastal areas, especially popular tourist destinations, can generate significant funds for biodiversity conservation and protecting open spaces from development, given the high property values and ownership by affluent individuals and tourism-related businesses.	Property owners, Donors
Tradable Development Rights and Wetland Banking	Tradable development rights and wetland banking are conservation strategies involving permits for potentially harmful development in specific areas in exchange for conserving natural environments elsewhere. This approach mirrors greenhouse gas emissions trading markets and aims to protect biodiversity on private lands	Property developers
Conservation Concessions	Conservation concessions are agreements where the government or local users protect an area in exchange for compensation from conservation organizations or investors, resembling resource concessions but with a focus on preservation rather than commercial exploitation. Local community compensation	Conservation investors

	and funding for area management are key aspects.	
Fishing Industry Revenues		
Tradable Fishing Quotas	Tradable Fishing Quotas, also known as Individual Fishing Quotas (IFQs) or Individual Transferable Quotas (ITQs), privatize heavily exploited fisheries to promote conservation and sustainability. Instead of imposing overall catch limits, specific shares of the allowable catch are allocated to individuals or groups. These quotas can be freely bought, sold, leased, or mortgaged, encouraging long-term resource conservation and reducing the need for costly government capacity reduction programs.	Commercial fishers
Fish Catch and Services Levies	Fish catch and services levies are fees imposed on commercial fishers to fund fisheries research, management, and conservation efforts. These charges may also support monitoring and protection of marine wildlife, especially protected species. In some countries, although mandatory, the revenue from these levies goes to industry and conservation groups for marine conservation activities rather than the government.	Commercial fishers
Eco-Labeling and Product Certification	Eco-labeling and product certification, like the Marine Stewardship Council (MSC) and Marine Aquarium Council (MAC), set sustainability standards for fisheries and marine life collection. MSC labels seafood meeting these criteria, empowering consumers to choose eco-friendly options. MAC encourages reef conservation by certifying the marine life supply chain and plans to sustain itself through industry fees. Some certified seafood companies, like	Seafood producers, Wholesalers, retailers and end-use purchasers of ornamental tropical fish and corals

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	EcoFish, voluntarily contribute a portion of profits to marine conservation.	
Fishing Access Payments	Fishing Access Payments compensate coastal countries for granting access to their waters under the U.N. Convention of the Law of the Sea. These payments, either state-to-state or enterprise-to-state, can be financial or include assistance, but their stability and impact on sustainable fishing practices vary.	Governments, Associations of and/or Individual fishers
Recreational Fishing License Fees and Excise Taxes	The payment of fishing license fees, taxes on fishing gear, equipment, and boat fuel from recreational fishing contributes substantial revenue to conservation efforts.	Recreational fishers
Fines for Illegal Fishing	In several countries, fines for illegal activities like logging, hunting, and fishing are directed to the national Treasury, not for conservation. Similarly, proceeds from sales of illegally caught timber, fish, or wildlife often follow the same path. To allocate these funds for conservation, specific legislation would be required in nations where Treasury is the default destination for such fines and forfeitures.	Fishers
Energy and Mining Revenues		
Oil Spill Fines and Funds	Numerous U.S. states and Canadian provinces allocate funds from pollution fines and damage awards to support broader, long-term conservation initiatives, extending beyond specific pollution incidents. Additionally, special funds may be established in anticipation of oil spill cleanup expenses and mitigation efforts.	Energy companies, Donors

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Royalties and Fees from Offshore Mining and Oil and Gas	Funds generated from offshore mining, oil, and gas royalties and fees support conservation efforts, balancing the extraction of one resource with the preservation of another. Examples include the U.S. Land and Water Conservation Fund, funded by offshore drilling lease fees, and various state conservation funds using revenues from mineral and energy extraction to protect and restore natural areas.	Energy and mining companies
Right-of-Way Fees for Oil and Gas Pipelines and Telecommunications	Certain countries require utility, telecom, and energy companies to pay fees for right-of-way within protected areas. For example, telecommunications tower owners on Mount Kitanglad pay an annual fee based on their revenues. In Brazil, a law mandates an environmental compensation fee, a small percentage of construction or maintenance costs, for infrastructure within national parks, with the proceeds dedicated to conservation in those areas.	Private companies
Hydroelectric Power Revenues	Hydroelectric power revenues refer to the income generated from the production and sale of electricity generated by hydroelectric power plants, which use the energy of flowing water to generate electrical power. In the provided example, a portion of the revenue from hydroelectric power sales is used to fund conservation and enhancement efforts related to salmonid fisheries in Iceland.	Power producers
Voluntary Contributions by Energy Companies	Energy companies are providing financial support for conservation near their extraction sites. Independent conservation organizations manage these contributions, and there is potential for similar support in marine conservation during offshore drilling and deep-sea mining.	Energy companies
For-Profit Investments Linked to Marine Conservation		

Private Sector Investments Promoting Biodiversity Conservation	Private sector biodiversity investments, known as biodiversity businesses, incorporate conservation and sustainable biological resource use into their operations. These ventures can be land-based, like certified forestry and organic agriculture, or marine-focused, involving activities such as ecotourism and sustainable harvesting of marine resources. Building capacity in this emerging market segment is crucial.	Private investors
Biodiversity Prospecting	Biodiversity prospecting involves pharmaceutical companies exploring natural resources for medicines, compensating host countries for exclusive screening rights. However, it often lacks strong economic incentives for habitat conservation due to technology shifts in pharmaceutical research and distribution of benefits away from biodiverse regions.	Pharmaceutical companies

Financing Marine Conservation concludes that there is no one-size-fits-all approach to financing marine conservation projects. Instead, **a combination of financing mechanisms may be necessary to achieve conservation goals**. The guide emphasizes the importance of conducting feasibility analyses to determine a conservation project's viability and the potential funding sources. It also highlights the need for collaboration between stakeholders, including governments, NGOs, and the private sector, to develop and implement effective financing mechanisms. Finally, the guide stresses the importance of monitoring and evaluating the effectiveness of financing mechanisms to ensure that they are achieving their intended conservation outcomes (Spergel & Moye, 2004).

COMPENSATORY MEASURES

The UK Department for Environment Food and Rural Affairs, 2021 made “The Best Practice Guidance for Developing Compensatory Measures in Relation to Marine Protected Areas”. It is a comprehensive guide that provides valuable insights and recommendations for minimizing the impact of human activities on marine ecosystems. The guide emphasizes the importance of early and ongoing discussions between applicants and responsible authorities to explore potential compensatory measures and ensure their efficacy and feasibility. Applicants are encouraged to be as

specific as possible when outlining proposals for compensatory measures, including details such as timings, materials, construction methods, scales, and monitoring. The guide also emphasizes the importance of considering the avoid/reduce/mitigate hierarchy fully and sequentially and seeking necessary agreements from other parties before proposing compensatory measures (UK, 2021).

Table 8: Hierarchy of Compensatory Measures for the Marine environment Hierarchy extracted from UK Department for Environment Food and Rural Affairs, 2021.

Hierarchy of Measures	Description	Marine examples
1. Address same impact at same location	Address the specific impact caused by the permitted activity in the same location (within the site boundary)	On-site creation, restoration or relocation of feature that will be harmed/lost. e.g. replace seabirds lost to 'birdstrike' by controlling predators at nesting sites in SPA.
2. Same ecological function different location	Provide the same ecological function as the impacted feature; if necessary, in a different location (outside of the site boundary)	Off-site creation or restoration of feature that will be harmed/lost. Measures taken to enhance a seabird population delivered in a different location to the impacted population of same species, eg Artificial nesting platforms
3. Comparable ecological function same location	Provide ecological functions and properties that are comparable to those that originally justified the designation in the same location as the impact	On- site creation or restoration of a similar feature to the one that will be damaged / lost. Broader measures taken to benefit a feature of the site that provides a similar environmental benefit to the one that is lost or damaged, e.g. measures to

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		enhance population of the protected seabird species
4. Comparable ecological function different location	Provide ecological functions and properties that are comparable to those that originally justified designation; if necessary, in a different location (outside of the site boundary)	Off-site creation or restoration of a similar feature to the one that will be damaged or lost. Broader measures taken to benefit a feature of the site that provides a similar environmental benefit to the one that is lost or damaged, e.g. measures to enhance population of a different protected seabird species in a different location to where the impact has occurred

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3. Reporting Guide

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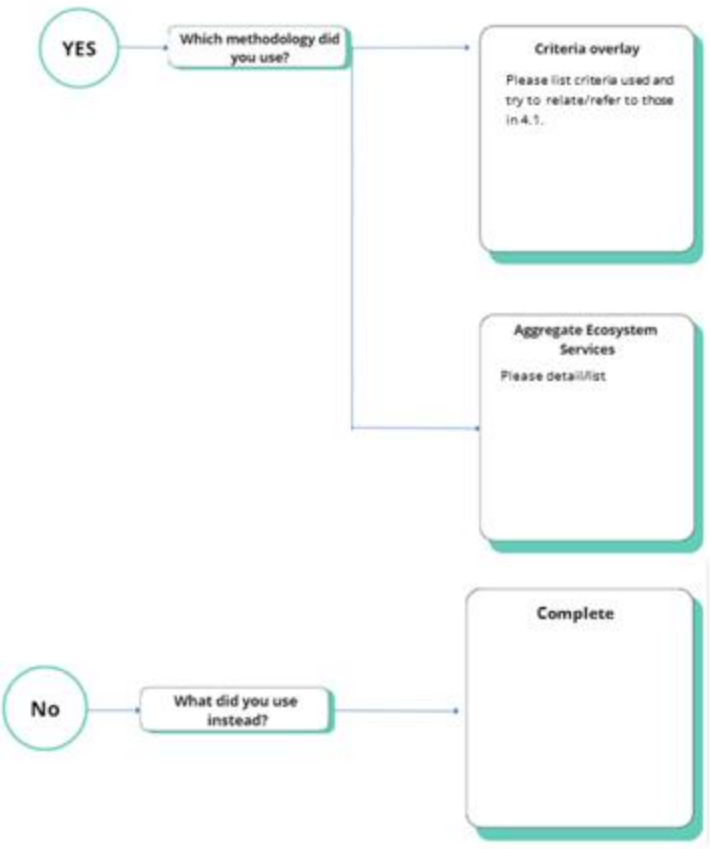

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Develop actual scenario	Propose your area	Add inputs about climate
Graciosa example:		
		
Parques Naturais Ilha	Proposed area test	Areas of importance for climate change as perceived by stakeholders

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Arguments

Try to relate the arguments used with the Portfolio in Annex 1

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You can upload all your materials (photos, recordings, etc.) into the folder from Task 4.3

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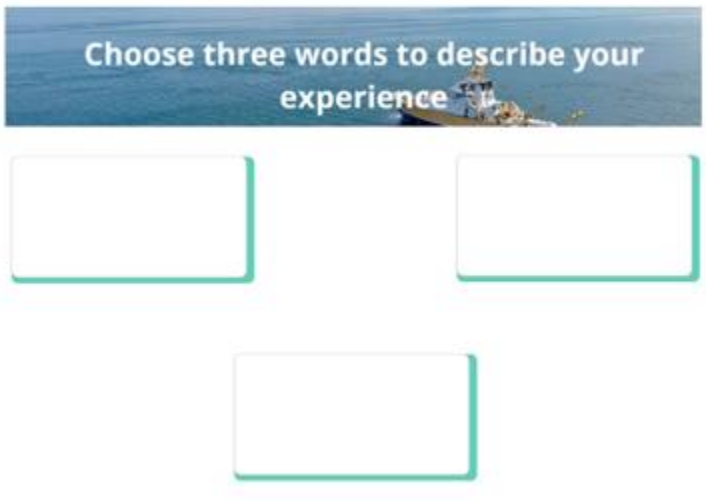

4. Example of data Analysis in the Graciosa Island Trade-off

Authors: Débora Gutierrez, Helena Calado, Raquel Reis Coimbra, Giovana Cioffi

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Introduction

Scenarios are essentially narratives or storylines that reasonably depict how future events are likely to unfold. In the Maritime Spatial Planning (MSP) context, there is growing recognition within policy and research circles regarding the value of scenarios. Numerous institutions advocate for creating plausible future trajectories for the marine environment and space (Calado et al., 2021).

In order to accomplish the objective of a trade-off exercise, it is recommended to develop two scenarios: one referred to as "Business as Usual" (BAU) and the other representing a proposed area. These scenarios serve as essential tools in decision-making processes, allowing stakeholders to compare and contrast the current state of affairs (BAU) with a potential future state (the proposed area). By juxtaposing these two scenarios, organisations can gain valuable insights into the trade-offs, helping them make informed choices and effectively navigate complex decision landscapes. This approach facilitates a structured assessment of the costs, benefits, risks, and opportunities associated with different courses of action.

For the purpose of this example, an exercise developed out of the context of the Blended Intensive Program on Maritime Spatial Planning course at the University of the Azores. Therefore, these materials are fictional.

In the SeaSketch Project administration panel:

1) In the Sketch project, create the proposal options available in the Forum. This example used single line, simple polygon, and MPA options.
2) After creating the proposal option, add the code below in **Geoprocessing** so that the program automatically cuts the land portion. The MPA option already has this automatic function, but the Simple Polygon option does not, so you need to add it if desired. (Figure 1)

https://h13gfvr460.execute-api.us-west-2.amazonaws.com/prod

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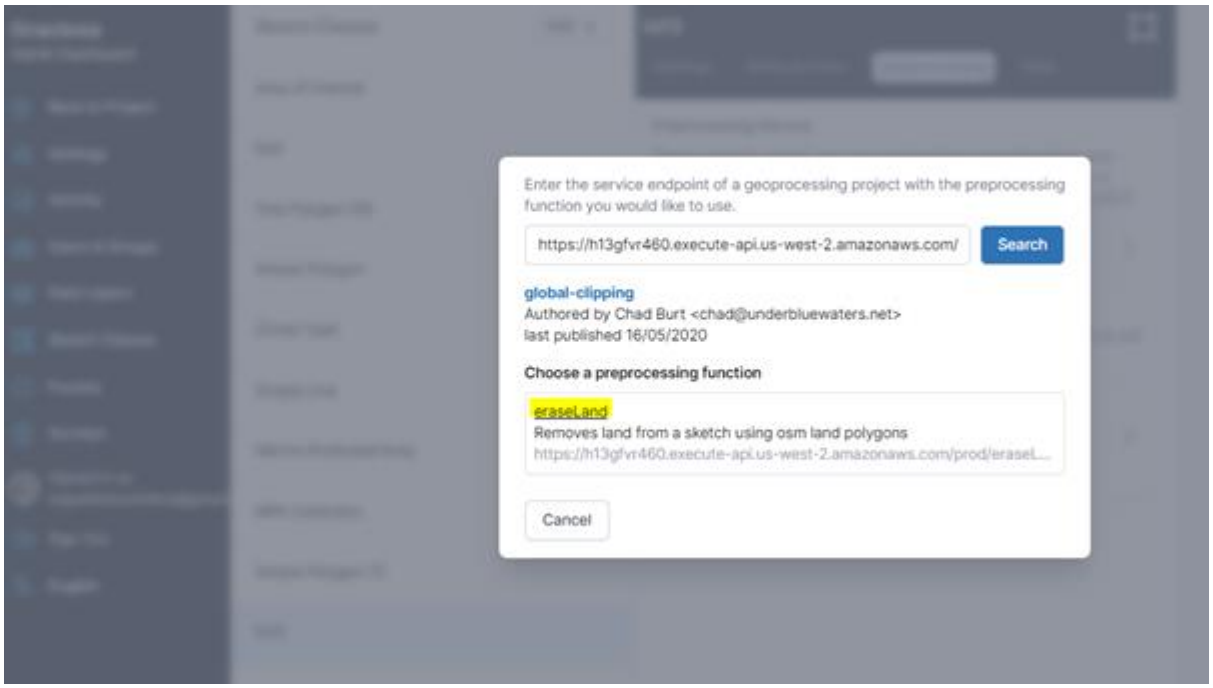

Figure 1. Inserting the link to the Geoprocessing tool in Sketch Classes in Admin Dashboard.

3) It is also possible to define the type of information you would like to obtain with the proposals (Attribute Form) and the characteristics of the polygon/line.

In the public project:

1) In the Sketch tools part, click on “create”, and there will be all the options that were created in the previous step;
2) After creating the proposal, go to the "Public forum", start a topic or comment explaining the proposal and attach the previously created polygon/line (share → sketches). You can also insert a map bookmark to get an overview of the area's appearance.
3) Then, you should build the backdrops by repeating this process for each layer you create.

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Some information that may help:

1) To be able to create proposals in Sketch tools by viewing data on activities, biodiversity, etc. The layers referring to these data must be published in the public project;
2) After creating the proposals, you can download them and add them to Data Layers to edit them separately.

Scenario example

In this example, the basis for discussion was the “Business as Usual” (BAU) scenario that represents the actual Island Park and present situation.

Overview:

Scenario 2 is nature protection prioritised and based on key policy provisions. Promoting sustainable maritime activities focused on key sectors (fisheries and tourism). To achieve Good environmental status while also minimising conflicts between sectors. It harmonises economic growth with marine protection and sustainable practices.

Pros and cons:

- More impact at the local level, improving life quality and ecosystem health.
- New regulations can create conflicts between sectors and new restrictions on conservation areas, therefore decreasing available areas for sector activities like fishing.

a) The expansion of Natural Island Park is proposed to cover a broader area of underwater cultural heritage, a special protection zone, and a special conservation zone. It is a highly protected area, where strong regulated indirect uses are allowed and limpet catching, considering its importance for the local population and cultural tradition.

b) a new MPA near “*Porto da Pesca da Folga”* since it is near a marine strip of ecological reserve and a special conservation zone. However, it does overlap with some important fishing areas. Since it is known that MPAs work as a nursery for new and important fish, and thanks to the spillover effect – that occurs in the borders of the MPA – the quantity, quality and biomass of fish will increase, and so potentially will the income for fishermen in that area. This must be considered when negotiating trade-offs.

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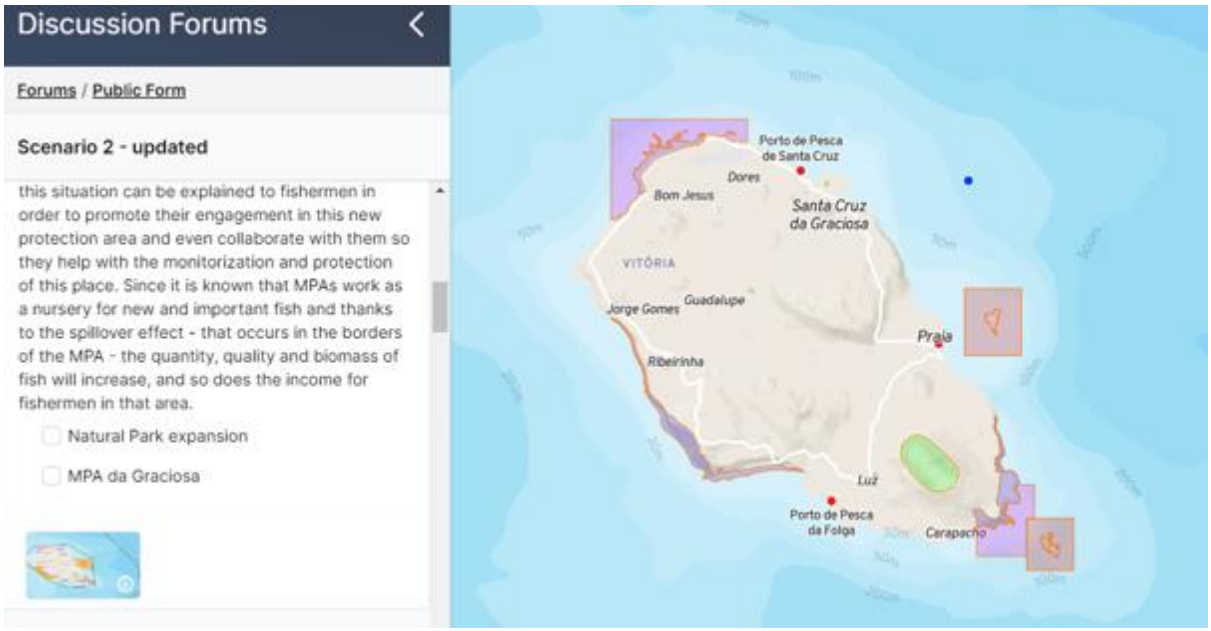

Figure 2. Natural Islands Park.

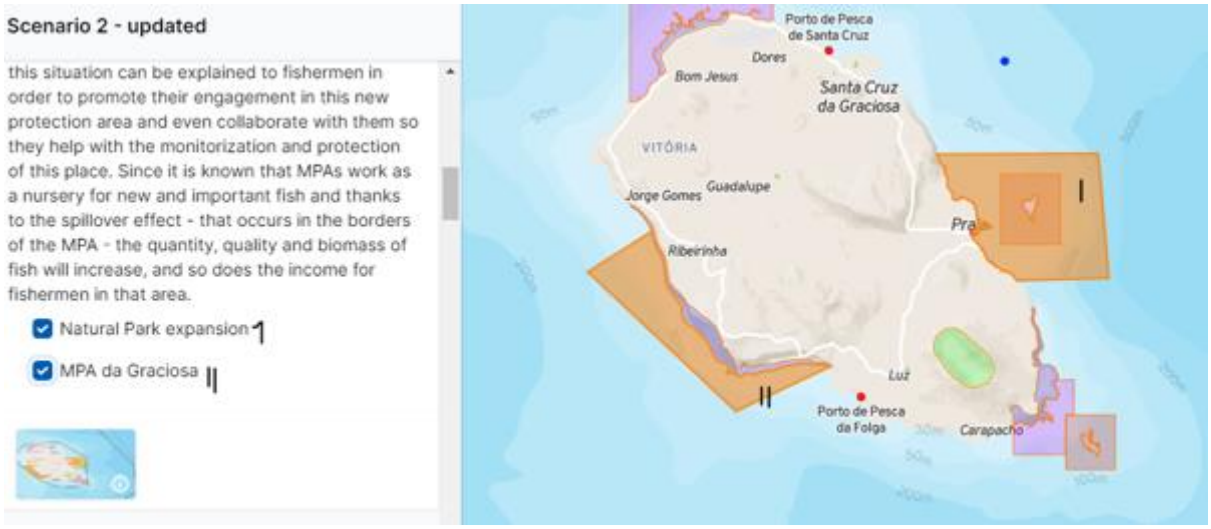

Figure 3. Expansion of Natural Park Island and new MPA.

Discussion:

Aquaculture must be reallocated, considering it overlaps the MPA da Graciosa. It will be reallocated according to potential areas mapped by the Azores government in the LoCaqua Project.

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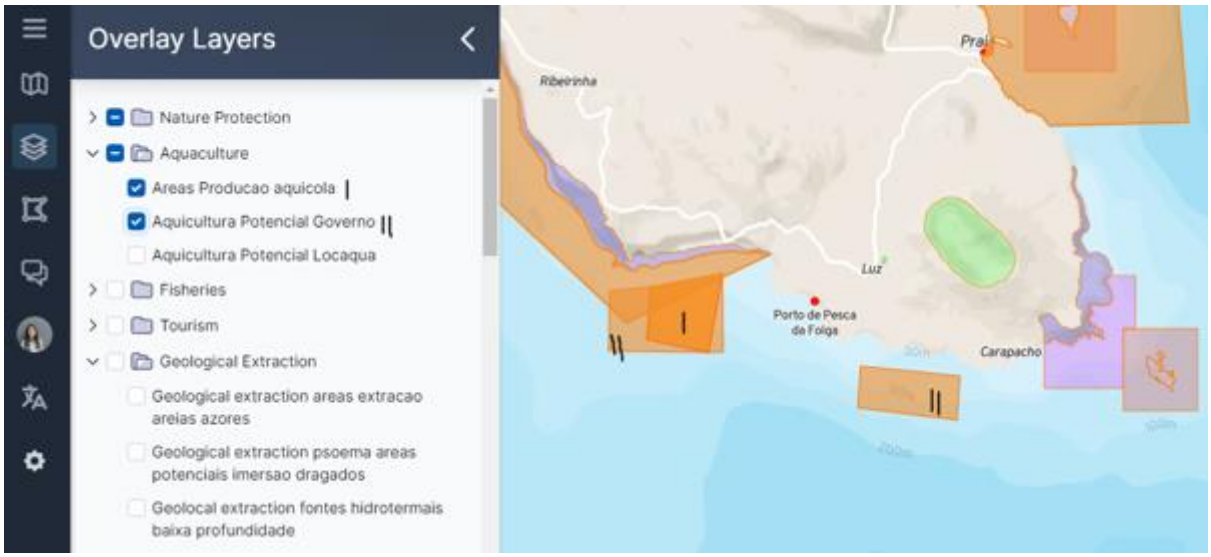

Figure 4. Preview of Aquaculture areas.

1- Aquaculture production; 2-Potencial aquaculture new areas.

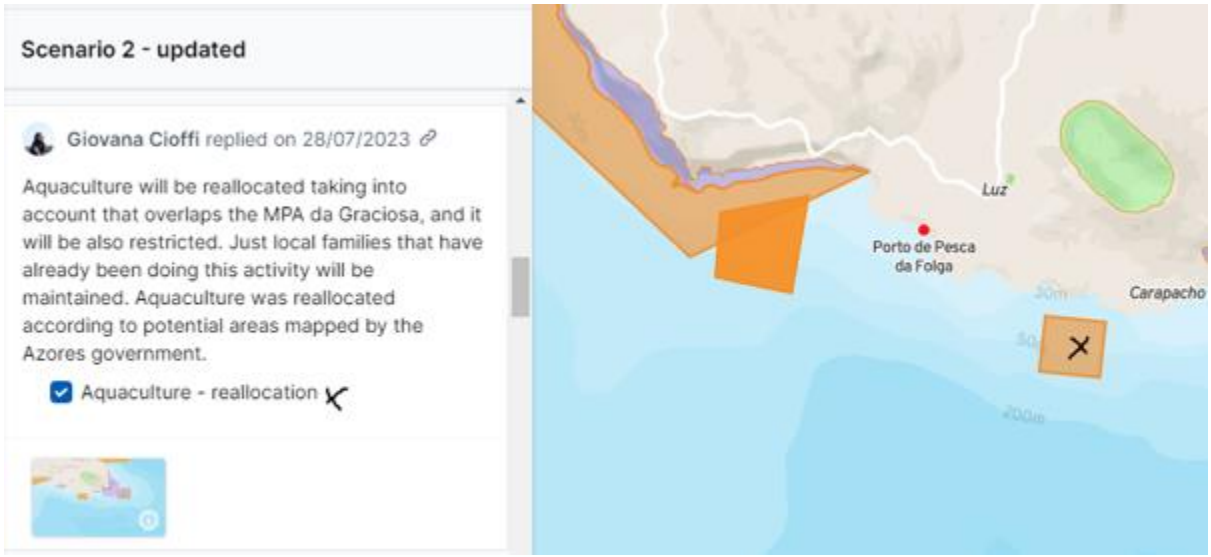

Figure 5. Proposal for reallocation of the aquaculture zone.

To accomplish this scenario, there should be four regulated zones:

Zone A - Regulation of nautical tourism, diving, and sports. Bathing zone according to the Portuguese Coastal Management Plan (POOC, Portuguese abbreviation).

Zone B - Regulation of diving and shellfishing (limpet - *Patella aspera*). They are overlapping between Decree 57/2018 (limpet catching) and the Ilhas Natural Park legislation.

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Zone C - Regulation of shipping, mooring and port activity. Overlapping with the aquaculture zone. Special attention to the MPA da Graciosa's buffer zone.

Zone D - Regulation of marine sports (e.g., sailing) and wind farm structure.

Figure 6. Four new regulated zones. Zone A- Regulation of nautical tourism, diving, and sports; Zone B - Regulation of diving and shellfishing (*Patella aspera*); Zone C - Regulation of shipping, mooring, and port activity; Zone D - Regulation of marine sports (e.g., sailing) and wind farm structure.

This line indicates the Fishing Exclusion Area, which covers up to approximately 2 nm. This has negative impacts on fishers, but establishing this area brings positive spill-over effects with medium and long-term benefits for fishers (increase in product quality, size, abundance of species and diversity of target species).

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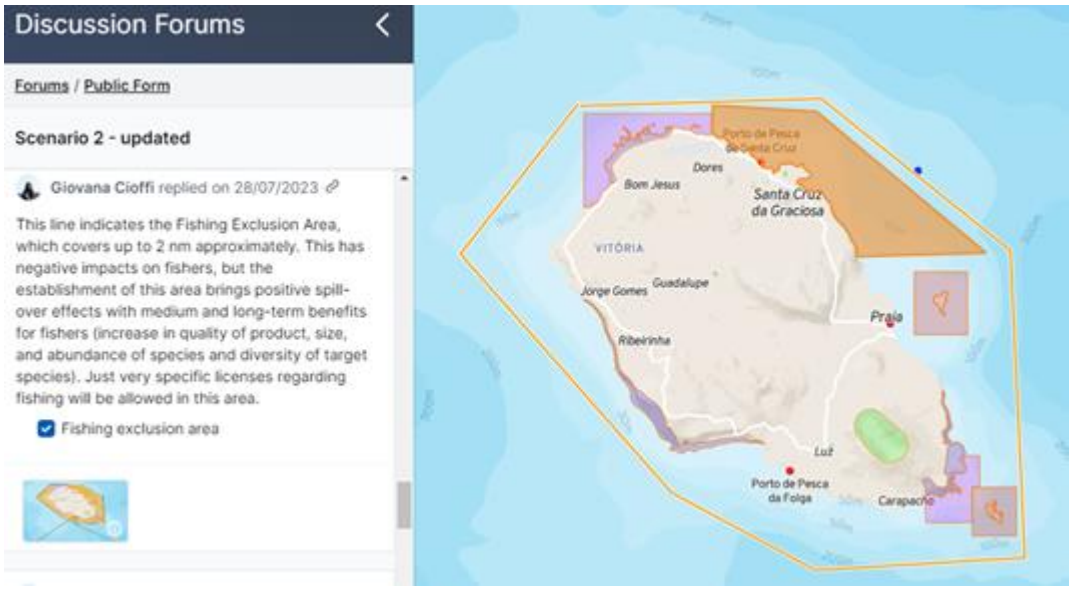

Figure 7. Fishing exclusion area.

Fishermen who follow new rules can have access to certifications like eco-labels that generate higher profits and high environmental standards, economic compensation or any other measure negotiated during trade-offs (see the portfolio of arguments).

Recreational and touristic fishing are not allowed in any way.

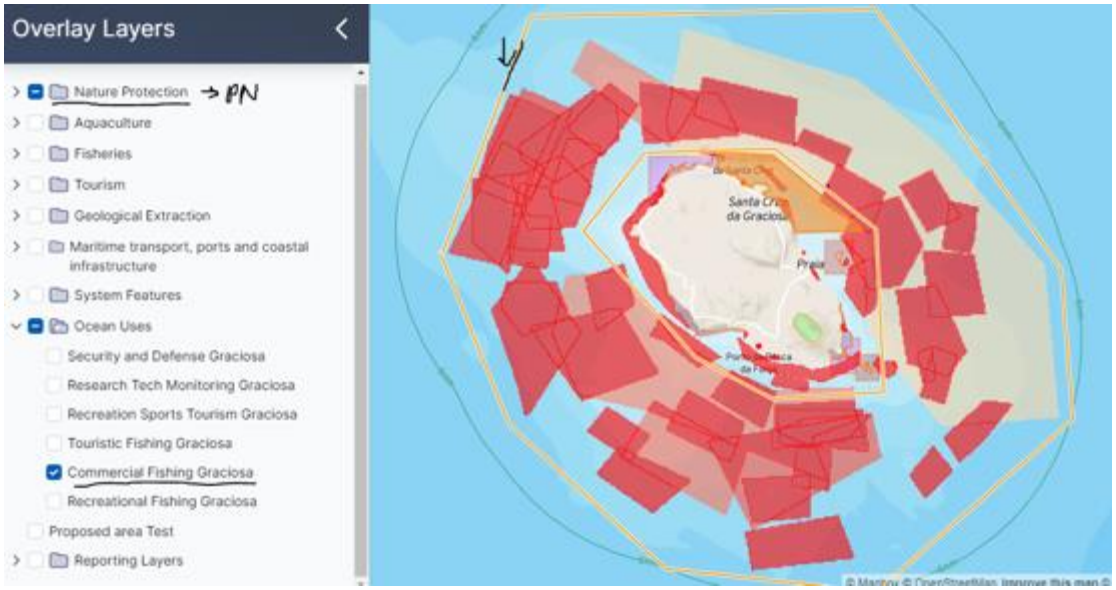

Figure 8. The line indicates the Regulated Fishing Area. Red polygons are the commercial fishing area in Graciosa.

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Heatmap methodology

This doc describes the basic method behind creating heatmaps:

https://github.com/seasketch/heatmap/blob/main/docs/algorithm.md

This doc tells you how to run the calculations using scripts developed by people in my lab:

https://seasketch.github.io/python-sap-map/install.html

Other files

- *https://www.seasketch.org/graciosa*
- Calado, H., Pegorelli, C., Vergílio, M., Hipólito, C., Campos, A., Moniz, F., Costa, A. C. C., da Silva, C. P., Fonseca, C., Santos, C. F., Gabriel, D., Guerreiro, J., Gil, A. J. F. J. F. F., Johnson, D., Ng, K., Monwar, M. M. M., Ventura, M. A. A., Vivero, J. L. S., Pinho, M., … Papaioannou, E. A. A. (2021). Expert knowledge-based co-development of scenarios for maritime spatial planning in the Northeast Atlantic. *Marine Policy*, *133*(March), 104741. https://doi.org/10.1016/j.marpol.2021.104741
- *MarsP report on "CURRENT MARITIME USES, ACTIVITIES AND CONSTRAINTS IN MACARONESIA" - it is possible to find information by activity. ANNEX I is for Azores (page 45) and there is the characterization of each maritime sector of Azores. The material is in English https://marsp.eu/media/files/None/marspwp2d25marspcurrent-maritime-uses.pdf*
- *Azorean government report regarding the Marine Strategic for pressures and impacts in this link, but in this case, the material is in Portuguese https://www.dgrm.mm.gov.pt/documents/20143/43971/Parte_B_Atividades_pressoes_e_impactes-Acores.pdf/ab7ddbc3-ea5a-1e5d-bbc6-5b8d7213ab18*

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5. Table Participatory Mapping Tool

Table 1: Summary of the participatory mapping tools for MSP4BIO Trade-Offs objectives (adapted from Burnett et al., 2023).

Tool	Objectives / Analytics	Coasts	Target Audience	Strengths	Challenges	System	Developer
Mapbox	Exploratory: choropleth maps, proportional and graduated symbol maps, density maps, and heatmaps	Free/Pay as you go services	companies, government agencies, and organisations of all sizes	Supplies its users with foundational map data, navigation and geocoding capabilities, and a large variety of styling tools to customise the look of maps that. A basic standalone mapping solution that requires little to no GIS knowledge. In this capacity, Mapbox excels by providing an easy-to-use interface that can be used to design and	More used to customise data already collected. More focused on the front end. When it comes to gathering data, which is equally important in many participatory mappings, Mapbox does not give its users a ready-to-use solution.	Web application	Mapbox

				publish engaging maps and data visualisations.			
Mapeo	N/A	Free		To document environmental and human rights information and to collect data about their land. It aims to be simple to use and accessible, and the software is free, open-source, and can be customised with local languages and settings. No Need for Server Dependence.	Focused on land data and with punctual information. It has been developed to gather observations in the field. Mapeo is a tool still in development, and some aspects the authors found deficient appear on its roadmap for this year (Digital Democracy, 2022), such as iOS, easier background map	Mapeo Desktop: Linex, Windows, Mac Mapeo Mobile: Android, iOS (2022)	Digital Democracy (Dd)

					management, route tracking etc. Functionality limited to ensure continued ease of use and intuitive design, with more complex data analyses to be carried out by exporting data to other programs.		
Maptionnaire	Exploratory: choropleth maps, proportional and graduated symbol maps, density maps, and heatmaps, Explanatory	$950-50K per year	Is a community engagement platform that aims to bridge the gap between planners or decision-makers and citizens.	The service enables the creation of community engagement activities, systematic and comprehensive data collection, analysis and reporting of	It is paid software. Other tools, e.g., co-creation workshops, that promote deeper collaboration and help converge knowledge to workable	SaaS	Mapita Oy

	: hotspot mapping			data and activities. Offers a specific analytical window where collected point, line or area-based mappings can be visualised and analysed.	solutions, are needed to complement a planner's toolbox.		
Sapelli	N/A	Free	Aimed to be used within a wider socio-technical approach which means that the software is expected to be used within a social process that considers inclusivity, equity, and risks and benefits.	The software enables people with no or limited literacy, as well as limited technical literacy, to collect, share and analyse spatial data.	Categorised as a tree questionnaire, the is no input of area design. Timing consuming to create a project.	Android, Microsoft Windows	Matthias Stevens, Michalis Vitos, Julia Altenbuchner, Oliver Roick, Julius Osokinas, Joe Woodhouse and Contributions from the Open-Source Community

SeaSketch[i]	External	Free	Originally developed to support Marine Spatial Planning, SeaSketch is also used for more generalised purposes, including research planning and crowdsourcing of spatial information.	Is intended to democratise planning efforts by exposing authoritative datasets through a publicly accessible web interface alongside tools that non-technical stakeholders may use to contribute information (such as where and how ocean space is used and valued), sketch and evaluate spatial plans (such as prospective ocean zones) and share ideas in public	To respect the limited time that most participants have at their disposal, the geodesign approach inherent in SeaSketch should be combined with other tools to help users narrow the potential solution set and arrive at the best possible solutions quickly. Therefore, stakeholders need to have a basic level of technical proficiency, enabling them to, at the very least, click	Web Application	McClintock Lab

				and private forums. supports the iterative sketching and analysis of plans (sketches), primarily zones that represent prospective marine spatial plans. SeaSketch has the capability to store and display many different forms of information from users with a wide range of backgrounds and capabilities. The second way spatial information collected from	between different pages of the SeaSketch project and toggle between layers on the map. They may also need to understand how to create and add to forum messages and/or draw shapes on the map. For certain stakeholder groups, it is necessary to have trained chauffeurs for some of these tasks.		

				another source can be incorporated into SeaSketch is through the manual upload of shapefiles into the application. This feature can also help avoid potential fatigue from respondents at a site that has engaged in previous participatory mapping projects, an issue common in areas with high biodiversity and conservation interest.			
Sketch Map Tool	N/A	Free	The automation of	The sketch maps can	The users of the Sketch	Web	GIScience Heidelberg

			the steps allows the use of the tool with little technical knowledge. Further, it is open-source software so communities with limited resources can use it for their projects.	collect all kinds of markings, such as risk perception. It can be used with little technical knowledge, and local authorities can collect data and map events themselves. the website of the Sketch Map Tool enables to transfer analogue information into a digital form in a fast way.	Map Tool should be thoughtful about the participants' safety needs and propriety security data. For the analysis of the results, the installation of a geoinformation system (GIS) is required.	Application, Software	(Heidelberg University), Heidelberg Institute for Geoinformation Technology
Survey 123 for ArcGIS Online	Exploratory, Explanatory, and Predictive (predictive	$500–$3800 per year	It allows users to create, publish and	A feature layer is generated, and its data model corresponds	There are no direct costs for a Survey123 license, but an ArcGIS Online	Web Application	Esri

	analysis, modelling)		share online surveys.	with the survey, which allows for setting up the visualisation specifications even before the data is gathered. From a frontend point of view, the technical level for all stakeholders participating in the mapping initiative (i.e., contributing data to the survey) is quite low.	subscription is needed to use Survey123 (as an author), i.e., to create and publish a survey and to visualise and publish the results in a web map. From a backend point of view, the technical level to create, design and publish a survey and then visualise its results in an interactive web map is a bit more advanced and requires at least basic skills in information and communicatio		

					n technologies, ICT and/or geodata handling and management.		
Terrastories	N/A	Free	Terrastories is a free and open-source participatory mapping software enabling communities to build a database of place-based stories and visualise these on a digital map. Co-designed.	Co-designed with Indigenous communities, Terrastories leverages a simple interface to serve the focused needs of its targeted users: to map information that is culturally relevant and important to communities. Terrastories allow for uploading information in different multimedia formats and	Terrastories is Primarily a Data Visualization Tool, Not a Data Collection Tool. It is more focused on story mapping and do not attribute values to ranking. To specific objectives. depending on where you use or host Terrastories, there may be hardware or server costs associated with Terrastories.	Desktop and Mobile Responsive	Terrastories (Open-source team)

				protect the information by granting users different levels of access. Terrastories is easy-to-use, requiring a low level of technical expertise.			
Ushahidi		Free for nonprofits, revenue-based pricing scale	A broadly available platform for collecting and visualising information directly from people experiencing or responding to crises.	Citizen-generated data via SMS, Email, Twitter, Web and smartphone apps, and uses a map-based user interface to display this data, allowing marginalized groups to share information for crisis response, human rights	Emergency communication/ mapping. It can be time-consuming to fit to Ocean Governance dialogue.	Web Application, Open Source GNU/Linux, Google Maps, Google Earth	Ushahidi

				protection and good governance. empowers people through citizen-generated data to develop solutions that strengthen their communities. Holistic data gathering platform & integrated tools; Accessible, easy-to-use and open-source; Available globally in dozens of languages; Dedicated support and expertise. The Ushahidi			

				platform is designed for versatility and has been adapted for many different purposes			
Invest*	Models that quantify and map the values of ecosystem services. The modelling suite is best suited for analyses of multiple services and multiple objectives.	Free	Is designed to inform decisions about natural resource management.	Multi-service, modular design provides an effective tool for exploring the likely outcomes of alternative management and climate scenarios and for evaluating trade-offs among sectors and services.	Still an ongoing process, with some features/ models available. Creating scenarios may be very time-consuming if, for example, a stakeholder process is used, or climate modelling is required. Intermediate geographic information system (GIS) skills are required for many InVEST	Web Application	Natural Capital Project

					analysis steps, especially when creating model inputs and working with model outputs.		
The Reef*[ii]	the immersive hub for training in the blue energy sector. At The Reef, we redefine training and education in the blue energy sector by making full use of VR, XR and AR.	Depends on the project. $$$	The Reef is a dynamic ecosystem where you can gain the necessary skills to boost your career.	With projections on three walls and stereo 3D technology with head tracking, you can fully immerse yourself in a virtual world.	It is in Ostend/ Belgium.	VR, XR and AR. HCI cluster. 3D SLAM scanner.	Collaboration between four institutions
Tool	Objectives/ Analytics	Coasts	Target Audience	Strengths	Challenges	System	Developer

* Not listed in the Burnett et al., 2023.

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6. Table Climate Vulnerability Tools

Table 1: Summary of the participatory mapping tools for MSP4BIO Trade-Offs objectives.

Tool	Goals	Audience	Strength	Challenge	System	Developer
Adaptation Support Tool[iii]	Assist policy makers and coordinators on the national level in developing, **implementing**, **monitoring,** and evaluating climate change adaptation strategies and plans	National, sub-national, transnational Cross-sectors, multi-level governance	Design for Europe Practical guidance too	based on the adaptation policy cycle, which is a valuable analytical tool, but in practice, steps may tend to overlap and intermit.	Guide	Climate ADAPT
CO-IMPACT for Nature-based Solutions[iv]	Help to create Nature-based Solutions / project evaluation and monitoring plan. Make the process of	Officers and cities	Results straight forward and simple for anyone		Website	Connecting Nature

	building a baseline and impact assessment plan					
Climate Impacts Decision Support Tool (CIMPACT-DST)[v]	Helps incorporate climate change impacts into their jurisdiction's planning and operations.	Any level of government	Easy to use Brings together information about the impacts of climate change—information that is typically found in multiple places and is hard for non-scientists to interpret—into one place, using more accessible language. Customized on a case-by-case basis		Excel-based	Cascadia Consulting

CAKE[vi]	Knowledge sharing platform that houses an extensive digital library of high-quality climate change adaptation case studies, tools, and resources	Practitioners, planners, decision-makers and researchers	Providing accurate, timely, and useful information to CAKE users. Increasing awareness of adaptation projects, options, practitioners, and resources. Engaging the broader community to develop the field of adaptation.	Especially documentation about projects in the United States	Website	Eco Adapt
FEBA-tool[vii]	Searchable database of over 200 tools and methods relevant to EbA	Practitioners, planners, decision-makers and researchers	More than 240 tools, methodologies and guidance documents	A lot of tools, can be confusing	Website	Friends of FEBA

			Cover an array of topics, including planning and assessments, implementation and valuation, monitoring, and mainstreaming. Designed to help users find the most appropriate tools and methods to support their work and put them into practice			
Reef Resilience Network[viii]	Database featuring the latest science, tools, and management strategies important to reef resilience.		A lot of different topics Easy to use	Only about the reef protection	Website	Reef Resilience Network

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Climate Vulnerability Assessment[ix]	Systematically evaluate climate impacts over a broad range of species to understand vulnerability	Fishery practitioners	Uses quantitative data when available, but qualitative information and expert opinion are used when quantitative data is lacking	Only information about fisheries	Excel-based	Environmental Defence Fund
Seascapemodels	Use quantitative tools to inform environmental decisions in the oceans. Bring ecological complexity to the planning tools used to inform decision making	practitioners, planners, decision-makers and researchers	Bring ecological complexity to the planning tools used to inform decision making	Mathematical models via programming can be complex to use	Mathematical models and statistical analysis via R programming language	Seascape Models group
AQUATOX	Ecosystem simulation model Can be used to evaluate potential ecosystem responses to climate change	Ecologists, biologists, water quality modelers, and anyone who performs ecological risk assessments	Comprehensive model available for risk assessment	Mathematical models can be complex to use	Simulation model	EPA

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		for aquatic ecosystems.				

7. ES Mapping process

Assessing the impact of human activities on these ES, therefore, requires taking an interest in quantifying the contributions, or 'benefits', provided by ecosystems regarding human welfare and mapping these services.

Mapping ES visually represents aspects such as supply, demand, trends, and other elements associated with these services. Furthermore, maps prove valuable for analysing, interpreting, and communicating ecosystem service data. They can illustrate various aspects, such as service supply and utilisation locations, and demonstrate connections with land use or exposure to threats (Arjan, 2017).

Mapping, but also quantifying marine ES presents several challenges. The biggest challenges to quantifying and valuing marine ES are the inadequate knowledge to link ecosystem structure and function changes to produce valuable goods and services (Arjan, 2017) and the lack of appropriate marine data (von Thenen et al., 2020).

Two methods were developed to map ES for Task 4.3: criteria overlay and aggregated ecosystem service potential map. Several meetings with each test site leaders were organised to discuss their needs, expectations, available resources, etc. Both methods will be explained in the following sections.

Criteria overlay

The criteria overlay method overlays each criterion related to the ES. This method is based on Multi-Criteria Analysis (MCA). MCA is a method to structure and formalise decision-making processes. It allows ecological, economic and social criteria to be combined and is, therefore, well-suited to the context of ES (Fontana et al., 2013).

Previous studies demonstrate that the MCA method is frequently employed to assess ES (Fontana et al., 2013; Fontana et al., 2023; Marttunen et al., 2022). Furthermore, this method allows the map and analysis of the different ES.

The positive aspects of this method are that it is robust and links the different ES with the socio-economic and ecological criteria, but it requires time and human resources.

a. Selection of the three primary ES and the related criteria.

The first step in applying criteria overlay method is to select the three main ESs. The ES ranking developed by task 4.1 Socio-Economic Approach (Pegorelli et al., 2023) was used to make this choice for each test site. To select these three most important ESs, the ranking of each ES and the percentage of answers possible were checked. It should be noted that the higher the percentage, the more reliable the ranking of ES is Task 4.1 (Pegorelli et al., 2023) also highlights the socio-economic criteria linked to the various ES.

Based to this, socio-economic criteria related to these main ES were selected. The aim is, therefore, to map each socio-economic criterion linked to the main ES.

b. Choice of the indicators

The second step is to select the indicators that will be used to map different criteria relevant for each ES selected. These indicators are used to represent the main ES of each study area, as highlighted in task 4.1. (Pegorelli et al., 2023)

This choice was made thanks to the structured indicator pool developed by von Thenen et al. (2020). This database of indicators consists of 772 indicators related to marine ES and the assessment of these ES in the context of MSP (von Thenen et al., 2020). The advantage of this database is that it uses the same classification of ES (Common International Classification of Ecosystem Services (CICES)) as that used in Task 4.1 (Pegorelli et al., 2023), making it easier to find and select indicators. Furthermore, the choice to use this table enables us to select the relevant, high-quality indicators representing marine ES.

The most relevant indicators for mapping the socio-economic criteria related to these ES were chosen for each selected ecosystem service.

c. Data availability

The choice of indicators and data is intrinsically linked, if quality data are missing to map the indicators, another indicator should be used. The database developed by Task 2.1 (Review of the available datasets, data platforms and initiatives; Whatley et al., 2023) was explored to find the data corresponding to the selected indicators.

Tables linking criteria, ES, indicators and data sources were created and sent to each team from each test site.

d. Meetings with the test site leaders

Once the indicators and data sources had been selected, meetings were held with each test site to discuss their needs and expectations, adjust the methodology and identify other data sources.

e. Evaluation

Finally, the last step is to perform the MCA and map each criterion selected with the chosen indicators.

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Aggregated ecosystem service potential map

This method involves mapping the biophysical characteristics of ecosystems that contribute to the provision of ES. To create this type of map, all available information on the components of the ecosystem are aggregated. This method will aggregate the binary assessment of the contribution of the ES for each ecosystem component. In this binary scale, 0 represented no or negligible contribution of the ecosystem component to the ES. At the same time, 1 corresponds to a situation where the ecosystem component contributes significantly to the service. This method will, therefore, highlight the areas with the most potential ES (HELCOM, 2023; Ruskule et al., 2023). An example of the use of this method is illustrated in Figure 1.

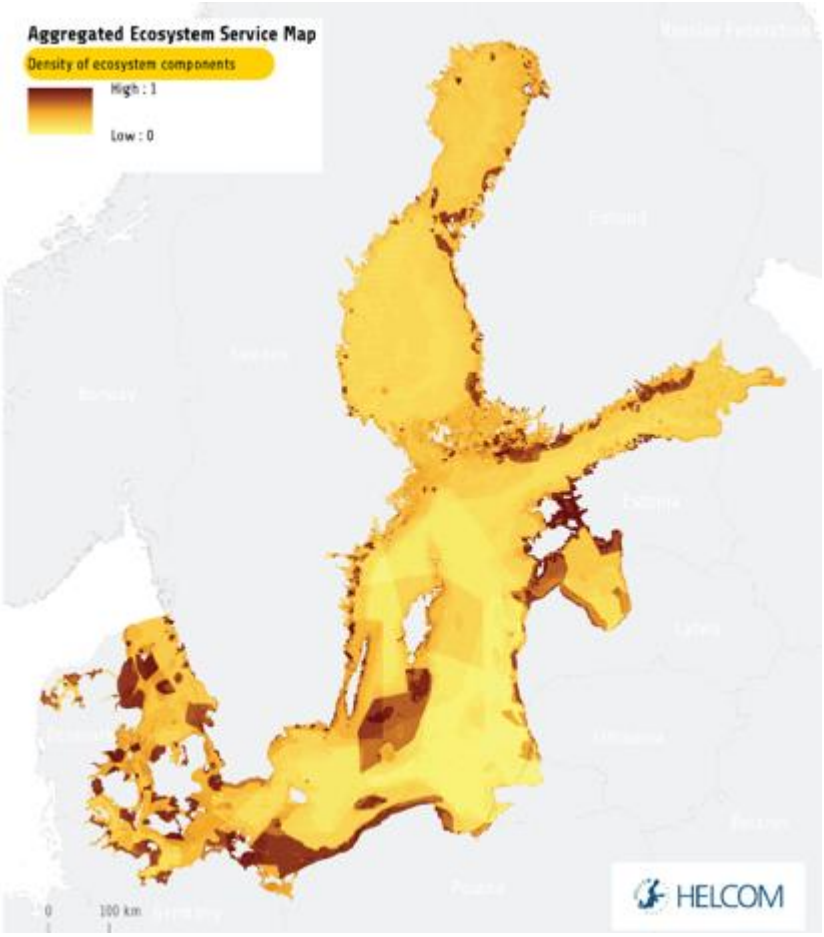

Figure 1: Aggregated ecosystem map developed by HELCOM (2023)

This method has the advantage of being simple to use and requires limited human and time resources. However, the disadvantage is that it is not robust. Indeed, it only considers the presence or the absence of ecosystem components to produce the map. In addition, each map component is considered equal, which means that the accuracy of the information represented is reduced. (HELCOM 2023; Ruskule et al. 2023). Furthermore, this method will only represent biophysical aspects and will not represent the socio-economic criteria of ES.

1. Bay of Cadiz

1.1. Introduction

The following sections present the different criteria related to the main ecosystem services (ES) present in the bay of Cadiz.

The choice of the different indicators for the ecosystem services was made on the basis of a structured indicator pool for marine spatial planning developed by von Thenen et al. (2020). Nevertheless, these indicators are a suggestion, it can be used fewer or more depending on test site needs.

The various data sources described in the following sections for each criterion were compiled on the basis of Task 2.1. As with the indicators, these data sources are only suggestions.

1.2. **Criteria 1:** Area is important for the generation of employment and income linked to no traditional activities.

ES: Lifecycle maintenance, habitat and gene pool protection

Providing habitats for wild plants and animals that can be useful to us (nursery), and Politization (coastal area), 'Gamete' dispersal.

Selected Indicators	Unit	Data source
Diversity and abundance of species with potential or biotechnology purposes	No. km²	Distribution species+ selected species with potential

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ES: Water used for nutrition, materials or energy

Water used as: drinking water, material and no-drinking (e.g., cooling) and energy (e.g., tidal)

Selected Indicators	Unit	Data source
Reduce the dependency on non-renewable abiotic energy sources	kW h-1	CORDIS
Wave energy resources	million watts	CORDIS
Amount of seawater extracted per year per area	m-3/ km-2	Seawater extracted data
Location activites using water used for nutrition, materials or energy	Location	

ES: Cultivated aquatic plants for nutrition, materials or energy

Plants that are cultivated in fresh or salt water that we eat, can use as a material, or energy source

Selected Indicators	Unit	Data source
Active compounds for nutraceutics; pharmaceutics; cosmetics	Tonne ha-1	habitat
Plants from in situ aquaculture	tonnes ha-1	FishStatJ FAO
Cultured seaweed abundance		
Harvest (plants, algae from aquaculture)	tonnes year-1 km-2	
Harvested cultured seaweed	tonnes year-1 km-2	
Harvest of materials from plants, and algae for direct use or processing	tonnes year-1 km-2	

Harvest of materials from plants, and algae for agriculture, and fodder	tonnes year-1 km-2	
Seaweed stock (area, biomass)	km2, tonnes km-2	Marine Macrophytes (seagrass and macroalgae)

1.3. **Criteria 2:** Area is important for fishery activity.

ES: Lifecycle maintenance, habitat and gene pool protection

Providing habitats for wild plants and animals that can be useful to us (nursery), and Politization (coastal area), 'Gamete' dispersal.

Selected Indicators	Unit	Data source
Seagrass seed dispersal rates by fish and birds		Ocean Productivity available to Fish (OPFish)
Species abundance and richness	indiv m-2, spp m-2	Aerial and Boat-based visual and Passive Acoustic Monitoring surveys of megafauna (fishes)
Juvenile fish density	abundance km-1	
Species distribution	km km-2	Distribution species
Area of habitat or density of biogenic habitat (e.g. seagrass, maerl or kelp beds) creating species "used" or identified as important for nursery or reproduction	km-2	Conservation status of habitat types and species: datasets from Article 17, Habitats Directive 92/43/EEC reporting; Benthic occurrences, habitat maps, and species traits; OSPAR Habitats - Point data+ selected habitats useful for the indicator

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ES: Pest and disease control

Controlling pests, invasive species and diseases

Selected Indicators	Unit	Data source
Species richness	No. of species	
Presence/absence/frequency of pests (e.g., algae blooms, foam, sea lice on farmed salmon)	No/km-2	Species identification in marine areas invaded by Rugulopteryx okamurae; Microalgae blooms
Distribution of alien species	No/km-2	Rugulopteryx okamurae monitoring (alien species); Accumulation of pressures that may cause the introduction of alien species

1.4. **Criteria 8:** The area is important due to the socio-cultural dependence of the coastal community with its environmental quality.

ES: Water conditions

Maintenance of physical, chemical, abiotic conditions

Selected Indicators	Unit	Data source
Water quality	Chemical analysis (contaminant concentrations) and visual analysis; total coliforms or other pathogens	Water Quality Viewer: Sea surface temperature; Water Quality Viewer: Chlorophyll-a concentration, Water Quality Viewer: Water transparency
Water in good physicochemical and	Chemical analysis	

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microbiological quality status ([O2], [DIN])		
Water transparency		Water Quality Viewer: Water transparency

ES: Lifecycle maintenance, habitat and gene pool protection[1]

Providing habitats for wild plants and animals that can be useful to us (nursery), and Politization (coastal area), 'Gamete' dispersal.

Selected Indicators	Unit	Data source
Social perception of existing conservation designations	Ranking	
Significance of nursery habitat for households	Ranking	
Importance and specificity of the provision of habitat based on expert knowledge (scores 0-3)	Ranking	
Submerged and intertidal habitats diversity	Km-2	Conservation status of habitat types and species: datasets from Article 17, Habitats Directive 92/43/EEC reporting
Protected area designated for its diverse habitat and abundant seabird colonies	Km-2	Spanish Institute of Oceanography - Maritime Information

ES: Regulation of baseline flows and extreme events

Controlling or preventing soil loss, regulating the flows of water in our environment and protecting people from extreme events (that can protect people)

Selected Indicators	Unit	Data source

[1] Indicators can be added according to the socio-cultural context of the area

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Changing shoreline	Change in beach profile (slope (gradient) and width (m) and stability) over time determined empirically from photos, satellite, LiDAR, ARGUS camera and modeled	Outline of the coastline
Beach profile (slope and width); extent of maintenance and improvement required to provide protection	"Change in beach profile (slope (gradient) and width (m) and stability) over time determined empirically from photos, satellite, LiDAR, ARGUS camera and modelled"	
Sediment accumulation rate	cm year-1	
Shoreline erosion rate	mm year-1 km-2	
Measures implemented against erosion		
Measures implemented against extreme events		

1.5. **Criteria 15:** Area is important with occurrence of iconic species/habitats for the local community.[2]

ES: Lifecycle maintenance, habitat and gene pool protection

Providing habitats for wild plants and animals that can be useful to us (nursery), and Politization (coastal area), 'Gamete' dispersal.

Selected Indicators	Unit	Data source

[2] need to define iconic species/habitats to choose the right indicators and the right data sources.

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Submerged and intertidal habitats diversity	Km²	Conservation status of habitat types and species: datasets from Article 17, Habitats Directive 92/43/EEC reporting
Habitat map	Km²	Conservation status of habitat types and species: datasets from Article 17, Habitats Directive 92/43/EEC reporting
Extent of marine protected areas	Km²	Spanish Institute of Oceanography - Maritime Information
Presence of iconic species	No iconic sp/km²	Distributions of Marine Mammals, Seabirds, Sea Turtles, Sharks & Rays
Presence of coralligenous community or cetacean population		Distributions of Marine Mammals, Seabirds, Sea Turtles, Sharks & Rays; Conservation status of habitat types and species: datasets from Article 17, Habitats Directive 92/43/EEC reporting

ES: Intellectual and representative interactions with environment (abiotic and natural)

Researching and studying nature+ The beauty of nature (appreciated for their inherent beauty)

Selected Indicators	Unit	Data source
Seascape beauty estimation	Questionnaires; seascape metrics	
Species, habitats or ecosystems that are being or can potentially be studied to increase scientific knowledge	No. of such species, habitats, ecosystems	

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Abundance of key species of individual interest	Count data	

1.6. **Criteria 18:** Area with current/potential importance to explore and demonstrate approaches and management solutions, and/or to scientific purposes

ES: Lifecycle maintenance, habitat and gene pool protection

Providing habitats for wild plants and animals that can be useful to us (nursery), and Politization (coastal area), 'Gamete' dispersal.

Selected Indicators	Unit	Data source
Protected area designated for its diverse habitat and abundant seabird colonies		Surface of the marine protected areas; Spanish Institute of Oceanography - Maritime Information
Scientific Studies about this criterion	No. year-1 km-2	
Species, habitats or ecosystems that are being or can potentially be studied to increase scientific knowledge	No. of such species, habitats, ecosystems	
Importance and specificity of pollination in dunes based on expert knowledge (scores 0-3)	Ranking	

ES: Regulation of baseline flows and extreme events

Controlling or preventing soil loss, regulating the flows of water in our environment and protecting people from extreme events (that can protect people)

Selected Indicators	Unit	Data source
Scientific Studies about this criterion	No. year-1 km-2	

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Importance and specificity of storm protection based on expert knowledge	Ranking	

ES: Water used for nutrition, materials or energy

Water used as: drinking water, material and no-drinking (e.g., cooling) and energy (e.g., tidal)

Selected Indicators	Unit	Data source
Scientific Studies about this criterion	No. year-1 km-2	

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2. Azores

2.1. Introduction

The following sections present the different criteria related to the main ecosystem services (ES) present in Azores.

The choice of the different indicators for the ecosystem services was made on the basis of a structured indicator pool for marine spatial planning developed by von Thenen et al. (2020). Nevertheless, these indicators are a suggestion, it can be used fewer or more depending on test site needs.

The various data sources described in the following sections for each criterion were compiled on the basis of Task 2.1. As with the indicators, these data sources are only suggestions.

2.2. **Criteria 4:** Area is important for shipping

ES: Other type of regulation and maintenance service by abiotic/biotic processes

Selected Indicators	Unit	Data source
Length of shipping lanes	km	Shipping density, Maritime traffic lanes
Tonne-kilometres of shipping traffic	Tonne-kilometre	Shipping density, Maritime traffic lanes

2.3. **Criteria 7:** Area is important for locally-caught seafood

ES: Intellectual and representative interactions with environment (abiotic and natural)

Description: The things in nature that help people identify with the history or culture of where they live or come from + Researching and studying nature

Selected Indicators	Unit	Data source
Social perception of identity/heritage	Ranking	
Importance and specificity of cultural heritage based on expert knowledge	Ranking	
Species, habitats or ecosystems that can potentially form the core of	No. km-2	Biodiversity Data Portal - Azores

contributing to a cultural custom, rite or way of life		
Scientific studies	No. year-1 km-2	Research Area

ES: Physical and experiential interactions with the environment (abiotic e.g. caves; Natural e.g. whales)

Description: Using the environment for sport, ecotourism, recreation, health

Selected Indicators	Unit	Data source
Number per area of specific seascape features	No km-2	
Number of recreational fishing trips	No	
Amount or catch rate of target fish species (in this case limpet)	Tonnes km-2	

2.4. **Criteria 8:** The area is important due to the socio-cultural dependence of the coastal community with its environmental quality.

ES: Intellectual and representative interactions with environment (abiotic and natural)

Description: The things in nature that help people identify with the history or culture of where they live or come from + The beauty of nature (appreciated for their inherent beauty)

Selected Indicators	Unit	Data source
Social perception of identity/heritage	Ranking	
Importance and specificity of cultural heritage based on expert knowledge	Ranking	
Species, habitats or ecosystems that can potentially form the core of	No km-2	Biodiversity Data Portal - Azores

contributing to a cultural custom, rite or way of life		

ES: Physical and experiential interactions with the environment (abiotic e.g. caves; Natural e.g. whales)

Description: Using the environment for sport, ecotourism, recreation, health

Indicators	Unit	Data source
Sea space available for recreation	Number of km2 of sea with safe water quality available for recreational use	Maritime tourism, Nautical sports Whale Watching
Presence of coralligenous community or cetacean population	Count data	Biodiversity Data Portal - Azores CETUS: Cetacean monitoring surveys in the Eastern North Atlantic Marine mammal sightings in the Azores between 2004 and 2013 recorded by Biosphere Expedition
Abundance and diversity of key species of recreational interest	Count data	
Presence of iconic/endangered species No.	Count data	
Status/population estimates of iconic species	Count data	
Extent and variability of coastal seascapes	No. ha-1	

2.5. **Criteria 11:** Area important for recreation and leisure.

ES: Intellectual and representative interactions with environment (abiotic and natural)

Description: The things in nature that help people identify with the history or culture of where they live or come from + Researching and studying nature

Selected Indicators	Unit	Data source

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Social perception of identity/heritage	Ranking	
Importance and specificity of cultural heritage based on expert knowledge	Ranking	
Species, habitats or ecosystems that can potentially form the core of contributing to a cultural custom, rite or way of life	No km-2	Biodiversity Data Portal - Azores
Scientific studies	No. year-1 km-2	

ES: Physical and experiential interactions with the environment (abiotic e.g. caves; Natural e.g. whales)

Description: Using the environment for sport, ecotourism, recreation, health

Indicators	Unit	Data source
Sea space available for recreation	Number of km2 of sea with safe water quality available for recreational use	Maritime tourism, Nautical sports Whale Watching Diving
Presence of coralligenous community or cetacean population	Count data	Biodiversity Data Portal - Azores CETUS: Cetacean monitoring surveys in the Eastern North Atlantic Marine mammal sightings in the Azores between 2004 and 2013 recorded by Biosphere Expedition
Abundance and diversity of key species of recreational interest	Count data	
Presence of iconic/endangered species No.	Count data	
Status/population estimates of iconic species	Count data	

Extent and variability of coastal seascapes	No. ha-1	

2.6. Criteria 12: Area is important because of the presence of cultural symbolic value.

ES: Intellectual and representative interactions with environment (abiotic and natural)

Description: The things in nature that help people identify with the history or culture of where they live or come from + The beauty of nature (appreciated for their inherent beauty)

Selected Indicators	Unit	Data source
Social perception of identity/heritage	Ranking	
Importance and specificity of cultural heritage based on expert knowledge	Ranking	
Species, habitats or ecosystems that can potentially form the core of contributing to a cultural custom, rite or way of life	No km-2	Biodiversity Data Portal - Azores
Scientific studies	No. year-1 km-2	
Fish studies as a source of information		

2.7. **Criteria 13:** Area is important because of the presence of structure with significant historical and cultural . (monuments, etc)

ES: Intellectual and representative interactions with environment (abiotic and natural)

Description: The things in nature that help people identify with the history or culture of where they live or come from + The beauty of nature (appreciated for their inherent beauty)

Selected Indicators	Unit	Data source
Social perception of identity/heritage	Ranking	
Importance and specificity of cultural heritage based on expert knowledge	Ranking	
Species, habitats or ecosystems that can potentially form the core of contributing to a cultural custom, rite or way of life	No km-2	Underwater cultural heritage sites of the Azores (shipwrecks etc.)
Scientific studies	No. year-1 km-2	

2.8. **Criteria 15:** Area is important with occurrence of iconic species/habitats for the local community.

ES: Intellectual and representative interactions with environment (abiotic and natural)

Description: Researching and studying nature+ The beauty of nature (appreciated for their inherent beauty)

Selected Indicators	Unit	Data source
Seascape beauty estimation	Questionnaires; seascape metrics	
Species, habitats or ecosystems that are being or can potentially be studied to increase scientific knowledge	No. of such species, habitats, ecosystems	Biodiversity Data Portal - Azores
Abundance of key species of individual interest	Count data	Biodiversity Data Portal - Azores

ES: Physical and experiential interactions with the environment (abiotic e.g. caves; Natural e.g. whales)

Description: Using the environment for sport, ecotourism, recreation, health

Indicators	Unit	Data source

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Sea space available for recreation	Number of km2 of sea with safe water quality available for recreational use	Maritime tourism, Nautical sports Whale Watching
Presence of coralligenous community or cetacean population	Count data	Biodiversity Data Portal - Azores CETUS: Cetacean monitoring surveys in the Eastern North Atlantic Marine mammal sightings in the Azores between 2004 and 2013 recorded by Biosphere Expedition
Abundance and diversity of key species of recreational interest	Count data	
Presence of iconic/endangered species No.		
Status/population estimates of iconic species		
Extent and variability of coastal seascapes	No. ha-1	

2.9. **Criteria 17:** Area is important to be managed due to spatial conflicts among users.

ES: Other type of regulation and maintenance service by abiotic/biotic processes

Indicators	Unit	Data source
Expert consultation		SeaSketch consultation

ES: Physical and experiential interactions with the environment (abiotic e.g. caves; Natural e.g. whales)

Description: Using the environment for sport, ecotourism, recreation, health

Indicators	Unit	Data source
Sea space available for recreation	Number of km2 of sea with safe water quality available for recreational use	Maritime tourism, Nautical sports Whale Watching

		Diving
Possibility of snorkeling, swimming, boating activities, annual number of recreation trips	Km²	Maritime tourism, Nautical sports Diving
Whale watching	Number boat/km²	
Extent of marine protected areas, presence of iconic species	km2	Protected Areas database (including MPAs, OSPAR MPAs, Ramsar, CDDA and Natura 2000)

North Sea

2.10. Introduction

The following sections present the differents criteria related to the main ecosystem services (ES) present in the Belgium North Sea area.

The choice of the differents indicators for the ecosystem services was made on the basis of structured indicator pool for marine spatial planning developed by von Thenen et al. (2020). Nevertheless, these indicators are a suggestion, and you can use fewer or more depending on your needs.

The various data sources described in the following sections for each criterion were compiled on the basis of Task 2.1. As with the indicators, these data sources are only suggestions.

2.11. Criteria 1: Area is important for the generation of employment and income linked to no traditional activities

ES: Offshore renewable energy

Selected Indicators	Unit	Data source
Rates of tidal and wind-driven currents	m3 s -1; turbidity (mg m-3 or NTU)	Flemish Banks Monitoring Network
Energy Production	TWh/year	Energy Offshore windparks

Wave energy resources	million watts	Flemish Banks Monitoring Network

ES: Nursery habitat and maintenance

Selected Indicators	Unit	Data source
Abundance of seagrasses	indiv. m-2	Seagrass cover (Essential Ocean Variable) in Europe - points (2021) and polygons (2019)
Habitat health status (habitat fragmentation)	Habitat fragmentation index	

ES: Farmed aquatic plants

Selected Indicators	Unit	Data source
No. of species (animals from aquaculture	No. km-2	
Fish and shellfish populations (biomass, abundance)	tonnes km-2, no. km-2	

2.12. **Criteria 3:** Area is important for the development of blue economy activities

ES: Offshore renewable energy

Selected Indicators	Unit	Data source
Rates of tidal and wind-driven currents	m3 s -1; turbidity (mg m-3 or NTU)	Flemish Banks Monitoring Network
Energy Production	TWh/year	Energy Offshore windparks

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ES: Farmed aquatic plants

Selected Indicators	Unit	Data source
No. of species (animals from aquaculture	No. km-2	
Fish and shellfish populations (biomass, abundance)	tonnes km-2, no. km-2	
Farm aquaculture		

ES: Sand and other minerals

Selected Indicators	Unit	Data source
Volume of sand available for extraction	No. km-2	Aggregate extraction areas

2.13. Criteria 4: Area is important for shipping

ES: Area is important for shipping

Indicators	Unit	Data source
Length of shipping lanes	km	Shipping density
Tonne-kilometres of shipping traffic	Tonne-kilometre	Shipping density

2.14. Criteria 8: The area is important due to the socio-cultural dependence of the coastal community with its environmental quality

ES: Coastal protection

Indicators	Unit	Data source
Scientific studies	No. year-1 km-2	

ES: Scientific research

Indicators	Unit	Data source
Scientific studies	No. year-1 km-2	

2.15. Criteria 16: Area is important because allows the access to relevant areas for the marine users.

ES: Navigation surface

Indicators	Unit	Data source
Length of shipping lanes	km	Shipping density
Tonne-kilometres of shipping traffic	Tonne-kilometre	Shipping density

2.16. Criteria 17: Area is important to be managed due to spatial conflicts among users.

ES: Navigation surface

Indicators	Unit	Data source
Length of shipping lanes	km	Shipping density
Tonne-kilometres of shipping traffic	Tonne-kilometre	Shipping density

ES: Recreation

Indicators	Unit	Data source
Production (recreational fishing)	km	
Biomass (potential supply of recreational fishing)traffic	Tonne-kilometre	
Abundance (and diversity) of observed species (wildlife watching)		

2.17. Criterion 18: Area with current/potential importance to explore and demonstrate approaches and management solutions, and/or for scientific purposes

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ES: Offshore renewable energy

Indicators	Unit	Data source
Rates of tidal and wind-driven currents	m3 s -1; turbidity (mg m-3 or NTU)	Flemish Banks Monitoring Network
Energy Production	TWh/year	Energy Offshore windparks

ES: Navigation surface

Indicators	Unit	Data source
Aggregate extraction areas	kilometre	Shipping density
Volume available	Tonne-kilometre	Shipping density

ES: Coastal protection

Indicators	Unit	Data source
Length of natural coastal line	kilometre	Shipping density
Presence and elevation of biogenic habitat, e.g., saltmarsh beds; seagrass beds; bivalve, coral and polychaete reefs	Tonne-kilometre	Shipping density
Shoreline erosion rate		
Composite indices based on wave regime, tidal range, relative sea level, storm surge		

3. NW Mediterranean

3.1. Introduction

The following sections present the different criteria related to the main ecosystem services (ES) present in the Western part of the Mediterranean.

The choice of the different indicators for the ecosystem services was made based on a structured indicator pool for marine spatial planning developed by von Thenen et al. (2020). Nevertheless, these indicators are a suggestion, they can be used fewer or more depending on test site needs.

The various data sources described in the following sections for each criterion were compiled based on Task 2.1. As with the indicators, these data sources are only suggestions.

3.2. **Criteria 2:** Area is important for fishery activity.

ES: Lifecycle maintenance, habitat and gene pool protection

Selected Indicators	Unit	Data source
Seagrass seed dispersal rates by fish and birds		Ocean Productivity available to Fish (OPFish)
Species abundance and richness	indiv m-2, spp m-2	Aerial and Boat-based visual and Passive Acoustic Monitoring surveys of megafauna (fishes)
Juvenile density	abundance km-1	
Species distribution	km km-2	

ES: Pest and disease control

Selected Indicators	Unit	Data source
Control of aquatic disease-bearing invertebrates and plants by fish		Presence of aliens species in the ports, in some specifics mapped spots.
Absence of pathogens	H', ind. m-2	
Presence of alien species	No. km-2	

3.3. **Criteria 4:** Area is important for shipping.

ES: Other type of regulation and maintenance service by abiotic/biotic processes

Selected Indicators	Unit	Data source
Length of shipping lanes	km	Shipping density, PSSA rules
Tonne-kilometres of shipping traffic	Tonne-kilometre	Shipping density

3.4. **Criteria 5**: Area is important for dredging.

ES: Other type of regulation and maintenance service by abiotic/biotic processes

Indicators	Unit	Data source
Amount of sediment prevented from sedimentation in natural channels used for shipping	m3 year-1	Withdrawal of relict sands / Dredged sediment dumping+ Channels for shipping; Aggregate extraction areas
Sand/gravel	tonnes ha-1	Withdrawal of relict sands / Dredged sediment dumping; Aggregate extraction areas

3.5. Criteria 8: The area is important due to the socio-cultural dependence of the coastal community with its environmental quality.

ES: Lifecycle maintenance, habitat and gene pool protection

Indicators	Unit	Data source
Habitat health status	Habitat fragmentation index; presence of alien species	Sspeces in ports

Area of habitat or density of biogenic habitat (e.g. seagrass, maerl or kelp beds) creating species "used" or identified as important for nursery or reproduction	Extent (km2)	
Coral extent and condition	km2	

ES: Other biotic characteristics that have a non-use value

Indicators	Unit	Data source
Species, habitats or ecosystems that can potentially form the core of contributing to a cultural custom, rite or way of life		
Extent of MPAs	Km²	Marine protected Area
Presence of endangered, protected, iconic and/or rare species or habitats		Reports of marine mammal strandings on the coast of metropolitan France in 2014-2020
landscape interest	Km²	Iconic tourist areas, UNESCO heritage sites

ES: Wild plants (terrestrial and aquatic) for nutrition, materials or energy

Indicators	Unit	Data source
Seaweed stock (area, biomass)	m2, tonnes km-2	Seagrass cover in Europe
Community perception on the importance of mangroves in food provision (honey and fisheries)	ranking	
Use of plant-based resources for energy	tonnes year-1 km-2	

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3.6. Criteria 15: Area is important with occurency of iconic species/habitats for the local community.

ES: Lifecycle maintenance, habitat and gene pool protection

Indicators	Unit	Data source
Species abundance and richness	indiv m-2, spp m-2	
Extent of marine protected areas, presence of iconic species	km2	
Status/population estimates of iconic species		
Presence of endangered, protected, iconic and/or rare species or habitats	No. ha-1	Density of Loggerhead Turtles in the Mediterranean Sea, Reports of marine mammal strandings on the coast of metropolitan France in 2014-2020
Social perception of existing conservation designations	% respondents considering it important	
Significance of nursery habitat for households	ranking	

need to know which are the iconic species of the area to be able to find a source of indicator

ES: Physical and experiential interactions with the environment (abiotic e.g., caves. natural: whales)

Indicators	Unit	Data source
Sea space available for recreation	Number of km2 of sea with safe water quality available for recreational use	

Presence of coralligenous community or cetacean population	Count data	Marine mammals aerial survey and Boat-based visual and Passive Acoustic Monitoring surveys; Aerial and Boat-based visual and Passive Acoustic Monitoring surveys of megafauna (Birds); Aerial and Boat-based visual Monitoring surveys of megafauna (turtles); Aerial and Boat-based visual and Passive Acoustic Monitoring surveys of megafauna (fishes); Visual observations on dedicated aerial platform - 3. Observations of marine megafauna and human activity
Abundance and diversity of key species of recreational interest	Count data	
Presence of iconic/endangered species No.		
Status/population estimates of iconic species		

ES: Intellectual and representative interactions with environment (abiotic and natural) The beauty of nature (appreciated for their inherent beauty)

Indicators	Unit	Data source
Species, habitats or ecosystems that can potentially form the core of contributing to a cultural custom, rite or way of life	No/km²	
Abundance of key species of individual interest	Count data	

3.7. Criteria 17: Area is important to be managed due to spatial conflicts among users.

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ES: Other type of regulation and maintenance service by abiotic/biotic processes

Indicators	Unit	Data source
Expert consultation		SeaSketch consultation

ES: Physical and experiential interactions with the environment (abiotic e.g., caves. natural: whales) (Using the environment for sport, ecotourism, recreation, health)

Indicators	Unit	Data source
Sea space available for recreation	Number of km2 of sea with safe water quality available for recreational use	
Possibility of snorkeling, swimming, boating activities, annual number of recreation trips	Km²	Coastal and Maritime tourism
Whale watching	Number boat/km²	
Extent of marine protected areas, presence of iconic species	km2	Marine protected Area

3.8. Criteria 18: Area with current/potential importance to explore and demonstrate approaches and management solutions, and/or to scientific purposes.

ES: Lifecycle maintenance, habitat and gene pool protection

Indicators	Unit	Data source
Presence and diversity of species with potential/actual useful genetic material	Presence/absence diversity	
Species abundance and richness	indiv m-2, spp m-2	

Extent of marine protected areas, presence of iconic species	km2	
Status/population estimates of iconic species		
Presence of endangered, protected, iconic and/or rare species or habitats	No. ha-1	

ES: Atmospheric composition and conditions

Indicators	Unit	Data source
Blue C	tonnes C	
Net photosynthetic rate	kgC ha-1 year-1	
C sequestration	tonnes C year-1	

ES: Wild animals (terrestrial and aquatic) for nutrition, materials or energy

Indicators	Unit	Data source
Fish and shellfish populations (biomass, abundance)	tonnes km-2, no. km-2	
Amount of fish harvested	Amount km-2 year-1	
Areas to support seafood production	ha	
Area of no-take zones	km2	
Area of marine protected areas	km2	Nationally designated areas (CDDA)/ Specially Protected Areas of Mediterranean Importance
Quantity of available raw material	Quantity (g/raw material)	

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Use of animal-based resources for energy	tonnes year-1 km-2	

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4. Black Sea

4.1. Introduction

The following sections present the different criteria related to the main ecosystem services (ES) present in the Black Sea.

The choice of the different indicators for the ecosystem services was made on the basis of a structured indicator pool for marine spatial planning developed by von Thenen et al. (2020). Nevertheless, these indicators are a suggestion, it can be used fewer or more depending on test site needs.

The various data sources described in the following sections for each criterion were compiled on the basis of Task 2.1. As with the indicators, these data sources are only suggestions.

4.2. **Criteria 1:** Area is important for the generation of employment and income linked to no traditional activities

ES: Wild animals (terrestrial and aquatic) for nutrition, materials or energy

Selected Indicators	Unit	Data source
Fish harvested by capture fisheries or produced in aquaculture	T/km²	Shellfish aquaculture; Marine finfish aquaculture

ES: Lifecycle maintenance, habitat and gene pool protection

Selected Indicators	Unit	Data source
Diversity and abundance of species with potential or biotechnology purposes	No. km-2	Distribution of species and habitats (according to art. 17 of the Habitats Directive)[3]
Protected area designated for its diverse habitat and abundant seabird colonies	Km-2	Distribution of bird species (reporting according to art. 12 of the Birds Directive)
Submerged and intertidal habitats diversity	No. km-2	Distribution of species and habitats (according to art. 17 of the Habitats Directive)

[3] need to filter this database according to species with potential or biotechnology purpose

ES: Physical and experiential interactions with the environment (abiotic)

Selected Indicators	Unit	Data source
Sea space available for recreation	Number of km2 of sea with safe water quality available for recreational use	Location of tourism and leisure infrastructure (land- and sea-based)
Number and quality of beaches	No. and size of blue flag beaches	Tourism
Number per area of specific seascape features	No. area-1	
Extent and variability of coastal seascapes (e.g. fjords, islands, submarine canyons)	No. ha-1	

4.3. **Criteria 2:** Area is important for fishery activity

ES: Lifecycle maintenance, habitat and gene pool protection

Selected Indicators	Unit	Data source
Seagrass seed dispersal rates by fish and birds		Ocean Productivity available to Fish (OPFish)
Species abundance and richness	indiv m-2, spp m-2	Aerial and Boat-based visual and Passive Acoustic Monitoring surveys of megafauna (fishes); Natura 2000 marine and coastal habitats
Juvenile density	abundance km-1	
Species distribution	km km-2	Distribution of species and habitats (according to art. 17 of the Habitats Directive)

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Area of habitat or density of biogenic habitat (e.g. seagrass, maerl or kelp beds) creating species "used" or identified as important for nursery or reproduction	km-2	Conservation status of habitat types and species: datasets from Article 17, Habitats Directive 92/43/EEC reporting; Benthic occurrences, habitat maps, and species traits; OSPAR Habitats - Point data+ selected habitats useful for the indicator

4.4. **Criteria 3:** Area is important for the development of blue economy activities

ES: Wild animals (terrestrial and aquatic) for nutrition, materials or energy

Selected Indicators	Unit	Data source [4]
Relative fish abundance	Catch per unit effort	Ocean Productivity available to Fish, Fishing Effort
Fish harvested by capture fisheries or produced in aquaculture	T/km²	Shellfish aquaculture; Marine finfish aquaculture
Wild fauna	tonnes ha-1	
Catch per unit effort	Pound per unit effort	Fishing Effort
Amount of fish harvested	Amount km-2 year-1	Global Fisheries Landings V4.0
Landings (wild animals)	tonnes year-1 km-2	Global Fisheries Landings V4.0

[4] Potential data: Ocean Productivity available to Fish (OPFish) does not provide indicator units, but fish production potential, so can be useful

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Landing of key market species (wild animals)	tonnes year-1 km-2	Global Fisheries Landings V4.0
Fish catch per household	kg household-1 year-1	

ES: Water used for nutrition, materials or energy

Selected Indicators	Unit	Data source
Amount of seawater extracted per year per area	$m^3/km^2/year$	Seawater extracted data
Use of water for non-drinking	m3 km-2	
Wave energy resources	million watts	Wave Monitoring System, CORDIS
Reduce the dependency on non-renewable abiotic energy sources	kW h-1	CORDIS

4.5. **Criteria 4:** Area is important for shipping

ES: Other type of regulation and maintenance service by abiotic/biotic processes

Selected Indicators	Unit	Data source
Length of shipping lanes	Km	Shipping density
Tonne-kilometres of shipping traffic	Tonne-kilometre	Shipping density

4.6. **Criteria 6:** Area is important for locally-caught seafood

ES: Wild animals (terrestrial and aquatic) for nutrition, materials or energy

Selected Indicators	Unit	Data source

Fish and shellfish populations (biomass, abundance)	tonnes km-2, no. km-2	Ocean Productivity available to Fish (OPFish)
Relative fish abundance	Catch per unit effort	Fishing Effort
Amount of fish/SeaFood catch	Amount km-2 year-1	
Fish catch per household	kg household-1 year-1	
Landing of key market species (wild animals)	tonnes year-1 km-2	

ES: Physical and experiential interactions with the environment (abiotic e.g. caves; Natural e.g. whales)

Selected Indicators	Unit	Data source
Sea space available for recreation	Number of km2 of sea with safe water quality available for recreational use	Location of tourism and leisure infrastructure (land- and sea-based)
Water quality	Chemical analysis (contaminant concentrations) and visual analysis; total coliforms or other pathogens (quantity per milliliter of water)	ANEMONE Black Sea Atlas
Levels of selected chemical compounds in fish, where such compounds constitute tainting		Black Sea - Contaminants aggregated datasets 1974/2017 v2018
Extent of marine protected areas	Ha	Protected areas (National legislation); Protected areas, part of

		the European ecological network NATURA 2000

4.7. **Criteria 8:** The area is important due to the socio-cultural dependence of the coastal community with its environmental quality

ES: Lifecycle maintenance, habitat and gene pool protection

Indicators	Unit	Data source
Habitat health status	Habitat fragmentation index; presence of alien species	
Area of habitat or density of biogenic habitat (e.g. seagrass, maerl or kelp beds) creating species "used" or identified as important for nursery or reproduction	Extent (km2)	

ES: Physical and experiential interactions with the environment (abiotic e.g. caves; Natural e.g. whales)

Indicators	Unit	Data source
Sea space available for recreation	Number of km2 of sea with safe water quality available for recreational use	
Number per area of specific seascape features	No. area-1	
Number and quality of beaches	No. and size of blue flag beaches	
% of total natural seascape	% of natural area in a specified area	
Extent of marine protected areas	Km-2	

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Presence of iconic species	No/km-2	Marine mammals

4.8. **Criteria 9:** Area is important for traditional human settlement, land-use, or sea-use which is representative of a culture, or human interaction with the environment.

ES: Wild animals (terrestrial and aquatic) for nutrition, materials or energy

Indicators	Unit	Data source
Fish and shellfish populations (biomass, abundance)	tonnes km-2, no. km-2	Ocean Productivity available to Fish (OPFish)
Amount of fish harvested	Amount km-2 year-1	Extraction of living resources/ fishery[5], Global Fisheries Landings V4.0
Areas to support seafood production	ha	MSP

ES: Intellectual and representative interactions with environment (abiotic and natural)

Indicators	Unit	Data source
Species, habitats or ecosystems that can potentially form the core of contributing to a cultural custom, rite or way of life	No/km²	Distribution of species and habitats (according to art. 17 of the Habitats Directive)
Abundance of key species of individual interest	Count data	Distribution of species and habitats (according to art. 17 of the Habitats Directive)
Seascape beauty estimation	Ranking	

[5] not in geographic data format, is it possible to get them?

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# of households that consider an area or aspects of an area as cultural heritage	No.	

4.9. **Criteria 10:** Area is important because of the presence of cultural and tradition activities that support local food security and sovereignty.

ES: Wild animals (terrestrial and aquatic) for nutrition, materials or energy

Indicators	Unit	Data source
Fish and shellfish populations (biomass, abundance)	tonnes km-2, no. km-2	Ocean Productivity available to Fish (OPFish)
Amount of fish harvested	Amount km-2 year-1	Global Fisheries Landings V4.0
Areas to support seafood production	ha	MARSPLAN-BS geoportal (W Black Sea MSP)

4.10. **Criteria 15**: Area is important with occurency of iconic species/habitats for the local community.

ES: Lifecycle maintenance, habitat and gene pool protection

Indicators	Unit	Data source
Species abundance and richness	indiv m-2, spp m-2	Natura 2000 marine species
Extent of marine protected areas, presence of iconic species	km2	Marine Protected Areas
Status/population estimates of iconic species		Marine mammals

Presence of endangered, protected, iconic and/or rare species or habitats	No. ha-1	
Social perception of existing conservation designations	% respondents considering it important	

ES: Physical and experiential interactions with the environment (abiotic e.g., caves. natural: whales)

Indicators	Unit	Data source
Sea space available for recreation	Number of km2 of sea with safe water quality available for recreational use	Location of tourism and leisure infrastructure (land- and sea-based)
Abundance and diversity of key species of recreational interest	Count data	
Presence of iconic/endangered species No.		
Status/population estimates of iconic species	Count/km-2	Marine mammals

ES: Intellectual and representative interactions with environment (abiotic and natural) The beauty of nature (appreciated for their inherent beauty)

Indicators	Unit	Data source
Species, habitats or ecosystems that can potentially form the core of contributing to a cultural custom, rite or way of life	No/km²	

Abundance of key species of individual interest	Count data	Marine mammals

4.11. **Criteria 17:** Area is important to be managed due to spatial conflicts among users.

ES: Physical and experiential interactions with the environment (abiotic e.g., caves. natural: whales)

Indicators	Unit	Data source
Sea space available for recreation	Number of km2 of sea with safe water quality available for recreational use	Location of tourism and leisure infrastructure (land- and sea-based)
Possibility of snorkeling, swimming, boating activities, annual number of recreation trips	Km²	Location of tourism and leisure infrastructure (land- and sea-based)
Extent of marine protected areas	km2	Marine Protected Areas
Expert consultation		SeaSketch consultation

4.12. **Criteria 18:** Area with current/potential importance to explore and demonstrate approaches and management solutions, and/or to scientific purposes

ES: Lifecycle maintenance, habitat and gene pool protection

Indicators	Unit	Data source
Presence and diversity of species with potential/actual useful genetic material	Presence/absence diversity	Distribution of species and habitats (according to art. 17 of the Habitats Directive)
Species abundance and richness	indiv m-2, spp m-2	Distribution of species and habitats (according to art. 17 of the Habitats Directive)

Extent of marine protected areas	km2	Marine Protected Areas
Status/population estimates of iconic species		Marine mammals
Presence of endangered, protected, iconic and/or rare species or habitats	No. ha-1	Marine mammals, Natura 2000 marine species

ES: Wild animals (terrestrial and aquatic) for nutrition, materials or energy

Indicators	Unit	Data source
Fish and shellfish populations (biomass, abundance)	tonnes km-2, no. km-2	Ocean Productivity available to Fish (OPFish)
Amount of fish harvested	Amount km-2 year-1	Global Fisheries Landings V4.0
Areas to support seafood production	ha	
Area of no-take zones	km2	
Area of marine protected areas	km2	Marine Protected Areas; Protected areas (National legislation); Protected areas, part of the European ecological network NATURA 2000;
Quantity of available raw material	Quantity (g/raw material)	
Use of animal-based resources for energy	tonnes year-1 km-2	

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[i] https://www.seasketch.org/
[ii] https://www.the-reef.be/en_GB/our-services
[iii] https://climate-adapt.eea.europa.eu/en/knowledge/tools/adaptation-support-tool
[iv] https://www.cakex.org/tools/co-impact-nature-based-solutions
[v] https://www.cakex.org/tools/climate-impacts-decision-support-tool-cimpact-dst
[vi] https://www.cakex.org/
[vii] https://toolsnavigator.friendsofeba.com/search
[viii] https://reefresilience.org/
[ix] https://fisherysolutionscenter.edf.org/tools/climate-vulnerability-assessment