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Deliverable D1.3 - *[Review of socio-ecological framework and methodologies]*

WP1 – [State of the art knowledge to underpin the Living Labs and development of the blueprint platform]

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Table of Contents

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1. Executive Summary

This deliverable D1.3 is the output of Task 1.3: Review of socio-ecological framework and methodologies, encompassing this report and two attached Excel files. Three reviews are included in this deliverable. Firstly, a review of monetary and non-monetary ecosystem services (ESs) valuation within marine protection areas (MPAs) and MPA networks (Chapter 3), which reviewed different valuation methods related to ESs within MPAs based on academic literature. Secondly, a review of business cases, opportunities, and incubator models (Chapter 4) applicable to MPAs and MPA networks. Thirdly, Chapter 5 consists of a review of tools and solutions related to MPAs and other effective conservation measures (OECMs). The third review focuses on tools for assessing positive and negative impacts from and on MPAs/OECMs and the solutions that can mitigate the negative impacts. The second and third reviews include sources not only from scientific literature but also from grey literature, projects, websites, and personal networks.

All three reviews are not exhaustive systematic reviews but rather serve as a preparatory phase to establish the foundation and/or background knowledge for T1.4 and WPs 2 and 3. The relations between the reviews in this task (T1.3)/deliverable (D1.3) and other tasks and WPs are explained in Chapter 2. From Chapters 3-5, each chapter includes an introduction of the review, methodology and review frameworks, and results. In Chapter 3, a detailed analysis of the review results is presented in this report. By contrast, for Chapters 4 and 5, the detailed review results are stored in two attached Excel files, and this report summarises the key trends from the collected business cases, models, tools, and solutions. The gaps related to research or tool development are also mentioned in each chapter (see the discussion and conclusion section in Chapter 3 as well as the result section in Chapters 4 and 5), which could act as suggested focus areas for the follow-up tasks in WPs 2 and 3. Each review can be regarded as an independent review, but they can also be used to supplement each other (see discussion in Chapter 6).

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2. Introduction

The goal of this task (T1.3) is to **understand three core aspects of Marine Protected Areas (MPAs) and Other Effective Area-Based Conservation Measures** (OECMs)[1]:(1) gathering up-to-date knowledge about the dependencies, impacts and values of human activities on/from marine ecosystems both inside and outside of MPAs or OECMs;(2) the tools and methodologies that have been developed to evaluate those dependencies, impacts and values; and (3) the potential solutions that can be used to mitigate the negative impacts on MPAs/OECMs.

This task functions as a preparatory phase to establish the foundation of WPs 2 and 3. To serve this function, the five review aspects described in the proposal were reorganised and grouped into three review tasks. These are: a review on ESs valuation within MPAs/OECMs and MPA networks; a review of business cases, opportunities, and incubator models; and lastly, a review of tools and solutions related to MPAs/OECMs. Table 1 summarises how these five review aspects described in the proposal are included in the three review tasks.

Table 1 summary of the relations between the review tasks in this report and the proposal text.

Proposal descriptions	Review in this report
(1) Review the current existing knowledge on the dependency and impact of human activities (e.g., fisheries, OWFs, shipping, military operations (due to current shifting priorities in the EU)) and society at large on biodiversity-ecosystem functioning and ecosystems' ability to ESs both inside and outside of MPAs/OECMs.	**Chapter 5: Review of tools and solutions related to MPAs/OECMs.** The existing knowledge is included as several criteria in the steps of the tool review. For example, "Does the tool evaluate the impacts from human activity to ecosystem or from MPA/OECM to human society (dependency)" and "What impacts and activities are evaluated by the reviewed tools", etc. Also, human activities and infrastructure are integrated into the same checking criteria. See section 5.2 for more details.
(2) Give an overview of tools available to evaluate the (positive and negative) impact of these activities on biodiversity and a review of the impact of existing infrastructure associated with tourism, energy, and fishing activities in the MPAs/ OECMs or MPA networks.	
(3) Review the valuation of MPA/OECMs ESs (in monetary and non-monetary terms) for decision making, and economically viable and socially just business cases within MPAs and MPA networks, while	**Chapter 3: Review on monetary and non-monetary ESs valuation within MPAs and MPA networks.** Covers the required: "Review the valuation of MPA/OECMs ESs for decision making".

[1] OECM refers to "A geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in-situ conservation of biodiversity with associated ecosystem functions and services and where applicable, cultural, spiritual, socio–economic, and other locally relevant values." (CBD, 2018)

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taking account of revenue streams that result from ESs.	**Chapter 4: Review of business cases, opportunities, and incubator models.** Integrates the rest of proposal description (3) into (5). See section 4.2 for more details.
(4) List Nature-enhancing Solutions associated with human activities at sea linking also to the concept of OECMs.	**Chapter 5: Review of tools and solutions related to MPAs/OECMs.** Extends the scope from listing solutions to a review of solutions. Some review criteria align with the review of tools. See section 5.2 for more details.
(5) Document economically viable and socially just business cases, business opportunities and business incubator models, linked with the blue finance and carbon finance.	**Chapter 4: Review of business cases, opportunities, and incubator models.** Extends the scope from simply documenting the cases and models to a review that can integrate part of (proposal description (3)).

Chapter 3 presents the methodology and results of a review on monetary and non-monetary ESs valuation within MPAs and MPA networks (simplified as the review on ESs valuation in the latter part of the report), which is the basis for T2.3 in WP2.

Chapter 4 contains the methodology and results from the review of business cases, opportunities, and incubator models (simplified as the business review in the latter part of this report). This will act as the input for T2.4 in WP2.

The review of tools and solutions related to MPAs/OECMs can be found in Chapter 5. This chapter establishes the groundwork for T1.4 in WP1, WP2 and WP3.

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3. Review on monetary and non-monetary ecosystem services valuation within MPAs and MPA networks

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3.1 Introduction

Marine protected areas (MPAs) are designated areas of ocean, coastal, or estuarine waters that are legally protected and managed for the conservation and sustainable use of marine ecosystems and biodiversity. MPAs can vary in size, protection level, and management objectives, separating them into different types of MPAs, ranging from multiple-use areas to fully protected and reinforced closure zones. The benefits of MPAs include protecting marine biodiversity and supporting ESs, such as enhancing fisheries, mitigating climate change impacts, combating marine litters and pollutions, and promoting sustainable development. MPAs are established through various mechanisms, including legislation, international agreements, and community-based management. The effectiveness of MPAs depends on several factors, including their size, location, level of protection, and management regime, as well as their level of community participation and support. A report by the NGO Oceana found that more than half of the MPAs within Europe had no management plan, and thus, potential for increasing their effectiveness (Perry et al., 2020).

Ecosystem services (ESs) are the benefits that people obtain from nature (Pascual et al., 2022). They include the provision of food, water, and other natural resources, the regulation of climate, water quality, soil fertility, as well as cultural and aesthetic values. ESs can generally be categorised into four types: (1) provisioning, (2) regulating, (3) cultural, and (4) supporting ESs (MEA, 2005). Figure 1 shows examples of each category. A report evaluating these four types of ESs, showed their significant contribution to welfare, health, and economic activities in a national context (Ireland) (Norton et al., 2018). Some classifications of ESs, such as CICES (Common International Classification of Ecosystem Services), exclude the 'supporting' services and consider them as being part of the underlying structures, processes, and functions that characterise ecosystems (Haines-Young & Potschin, 2018). In this review, we use the Millennium Ecosystem Assessment (MEA, 2005), which categorises ESs as follows (Figure1):

Figure 1 Examples of provisioning, regulating, cultural, and supporting ecosystem services (ESs) for marine ecosystems.

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The valuation of all these ESs is important to recognise the contribution of nature to human society and well-being and to support decision-making processes that ensure the sustainable use and management of natural resources. A valuation can be defined as the process of expressing a value for an action or object, and the benefits they offer (Farber et al., 2002). Angulo-Valdés and Hatcher (2010) defined 99 benefits provided by MPAs, which they classified into (1) benefits for humans (including direct and indirect benefits) and (2) benefits for nature. A wide range of methods and techniques are available to value these benefits mostly focusing on valuing benefits for humans (i.e., the anthropocentric perspective). The choice of a certain method or technique depends on the context and objectives of the study. In general, these valuation methods can either be monetary or non-monetary.

A **monetary ESs valuation** can be used for all types of ESs (i.e., provisioning, regulating, cultural, and supporting) and can estimate (direct and indirect) use values, non-use (existence and bequest) values, and option values. Use values can be associated with the (in)direct use of the ESs (such as fishery and mining), while non-use values can be associated with long-term sustainability and the preservation of intrinsic values of ecosystems (Failler et al., 2019). The latter can refer to the existence value, i.e., the satisfaction an individual gets from knowing an environmental asset will be preserved (independently of any use), or the bequest value, i.e., the satisfaction that individuals derive from knowing that a resource will be preserved for use by successive generations. The notion of the option value, introduced by Weisbrod (1964), is defined as the price that individuals are willing to pay to conserve an element in view of its possible use in the future. This value displays the characteristics of a risk aversion premium. It refers to all use values (both direct and indirect) that can be realised in the future. The difficulty of monetary valuation increases when the value is less tangible to individuals, meaning that the non-use value is more difficult to measure than the use value. The concept of Total Economic Value (TEV) is a framework used to consider all values, use, non-use, and option, assigned to marine ESs, in monetary terms. Multiple techniques for monetary valuations exist and are listed in this review report, together with their application on MPA(network)s.

Monetary valuation comes with the critique that it's immoral to put a price tag on nature, and some benefits will never be estimated because it's impossible to quantify them in monetary forms (Angulo-Valdés & Hatcher, 2010). **Non-monetary ESs valuation** goes beyond traditional economic methods and seeks to capture the full range of benefits associated with ecosystems, including those that are difficult or impossible to quantify in monetary terms. A non-monetary valuation can be both quantitative (e.g., number of species saved or number of homes affected) or qualitative (e.g., scale-based such as 'poor', 'good', or 'excellent') (Martin & Mazzotta, 2018).

Non-monetary ESs valuations often include participatory approaches, involving stakeholders such as local communities in the valuation process to capture their perceptions, attitudes, and values towards the ecosystems and their services. The perspectives of stakeholders cannot be ignored in ESs valuation because ESs are intimately tied to the well-being and livelihoods of people and

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communities affected. Different stakeholders have different interests, values, and knowledge related to ESs, and their involvement in the valuation process ensures that these diverse perspectives are considered and integrated into decision-making. Additionally, involving stakeholders builds trust, promotes transparency, and can lead to more socially and environmentally just outcomes. Overall, non-monetary valuation of ESs is important because it provides a more comprehensive understanding of the values and benefits associated with ecosystems and their services, and can inform policy and decision-making processes, also on the ESs values that are difficult to monetise. This can help to prioritise the protection and management of ecosystems and their services and ensure that their contributions to human well-being are fully recognised. Multiple techniques for non-monetary valuations exist, but their methods are less delineated compared to monetary ones. An overview is provided in this review report together with their application on MPA(network)s.

3.2 Method

This review report aims to summarise the literature on ESs' monetary and non-monetary valuation, specifically applied to MPAs and MPA networks. A literature search was done on the Web of Science, with the following keywords “marine protected area*”, and “ecosystem service* valuation”[2]. To guarantee the quality of the publications, only peer-reviewed papers have been considered. Initially, the search resulted in 128 articles. Articles were included in the final review if they (1) performed or gave an overview of ESs valuation methods, and (2) were focused on MPAs or MPA networks. A total of 73 articles followed these criteria and were included in the final review.

For each article included, the following data was retrieved:

- Author names, journal, publication year, the goal of the study, and main results.
- Whether the article provides a general overview of ESs valuation methods for MPA(network)s, or is an application of these methods to a specific MPA(network).
- Whether the article provides an application that is European or non-European.
- The valuation methods employed in the article, categorised as monetary, non-monetary, or mixed methods.

3.3 Results

3.3.1 General

A total of 73 articles were included in the final review, with publishing dates from 2003 to 2023. The most frequently used scientific journals were ‘Ecological Economics’, ‘Ecosystem Services’, ‘Marine Policy’, and ‘Ocean and Coastal Management’. From the 73 articles, 9 focused on general techniques and methods for ESs valuation in MPAs and 64 showcased actual applications. The application papers mostly focused on monetary valuation (n=38), some on non-monetary valuation (n=11), and

[2] The asterisk (*) represents any group of characters, including no character for searching in the Web of Science (https://webofscience.help.clarivate.com/en-us/Content/search-rules.htm). In this case, the asterisk was used to include both the plural and singular forms in searching.

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others mixed both monetary and non-monetary valuations (n=15). There is a balanced spread between European (n=29) and non-European (n=33) case studies (including overseas territories), and two studies mixing both European and non-European areas (n=2). Some of the application papers specifically focus on MPA networks (n=9).

3.3.2 Objectives of ESs valuation

Various studies included in the review employ ESs valuation for distinct purposes with a diverse range of motivations. There are two primary justifications for the valuation of ESs found in the literature investigated. The first pertains to its use for **decision-making processes**, while the second focuses on **enhancing effective communication**. Both are crucial for the long-term success of MPAs and MPA networks. First, to improve decision-making, ESs valuation collects pertinent information for various aspects such as the current state of the ES, spatial planning, conservation management, and coastal development. This can provide decision-makers with relevant data for better budget allocation, making trade-offs, formulating strategies to facilitate restoration or prevent degradation (e.g., through the implementation of park fees), and offering guidance on policymaking (e.g., ex-ante impact assessment of new regulations). Second, enhancing communication, particularly concerning the value of ecological ecosystems, is imperative for garnering increased support from stakeholders for marine projects, as well as novel policies and strategies. Furthermore, the valuation of ESs can serve as a tool for resolving conflicts that may arise within these contexts.

ESs valuation can be conducted both **ex-ante and ex-post**, providing insights before and after the implementation of an MPA or MPA network. Ex-ante valuation enables decision-makers to assess the potential benefits and costs of establishing an MPA or connecting MPAs into a network, aiding in the design and planning stages. Ex-post valuation allows for the evaluation of the actual impacts and effectiveness of an established MPA, informing adaptive management strategies and policy adjustments. However, both ex-ante and ex-post assessments are not without their respective challenges. These challenges are linked to (1) the (in)accuracy of quantifying values for complex ESs, (2) the broad range of methodologies and assumptions within valuation assessments, which might hinder comparability between studies, and (3) the complex nature of integrating preferences and needs of different stakeholders.

3.3.3 Monetary valuation

Based on the information retrieved within this review study, an overview is provided of **monetary methods** for ESs valuation currently used for MPA(network)s. Table 2 shows an overview of all methods used with examples of applications to MPAs or MPA networks. The list provided in Table 2 can be used to find examples of MPA applications for specific valuation methods. The overview of monetary valuation methods aligns with the findings presented in Norton et al. (2018)'s report.

3.3.3.1 Stated preference method

The **stated preference** methodology elicits people's preferences for hypothetical goods or services, using interviews, surveys, or other data collection techniques. Two types of stated preference

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methods are used to value ESs: (1) contingent valuation and (2) discrete choice experiments. **Contingent valuation** asks individuals directly about their willingness to pay (or accept) (WTP or WTA) for a good or service. **Choice experiments** present individuals with hypothetical choices between different goods and services with varying characteristics to (indirectly) derive people's preferences for different attributes which drive their choices.

Contingent valuation and discrete choice experiments are conducted using individual surveys, interviews, or workshops and focus groups. Kenter et al. (2016) compared retrieving values from group deliberation to individual information and found that the group values may be a better reflection of welfare implications. Most of the articles found in this review (41 out of 64 application articles) applied the stated preference methodology. The WTP for marine conservation in general, or applied to some more specific ecosystem features (e.g., conserving a shark population), are calculated, for example, to justify a tax increase or the implementation of an entrance fee for marine reserves (Brouwer et al., 2016; Castaño-Isaza et al., 2015; Daly et al., 2015; Ison et al., 2021; Malinauskaite, Cook, et al., 2020; Yu et al., 2018).

3.3.3.2 Revealed preference method

The **revealed preference** methodology assesses people's preferences for a good or service by observing their actual behaviour, for example by monitoring which goods people buy or which places they visit. The travel cost method and hedonic pricing method are two revealed preference methods, both using regression analysis for their calculations.

The Travel Cost Method (TCM), first suggested by Hotelling (1949) estimates the value of a non-market good or service. It is mostly used to estimate the recreational value of certain areas. The method assumes that the travel cost is the implicit price visitors pay for their trip to access (recreational) sites (e.g., a beach) or to be able to take part in an activity (Zhang et al., 2015). An example is provided by Trujillo et al. (2017) who estimated the financial benefits of scuba diving services in the coral reefs of Rosario and San Bernardo National Park in Colombia.

Hedonic pricing analyses the relationship between the price of a good or service and the characteristics that determine its value (e.g., the market price of a house). For example, assessing the value of cultural ESs focusing on how the proximity of aquaculture and scenic areas influenced housing prices (Spanou et al., 2020).

3.3.3.3 Input valuation methods

The **input valuation** methods assess how changes in the environment impacts biological resources or ecological services and thereby economic activities. Thus, biological resources or ecosystems services (e.g., fisheries) are treated as an "input" to the outputs of production (e.g., marketed fish catch) and thereby economic activities. Input valuation methods can be cost-based, based on the production function, or market-based.

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The **cost-based** method is a type of input valuation method that analyses the value of the inputs that are necessary to produce the non-market good or service. For this, one could rely on the replacement cost or the damage cost method. The **replacement cost method** can, for example, be used to value storm prevention and flood mitigation services by estimating the costs of replacing coastal habitats by constructing physical barriers to perform these services (Barbier, 2016). However, economists caution against using the replacement cost approach to estimate the value of ESs like storm protection. This is because it involves estimating benefits based on costs, and human-built solutions are often not the most cost-effective means of providing a service (Barbier, 2016). An alternative to the replacement cost method is the **damage cost method**. Barbier (2016) used the expected damage function approach to estimate coastal protection provided by mangroves. A non-market ES, such as the protection of a property or a human life, is valued by using the environment as an input to a benefit. However, this method has limitations as well, especially regarding risk-averse households, and may not accurately represent their willingness to pay to avoid risks. If households are highly risk averse, the option price for reducing the risk might exceed the expected damages (Freeman, 2003).

The **production function** method is another type of input valuation, closely linked with the cost-based ones, which analyses the relationships between the inputs used to produce a good or service and its output. For example, in the case of commercial fisheries, the value of the fishery as an ES can be estimated through changes in production and its impact on welfare. There are two approaches to this estimation: static and dynamic (Barbier, 2000). In static approaches, the estimation is calculated through changes in producer and consumer surplus measures, which are affected by environmental changes. For example, in case of fisheries, declining fish stocks diminish both producers' and consumers' welfare. In dynamic approaches the change is considered as an intemporal, "bioeconomic" effect. In case of fisheries this would mean that changes in environment could be modelled as part of the growth function of the fish stock, which again has impacts on social welfare. Both the cost-based methods and production function methods are usually depending on biophysical and ecological modelling expertise as well as data concerning production and markets.

Market-based methods are based on the principle of shadow pricing. Market prices of related goods and services are used as a proxy for the value of the non-market good or service. It is assumed that the market price, for example of fish, reflects the value that people place on the fish and the ecosystem that supports the fishery. For example, Sagoe et al. (2021) estimated the values for finfish and shellfish harvested annually as a proxy to express the income that would have been lost in the absence of nursery services provided by the marine habitats in Ghana.

3.3.3.4 Benefit transfer method

The **Benefit Transfer** (BT) method is an indirect economic procedure that uses existing valuations of similar ecosystems and their services in other locations to estimate the values within a new study area (often referred to as 'the policy site') (Johnston & Rosenberger, 2009). This is mostly done for economic values. The benefit transfer method relies on extrapolating values from one context to

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another, which highlights the importance of correspondence between both to achieve reliable results (Barbier, 2016).

3.3.4 Non-monetary valuation

Based on the articles found, we provide an overview below of all possible **non-monetary methods** for ESs valuation for MPA(network)s. Table 2 shows an overview of all methods used with examples of applications to MPAs or MPA networks.

3.3.4.1 Environmental accounting

Instead of valuing ecosystems from an economic point of view, based on market prices and human preferences, one can also follow a biophysical perspective (Franzese et al., 2017). This approach allows for an intrinsic valuation of natural capital, going beyond sole anthropocentric values. A monetary conversion can be applied afterwards, which offers the opportunity to have a mixed valuation but moves back towards the anthropocentric viewpoint.

Biophysical modelling and mapping can include observations, monitoring, surveys, and interviews to gather data. Biophysical modelling makes use of various methods such as carbon or water (quality) footprint models (Nahuelhual et al., 2020) and emergy (the amount of energy consumed to make a product or service) accounting. Mapping software is often used to spatially link biological data to existing and proposed conservation areas (i.e., creating biological valuation maps) (Gomes et al., 2018). The Marine Biological Valuation (MBV) protocol has been used to assess the biological value of MPAs (Derous et al., 2007; Gomes et al., 2018). The value of an area is assessed for different criteria in terms of its resilience and stability of species and species assemblages (Węsławski et al., 2009).

The (carbon) footprint analysis can be performed through a life cycle assessment (LCA) approach. This allows practitioners to calculate CO_2 equivalent emissions by software such as Open LCA or SimaPro, using databases such as Ecoinvent. Afterwards, one could decide to give a monetary value to the footprint, e.g., by using the Social Cost of Carbon (SCC) or Abatement Cost (AC) (Dauwe et al., 2023; Tyllianakis et al., 2020; Visintin et al., 2022). The SCC is the marginal cost of damage caused by carbon emissions or the marginal benefit resulting from reduced greenhouse gas emissions (Pearce & Pretty, 1993). Abatement costs reflect the cost of policies required to mitigate the damages from the emission of an extra ton of CO_2 (Tyllianakis et al., 2020). Examples of use of this method are found in Tyllianakis et al. (2020) and Visintin et al. (2022), which valued carbon sequestration and storage for an area including multiple MPAs in the UK and one in Italy, respectively.

Emergy accounting, another technique for environmental accounting, has been applied by, for example, Vassallo et al. (2017) where the accounting procedure relies on trophodynamic analysis. Vassallo et al. (2017) proposed this technique to value natural capital in MPAs. Emergy accounting can provide a value of natural and human-made capital by assessing the cost of production in terms of biophysical flows used to support its generation (Franzese et al., 2017).

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3.3.4.2 Participatory techniques

Participatory techniques have been used for ESs valuation as they allow for the engagement of a broad range of stakeholders, including local communities, in the decision-making process. It is essential to recognise that different stakeholders have different values, needs, and expectations when it comes to the use and management of natural resources. Through the use of participatory techniques, following a bottom-up approach, ESs valuation can reflect the priorities and perspectives of local communities and other stakeholders. Furthermore, participatory approaches can help to build trust and social capital among stakeholders, leading to more effective and collaborative management of natural resources.

Qualitative information is usually gathered by different techniques such as surveys (with rating, ranking, or open-ended questions), workshops, focus groups, and interviews with stakeholders. For example, Slater et al. (2020) used a set of linked participatory workshops for cross-sector stakeholder involvement to aid decision-making for a licensing decision for offshore wind farms in the North Sea (UK). The workshops resulted in spatial data, a list of benefits and ESs, and a conceptual map exploring linkages and trade-offs. In addition, surveys have been widely applied to assess well-being resulting from ESs. An example was developed by Kenter et al. (2016) who provided a set of 15 non-monetary indicators, which reflect well-being (e.g., rating the statement 'I have felt touched by the beauty of these sites'). These have been further applied by Spanou et al. (2020) to value cultural ESs on the West Coast of Scotland.

Some specific methodologies have been developed for participatory research using the techniques explained in the previous section (workshops, interviews, and surveys). One example is the **Community Voice Method**, which was applied by Ainsworth et al. (2019) to involve marine stakeholders in the UK to improve the valuation of coastal and marine cultural ESs. The Community Voice Method (http://communityvoicemethod.org/) is a technique using interviews that shows great promise in gathering and conveying diverse stakeholder perspectives in a democratic, cohesive, and non-confrontational manner (Cumming & Norwood, 2012). This method identifies shared values and subjective experiences, establishes management options and criteria, and develops value indicators for different environmental benefits and policy options through workshops.

Social mapping encompasses another group of methods that deal with participatory processes to map socio-economic conditions (and their relations), hotspots, social perceptions, values and priorities, focusing mostly on the valuation of CES (Nahuelhual et al., 2020). Social mapping pertains to the process of identifying and delineating specific areas that hold value and cultural significance. Johnson et al. (2019) applied the PPGIS approach to compare how social values relate to landscape metrics. Rees et al. (2010) employed a simple method for identifying recreational hotspots by asking respondents to indicate the frequency of their visits to specific sites on a scale of 1 to 5. This approach offers a simple and practical way to identify areas with high levels of recreational activity. Cunha et al. (2018) used the InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) model to calculate the number of photos in Flickr in a Portuguese region (including an MPA) as a

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proxy for the number of visitors. A last example is the Belgian project Lecofish where they interviewed fishermen to obtain local ecological knowledge, focusing on species occurrences (Belspo, n.d.).

A final example of a participatory method is the **Q method,** which is applied to an MPA by Pike et al. (2015). The Q methodology uses a series of interviews to derive 'factors' of value for its stakeholders, allowing the incorporation of minority viewpoints. The Q method can map the views of stakeholders and is especially applicable to examining CES that are more difficult to measure. It can help decision-makers to understand where and how stakeholders within MPAs 'place value' on CES.

3.3.4.3 Multi-criteria decision analysis

Multi-criteria decision analysis (MCDA) is a method of 'aggregation'. Different MCDA techniques exist such as global and local multi-attribute scaling, the analytical hierarchy process, and compromise programming (Martin & Mazzotta, 2018). MCDA is a non-monetary method in itself but can be used to combine monetary and non-monetary ESs values.

MCDA can be organised in a participatory way, engaging stakeholders in decision-making by identifying and prioritising relevant criteria. For example, Lopes and Videira (2019) developed PArticulatES, a three-stage framework for participatory MCDA that was successfully piloted in the Arrábida Natural Park in Portugal to value ESs. The framework provides a coherent platform for engaging stakeholders in scoping, assessment, and decision support to make informed decisions about ecosystem management and protection.

*Table 2. An overview of all valuation methods with examples of applications to MPAs or MPA networks. The numbers in column 2 ('Example MPA(network) application') refer to the list in **Appendix A** where all application articles used in this review study are listed.*

Method	Example MPA(network) application
Monetary valuation methods	
Contingent valuation - stated preference	5, 6, 9, 12, 13, 15, 18, 19, 21, 22, 25, 26, 28, 31, 33, 34, 42, 45, 47, 48, 50, 56, 61, 62, 65, 66, 67, 71
Choice experiments - stated preference	3, 9, 11, 16, 17, 30, 37, 38, 42, 52, 57, 60, 69, 70, 72
Travel cost method (TCM) - revealed preference	9, 25, 44, 52, 62, 64, 67
Hedonic pricing - revealed preference	8, 14, 62, 67
Replacement cost method	25, 67
Damage cost method	23, 41, 67
Production function method	41, 67
Market-based method	18, 21, 25, 32, 41, 42, 62, 63, 65, 67
Benefit transfer	10, 41, 42, 62

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Non-monetary valuation methods	
Environmental accounting (biophysical modelling/mapping, emergy, and footprint analysis)	18, 23, 24, 25, 36, 41, 46, 51, 52
(Well-being) surveys/interviews using e.g., the Likert scale and open-ended questions	8, 9, 12, 14, 47, 49, 62, 63, 65
Community voice method	27
Social mapping/ hotspot mapping	32, 34, 39, 49, 51, 63
Workshops (facilitated discussions)	53, 54, 58, 59, 67
Q method	43
Multi-criteria decision analysis (MCDA)	40, 55, 59

3.4 Discussion on ESs valuation for MPA(networks)

Most articles analysed in this review rely on monetary approaches, with a clear preference for stated preference methodologies, such as contingent valuation and discrete choice experiments. Depending on the goal of the study and the ES under evaluation, a different monetary approach or combination of approaches can be useful. For example, Lan et al. (2021) performed a comprehensive ex-ante evaluation of ESs for a potential MPA in Vietnam, combining methods like the market price method, travel cost method, carbon price method (for a monetary value of CO_2), replacement cost method, avoided damage cost method, the value of biodiversity (monetary, White and Cruz-Trinidad), and contingent valuation for non-use values. Table 3 provides an overview of the ESs they assessed, and the methods they applied.

Table 3 An overview of ESs assessed by multiple methods for monetary estimation in Lan et al. (2021).

Groups of value	Values	Methods for monetary estimation	References
Direct use value	Seafood	Market price	UNEP (2014)
	Construction materials and minerals	Market price	UNEP (2014)
	Tourism	Travel cost	UNEP (2014)
Indirect use value	Coastal protection	replacement cost	UNEP (2014)
	CO_2 absorption	certified emission reduction approach	14 Euros/ton per year by CER in Europe in 2011
	Nutrient filter	Avoided damage cost	UNEP (2014)
	Biodiversity, nursery grounds, habitat	Approach proposed by White et al.	White and Cruz-Trinidad (1998)
Non-use value	Bequest, conservation, option	CVM (open-ended question)	Hanley and Spash (1993)

Markets usually fail to capture the actual value of ESs (Costanza & Liu, 2014). In this case, economic valuation can be an alternative to provide a monetary measurement for ESs. Such valuation exercises enable and ease the inclusion of costs and benefits of biodiversity into decision-making processes for resource use (Rands et al., 2010) . Monetary valuation of ESs can, thus, be used to advocate the protection of MPAs for policymakers. Monetary valuation of ESs can also justify investments in ecosystem management which can help avoid future restoration costs and enables comparisons of economic welfare between decisions and policies related to MPAs (Balmford et al., 2002).

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A small number of articles focused only on non-monetary approaches. Unlike monetary values, which can be easily integrated into economic frameworks, non-monetary values often encompass subjective, cultural, and intangible aspects that are difficult to measure and compare across different contexts. The tangibility of monetary values provides a more straightforward and recognisable basis for justifying conservation efforts, as they can be directly compared to costs and benefits. As a result, the application of non-monetary approaches for ESs valuation remains relatively limited within the literature, despite their potential to capture a broader range of values, avoid many assumptions on economic values, and inform holistic management strategies. As can be seen in Table 2, most non-monetary applications use surveys and interviews with Likert scales and open-ended questions to value ESs.

Some applications use a mixed approach, combining monetary with non-monetary approaches. For example, Spanou et al. (2020) developed a valuation approach including non-monetary valuation through a eudaemonic well-being questionnaire and monetary valuation through hedonic pricing. Chen et al. (2018) combined data from interviews and questionnaires with a contingent valuation approach to evaluate public perceptions and WTP for ESs in Taiwanese fishery resource conservation zones. The Total Social Value (TSV) concept, instead of the TEV, can be followed to include ecological value, economic value, and socio-cultural value, which should be measured by both monetary and non-monetary approaches. The TSV concept is described and applied by Burdon et al. (2018). An integration of both natural and social sciences, together with stakeholder analysis and engagement, is important for a more comprehensive valuation of ESs.

Twenty-one application papers value one specific type of ESs (e.g.,(Gomes et al., 2018; Rees et al., 2010; Zambrano-Monserrate et al., 2018) focusing mostly on cultural ESs and sometimes on supporting ESs. All other application papers specify that they adopt a valuation for a combination of ESs and utilise various methodologies (e.g., (Failler et al., 2019; Hicks et al., 2009; Izidoro & Schiavetti, 2022; Pascal et al., 2018; Tyllianakis et al., 2020)). In general, navigating through this diverse pool of methods, tools, and ESs types remains challenging. In the Blue4all project, our objective is to provide effective guidance on suitable methods and tools for valuation, ensuring completeness by linking biological data with socio-economic considerations. Our aim is to consolidate existing findings and identify the most appropriate approaches for valuing ESs.

3.5 Conclusion

This review report provides a comprehensive summary of literature on ESs' monetary, non-monetary, and mix valuation, specifically applied to MPAs and MPA networks. The search was conducted on the Web of Science using specific keywords, resulting in an initial pool of 128 articles. After applying the selection criteria, 73 articles were identified and included in the final review.

It was found that the focus of the 73 studies retained was variable. For example, some articles focused on assessing the economic worth of ESs, whereas others emphasised the social and cultural significance of ESs. Another cluster of studies focused merely on the ecological aspects, aiming to

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evaluate the contributions of ESs to biodiversity conservation and environmental sustainability. Overall, the contrasting objectives pursued by different articles within the review study demonstrate the interdisciplinary nature of ESs valuation.

The findings of this review study highlight the prevalent use of monetary approaches in ESs valuation for MPAs and MPA networks. Stated preference methodologies, such as contingent valuation and discrete choice experiments, are particularly favoured among the analysed studies. Non-monetary approaches are deemed to be especially useful to assess cultural ESs, having the potential to capture a broader range of values. A combination of both monetary and non-monetary, combining biophysical modelling, social assessments, and monetary quantifications can acknowledge the complementary benefits of them all. The more complete the valuing of all ESs, the better one can inform decision-makers on balancing environmental, social and economic aspects in a way that is supported by stakeholders.

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4. Review of business cases, opportunities, and incubator models

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4.1 Introduction of the review

While the main purpose of MPAs is to protect marine biodiversity and ecosystems, the evidence shows that they may also bring socio-economic benefits and secure the development of the local communities, which have a key role in the success of an MPA (Bennett & Dearden, 2014a, 2014b; Russi et al., 2016). Therefore, understanding the existing business cases, opportunities, and incubator models and the experiences in them plays an important role in developing the toolbox in the BLUE4ALL project.

This chapter contains a review of some existing MPA-related business cases and practices. The purpose of this review is not to collect a comprehensive list of all existing business cases but a collection of the variety of opportunities to give an overview of what kinds of business opportunities and incubator models are applicable within MPAs, concerning their economically viable, socially just, relations to ESs, and the linkage to carbon- and blue finance. The blue finance refers to finance activities (e.g., investment, financing, insurance, banking) and finance instruments in supporting the development of the blue economy (i.e., economic activities that are ocean, marine, and coastal related with sustainable consideration) (Pereira & Nogueira, 2021; Yoshioka et al., 2020). The carbon finance refers to similar finance activities but for low-carbon economics, including but not limited to direct investment, financing, carbon trading, and bank loans in limiting greenhouse gas emissions (Yang & Luo, 2020). The results of this review are presented in two separate review tables (See Appendix B): (1) a review of business cases and opportunities, and (2) a review of business incubator models.

In this review, an incubation model can be understood as the approach in which an incubation entity provides support to a business opportunity, which aims at improving the survival probability of the business and accelerating its development (Pauwels et al., 2015). One incubation model may apply to different business cases at different sites. The business cases and opportunities include not only the established business cases but also activities and projects conducted in, near, or together with MPAs or MPA networks, which can bring financial streams, either to the local communities or for MPA management. For both reviews, the collected examples need to be applicable to MPAs/OECMs management. Therefore, blue business opportunities whose linkage to MPAs/OECMs cannot be identified, are out of the scope of this review.

4.2 Methodology

Since not all business cases, opportunities, and incubator models were documented in peer reviewed scientific literature, the research of the reviewed cases is conducted from a wide scope of sources. It is based upon information gathered from various platforms (e.g., WWF SharePoint, PANORAMA – Solutions for a Healthy Planet, Birdlife.org), the accumulated knowledge and practical experiences from Blue4All consortium partners and past projects, personal networks, conference

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abstracts, etc. In addition to the sources that the cases were identified, the relevant information was further collected through not only scientific and grey literature but also partner experiences and project websites. The collected cases or incubator models are mainly focused on, but not limited to, the European Seas. To keep the variety of the collected examples, similar repeated business cases (e.g., eco-tourism and recreational fishing) were not included in the review table.

For each case in the review table for business cases and opportunities, we identify:

1. The location and sea regions in which the business is conducted.
2. The evidence, time, beneficiary, and the key factors of success, if the business case is economically viable.
3. The linkage to blue- and carbon finance.
4. Socially just, in terms of the positive and negative impacts of social value the case brings and has on other stakeholders.
5. The required policies or regulations to make the business possible.
6. ESs and functions that the business relies on or has impacts on.

For the business incubator models, we provided:

1. A short description and the MPA examples for each model.
2. The linkage to blue- and carbon finance.
3. The required or related policies or regulations.

The above-mentioned review content was discussed and decided together with T2.4 to align with required information used for the follow-up task can be collected.

4.3 Results

The detailed review of the collected business cases and incubator models is documented in Appendix B. This section summarises an overall trend of the collected business cases and models. In total, 26 business cases and 7 business incubator models are included in this review. As the review criteria is slightly different, some concrete cases from the 7 business incubator models were also included in the review of business cases and opportunities. However, to prevent repetition, not all MPA examples from business incubator models were included in the review of business cases and opportunities. These cases are still listed in the example column of the incubator model review, which are available for further exploration if needed for the followed-up task.

The review shows that blue business incubators have been developed and tested for use in various sites and contexts and on different local or national levels. Therefore, they have the potential to be applied to other sites. Each Blue business incubator includes multiple MPA examples, providing evidence of its success. The factors of success are hard to conclude from the collected incubator models, as these vary between the business cases (see later part of this section). However, all the collected models emphasise the importance of involvement and collaboration with the local community, local businesses, and/or stakeholders. In addition, correspondent regulations and policies are also the key factors for success, although the specifically required regulation may vary case by case.

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Within the 7 collected business incubator models, “The Blue Business Incubator” and “Mediterranean Experience of EcoTourism (MEET)” are Mediterranean based (see Appendix B, sheet “Business incubator models”). As they are both (eco)tourism-based models, their revenue streams rely on the quality of the marine environment; thus, both are possible to link to blue finance if the business would like to seek financing or investment. The latter one, MEET, also has the potential to link carbon finance, as MEET includes a tool to estimate ecological footprints for the new business in their models.

“Blue Parks Initiative” and “BLUEprint” are two incubators to support MPAs globally, including a few examples from within the European Seas (see Appendix B, sheet “Business incubator models”). The first one support locals and provide opportunities to boost eco-tourism through an award; whereas the second supports a broader variety of business activities by providing a guideline to establish sustainable finance models for different business as well as guidance for planning and developing MPAs.

The remaining 3 business incubation models only have marine applications outside the European Sea, including Middle and South America. Two of them, “Eco2Fin” and “Seeking Protected Area Financial Sustainability”, especially assist in developing a sustainable financial strategy, with methods which might be valuable in exploring its applicability to the European Sea.

Of 26 collected business cases, four cases are outside the European Seas. Two are worldwide/international cases that also include the cases in European Seas. The remaining cases happened within the European Sea, but the collected cases show an unbalance among different Sea regions in Europe. The business cases in the Mediterranean Sea are most easy to find based on both partners' experiences and literature searching. Resulting in more than half of the collected business cases originating from the Mediterranean Sea. Six collected cases from the Atlantic Ocean (including the North Sea), but no cases for Baltic Sea and Black Sea were found.

The evidence of prosperity in terms of economic viability, environmental improvement, and social inclusion is evident across all reviewed cases. The economic boost is exemplified through the creation of new jobs and income opportunities for the local community, increased inclusion of women in maritime jobs, a boost in eco-tourism and fishing tourism, and the initiation of small-scale businesses with a focus on blue finance. A couple of cases also mentioned the utilisation of financing leverage, the implementation of a management model that offers a long-term strategy, and the development of a financial strategy to secure resources through fundraising (e.g., cases No. 1, 7, 26 in Appendix B, sheet “Business case and opportunity”). It can be noticed that tourism- and fishing-related businesses are commonly found (e.g., cases No. 1, 2, 5, 11, 16, 17, 20, 21, 22, 23, 25 in Appendix B, sheet “Business case and opportunity”), but it can be noticed some diversity and innovation among the cases. For example, for the cases related to fishing, it varies from production, process, and marketing. Other cases like the business combination of research (water monitoring and wind power), label for marketing, and carbon and biodiversity credits were also identified. The innovative and well-planning of the ideas can be observed from the case descriptions.

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Under the review criteria on the key factors to business success, many factors are mentioned from the 26 collected business cases. This includes, for example, creating enough jobs, economic benefits, and sustainable finance or having a good financial strategy and investment support (e.g., cases No. 1, 7, 14, 15, 17, 20 in Appendix B, sheet "Business case and opportunity"). Also, as mentioned in the results for incubator models, the substantial involvement of relevant stakeholders played a crucial role in achieving these results (e.g., cases No. 1, 4, 5, 17, 22 in Appendix B, sheet "Business case and opportunity"), emphasising their importance and contribution throughout the processes and activities. For other cases, even though the involvement and collaboration with relevant local stakeholders/community are not mentioned as key factors to business success, the descriptions of the planning process of some business cases include innovative methodologies that prioritise stakeholder and citizen participation, emphasising their central role. The relevant regulations/policies are also mentioned in a few cases (e.g., cases No. 15, 16, 19 in Appendix B, sheet "Business case and opportunity"). Other mentioned successful factors include education/training, uniqueness of the site, the success in keeping/protecting good marine ecological status, and so on.

Compared to economically viable, the review on socially just is less comprehensive. The social inclusive (e.g., involvement of locals) and the social benefit (e.g., preserving traditional knowledge, food security and health issues) are often mentioned. However, only two cases (No. 13 and 15 in Appendix B, sheet "Business case and opportunity") mentioned the possible social value loss from the business and 9 cases mentioned its possible negative impacts on other stakeholders. The lack of such information is partly because of lack of research but could also reflect many cases having good socially inclusive strategies.

Most of the collected cases also addresses environmental improvement through tangible approaches. It has successfully curbed environmental damage to fragile coastal and marine ecosystems, enhanced flood defences to minimise economic damage, improved water quality, and maintained the marine environment and biodiversity. The involvement and contribution of key stakeholders were necessary to achieve these improvements.

The transboundary approach is mentioned (either directly or indirectly) by three different collected cases and deserves attention (cases No. 10, 13, and 14 in Appendix B, sheet "Business case and opportunity"). The cases emphasised the value of knowledge-based transboundary dialogue and raised awareness among different stakeholders. MPA Pelagos Sanctuary (case No.13) highlights formalised partnerships among transboundary coastal towns as well as the establishment of the MPA covering 53% of adjacent high seas. The North Atlantic Current and Evlanov Sea-basin (NACES) MPA (case No.14) is emphasised as the first-ever designated MPA on the High Seas, based on tracking data. The shortcomings in proper management identified within case No.13 underscore the need for effective management practices.

In addition to the collected examples that showed the concrete business cases and models, Russi et al. (2016) provides a systematic overview of socio-economic benefits from European MPA, which gives an overview of other business opportunities not included in this Business Review. Also, Section

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5.3 reviews some solutions that can mitigate negative social-economic impacts. Those solutions supplement well this Business Review and together they serve as a good starting point for Task T2.4.

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5. Review of tools and solutions related to MPA/OECM

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5.1 Introduction of the review

This chapter presents the methods and results of two reviews. The first, titled 'Tool Review' in the beginning part of chapter 5, reviewed some of the tools that have been or can be used to evaluate the positive and/or negative impacts from society (including human activity and infrastructure) on ecosystems (inside or outside MPA/OECMs) as well as evaluate the positive and/or negative impacts from MPA/OECMs to society. The second review, titled 'Solution Review' in the latter part of this report, reviewed some potential solutions that can mitigate negative impacts, either from society to ecosystems (inside or outside MPA/OECMs) or from MPA/OECMs to society. Both reviews share the same framework with the same set of impact and activity indicators, although they are not directly linked to each other. With these reviews, we can not only identify what tools and solutions are available but also understand the up-to-date knowledge about which kinds of impacts have been/can be evaluated, what are the impacted targets, which activities are related, and on which MPAs such tools or solutions have been implemented. The reviews are not exhaustive but provide a quick overview of the available tools and solutions, providing a base for WP2 and 3 in identifying for further development.

5.2 Methodology

5.2.1 Common frameworks and indicators

Figure 2 shows the procedure for conducting the Tool and Solution reviews, which starts with defining the framework. Multiple frameworks have been proposed to evaluate the performance, effectiveness, goals and/or outcomes of MPAs (e.g., (Cardoso-Andrade et al., 2022; Intergovernmental Oceanographic Commission, 2006; Meehan et al., 2020; Picone et al., 2020)). However, only a few frameworks are used to understand the impacts from MPA/OECMs to society or from society to marine ecosystems. The two reviews conducted in this chapter were based on the framework utilised by Rasheed (2020) which systematically reviewed and categorised the indicators of human well-being that can be used to measure the relationship between human well-being and MPAs such as: *Community/Stakeholder perception*, *Trust, Equity*, *Income*, *Health*, *Biodiversity and species richness/density*, etc. We utilise the relationship between human well-being and MPAs as the primary indicator to explore both the impacts that society imposes on marine ecosystems as well as the impacts that MPAs/OECMs present to society. This establishes the core of the review. The Tool Review focuses on collecting the tools that can evaluate such relations whilst

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the Solution Review focuses on collecting solutions that mitigate such relations if impacts are negative.

Rasheed (2020) categorised the indicators into 4 domains of human well-being. The listed indicators were from Rasheed (2020) - supplemented by the indicators from Grorud-Colvert et al. (2021), Kaplan-Hallam and Bennett (2018), and Intergovernmental Oceanographic Commission (2006) - were adjusted and reclassified into 5 aspects. These aspects are: Cultural aspects; Societal and Governance aspects; Human capital and health aspects; Economic aspects, and Natural aspects. The mapping from 4 domains of human well-being to 5 aspects and indicators from different studies can be found in Appendix C under the "indicator summary" sheet. Table 4 presents the final list of impact indicators used in the Tool Review. A shorter list of impact indicators was used for the Solution Review (see Appendix C, sheet "Code&dropdown list" and Section 5.4). In both reviews, we also identified which activities cause impacts. The activity indicators were taken from HELCOM's Human Activities and Pressures matrix (HELCOM, 2016). This can also be seen in the "Code&dropdown list" sheet in Appendix C.

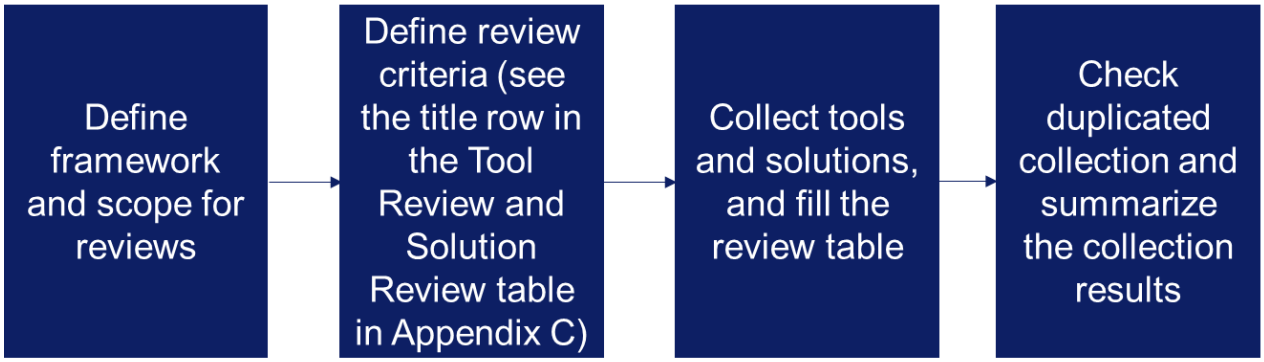

Figure 2 Procedure for conducting the Tool Review and Solution Review.

Table 4 Final list of aspects and impact indicators used in the review.

Aspect	Impact indicators
Cultural aspect	Cultural identity, cultural diversity, cultural integrity, traditional knowledge, innovations, and practices (belong to cultural ES, relate to indigenous)
	Other cultural ES (sense of place, way of life, heritage)
Societal and Governance aspect	Community/stakeholder perception
	Trust, equity, transparency, and accountability
	Resource access
	Governance & management (compliance, enforcement, administration, and related cost)
	Policy & legislation
	Institutional relationships, institutional diversity, social/community organization, or cohesion

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	Community empowerment
	Social resilience and vulnerability
	Stakeholder, community participation, resource user conflict, user relations
	Proximity to MPA
Human capital and health aspects	Health in all aspects (physical, mental, emotional, connection to nature, healthy food, and water etc)
	Human resources and capacity
	Education
	Population dynamics and family attributes
Economic aspects	Income, individual economic and material wealth
	Employment, livelihood, alternative livelihood, or skills
	Investments (businesses, financial security, bank savings)
	Financial aid/donor funding and support
	Market structure and system, sector activity and production, macroeconomics
	All kinds of ecosystem service value
Natural aspect	Provisioning service
	Biodiversity & species richness/density & abundance & population
	Reproductive output and replenishment
	Connectivity
	Trophic interactions
	Other ecosystem function
	Habitat conservation or protection
	Ecosystem health & quality
	Water quality
	Climate resiliences
	Other regulating service

5.2.2 Scope and review criteria of Tool Review

In the Tool Review, the collected tools are from various types of sources. Scientific literature, experiences from previous projects (grey literature or website), as well as tools developed by Blue4All consortium partners were included. We kept the scope and definition of “tool” flexible due to disagreement among different disciplines and needs from different WPs. The primary collection targets were developed platforms, software, or other tool-kind of models. However, such forms of tools are more commonly found in cases which evaluate the impacts belonging to Natural and Economic aspects. Therefore, the scope of the collection also includes guidelines, frameworks and evaluation approaches for the assessment of impacts. This was particularly common for indicators

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relating to Cultural, Societal and Governance, and Human capital and health aspects. This collection includes tools that have been applied for specific MPA(s) and tools that can be further developed to evaluate impacts related to MPAs. Also, even though the Tool Review targets on tools used for evaluating the impacts, some tools that were originally developed to help in optimising and strengthening MPA planning and management/governance in decision making or in evaluating the outcomes or effectiveness of MPAs were also included, as some of these tools can still evaluate certain impacts defined in Section 5.2.1 in some ways.

For the Tool Review, several key aspects of each tool were systematically evaluated. These aspects included:

1. The direction of positive/negative impacts (i.e., from MPA to society **or** society to MPA).
2. Is the tool a spatial explicitly tool?
3. What impact indicators are targeted?
4. Where was the tool applied (MPA specific)?
5. Was that MPA inside or outside European seas?

The full review criteria can be seen in the Appendix C (title row in sheet "Tool Review (section 1)".

5.2.3 Scope and review criteria of Solution Review

The collection of solutions is mainly from scientific literature and prior project experiences from the participating partners (grey literature and/or websites). We focused on examples that have been implemented in different regional seas around Europe, but we also included solutions implemented outside of the European seas, as well as solutions that have been proposed but not yet implemented.

For each collected solution, we identified:

1. The negative impacts and activities that the solutions target to mitigate.
2. The solution types (i.e., different levels of area-based solution).
3. Whether or not the solution has been implemented?
4. Where was the solution implemented?
5. The stakeholders who are responsible for and involved in the solution implementation.

The full review criteria can be seen in Appendix C (title row in sheet "Solution Review (section 2)".

5.3 Results of Tool Review

The detailed review of the collected tools is documented in Appendix C, sheet "Tool Review (section 1)". In total, 107 tools were collected, many of which cover more than one aspect. 51 tools evaluate the impacts on Cultural aspects; 38 for Societal and Governance aspects; 25 for Human capital and health aspects; 49 relate to Economic aspects, and 58 tools cover Natural aspects. 39 of the collected tools were applied to MPAs/OECMS in European seas. 46 tools were found to have been applied to MPAs/OECMs outside of the European seas. For the remaining tools that were collected, no MPA /OECM was identified for application in this review. This could be because the tools have not been applied to an MPA/OECM yet, or simply that no example was provided in the reviewed

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documents that list the tools. In this section, we summarise the key findings of the tools under each type of aspect. Under each aspect, the trend of the review criteria is summarised, and a few specific tools are mentioned. It should be noted that the tools included under a specific aspect do not eliminate their importance for other aspects. Additionally, the tools which were omitted for this section can still be found their details in Appendix C, sheet "Tool Review (section 1)".

5.3.1 Cultural Aspect

In total, 51 tools were found that can be used to evaluate the impacts on Cultural aspects. The indicators under this aspect can sometimes be found within guidelines or frameworks - e.g., Standardised Protocol for Evaluating Community Conservation Success (SPECCS) (Brichieri-Colombi et al., 2018). When the evaluated impact related to cultural aspects such as recreational services or activities, some software and tool-like models were found (e.g., InVEST Visitation: Recreation and Tourism model (Arkema et al., 2021)). However, in general, there was a limited range of literature available that dealt specifically with the cultural impacts relevant to MPAs and/or OECMs. Thus, the search for literature was broadened to include (1) evaluation approaches for impacts under the Cultural aspects, and (2) marine-related academic papers that analyse cultural services, but which may not be MPA/OECM specific.

Overall, the papers employed diverse methods and approaches in their analysis. Approximately 18 out of 51 papers (35%) utilised purely qualitative means of data collection and analysis. The remaining either used primarily quantitative approaches or blended both qualitative and quantitative methods. Additionally, the use of GIS-related methods was one of the most prominent approaches in the review. Through keyword searches, articles were gathered from around the world. Whilst most papers (21 papers) related to Europe, articles based in the Americas, Asia, Africa, and Australasia (less than 10 papers for each abovementioned region), were also reviewed.

For the papers that focused on the evaluation approaches, the most popular methods were interviews and survey questionnaires, but methods also included workshops, focus groups, as well as participant observation and photo talk (also referred to as community voice and photo voice). Survey questionnaires were used across quantitative and qualitative papers. Within qualitative-based studies, the results of these methods were often analysed through combinations of ethnographic and content analysis or contextualised with literature reviews. For those papers that used quantitative approaches, optimised Likert Scales were used to structure the survey. The results of these were analysed with a variety of different statistical measures, including the Kruskall-Wallis nonparametric test; Shapiro-Wilk normality test and Cronbach's alpha. Additionally, varying usage of Pearson's- and Spearman's rank correlation coefficient, Chi-Squared and Standard Deviation occurred, as well.

The human activities that dominated the focus of these papers were tourism and leisure as well as (recreational) fisheries. The vast majority dealt with the positive effects of identified cultural services on human life. The impact indicators of *Cultural identity, cultural diversity, cultural integrity, traditional knowledge, innovations, and practices (belong to cultural ES, relate to indigenous)* were identified in 25 reviewed papers. 43 papers covered the indicator of *Other cultural ES (sense of*

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place, way of life, heritage). Whereas the choice indicators of the study were overwhelmingly related to cultural aspects with some linkages to the other aspects.

To give examples, Malinauskaite, Davidsdottir, et al. (2020), Pearson et al. (2019), and Jackson-Bué et al. (2022) focused on the impact of certain symbolic species on human communities. This approach links the representational, spiritual, and material importance which certain nonhuman beings have and have had throughout the centuries in particular biocultural contexts. Whilst many examples of these human/nonhuman relationships have been emphasised in indigenous contexts, Jackson-Bué et al. (2022)'s study of the significance of Cockles (*Cardiidae*) across multiple European countries evaluated the cultural nuances of human connection to marine life whilst also linking cultural ESs to other forms of ESs. Another reoccurring theme was the presence of Indigenous and traditional ecological knowledge and the evaluation of one's *sense of place* within fishing communities (Baker et al., 2021; Dias et al., 2022; Pearson et al., 2019; Plaan, 2018; Urquhart & Acott, 2014).

Whilst not MPA specific, one very interesting study was done by Subiza-Pérez et al. (2019) in the creation of the PEAQS scale. Here, the focus was on the aesthetic qualities of natural spaces, with aesthetics being one of the least studied aspects of cultural ESs. Regarding further quantitative studies, the use of accessible geotagged social media data for a much larger scale study of cultural values through represented images is clearly growing as an approach (e.g., (Alieva et al., 2022; Erskine et al., 2021; Retka et al., 2019; Ruiz-Frau et al., 2011)). Whilst not as nuanced as some qualitative studies, these approaches can locate the larger trends and ways in which certain features are valued. GIS quantification and participatory approaches to mapping survey data on recreation and other forms of nature engagement also featured highly (e.g., (Gajardo et al., 2023; Nahuelhual et al., 2017; Ocelli Pinheiro et al., 2021; Tajima et al., 2023))

From the collected tools, multiple interdisciplinary approaches and methodological frameworks are being developed to better evaluate the culturally situated, nonmaterial elements of human interaction with the environment. However, in this literature, there is a tendency to prioritise certain activities (tourism, recreation, fishing) over others, like spirituality and sense of place. The initial search for tools yielded few results – pointing to a real need for development in this area. A clear 'gap' has been noted in relation to cultural service evaluation, particularly when discussing *intangible* cultural values, such as *sense of place or aesthetics*. Moreover, those cultural services that are studied typically relate to recreation, tourism, and fisheries/fishing communities. As was noted in many of these papers, much more needs to be done to evaluate those less-studied cultural service indicators.

5.3.2 Societal and Governance Aspect

In total, 38 tools were reviewed for the Societal and Governance aspect. Only 2 of those reviewed cover aspects solely related to Society and Governance. For the remaining 36 tools, a few were mentioned under the Cultural aspects, and some were considered as social-economic decision-making tools (see Section 5.3.4). The remaining were systematic frameworks, guidelines, or multidisciplinary models, which often cover multiple related aspects, such as Societal and

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Governance, Natural, and Economic aspects. Only 7 of the collected tools did not identify MPA/OECM cases where the tool was applied. Whereas half of the identified MPAs/OECMs are located within the European seas.

All the indicators listed under the Societal and Governance aspect were identified within the 38 tools. *Stakeholder and community* related indicators (multiple indicators) were the most covered impacts. Indicators relating to *Governance & management (compliance, enforcement, administration and related cost)* as well as *Policy & legislation* are also often tackled. The remaining indicators were explored less by the collected tools.

The tools, frameworks, and guidelines developed by IUCN were one of the main sources for the tools under this aspect. These included: the Social Assessment of Protected and Conserved Areas (SAPA), the Standardised Protocol for Evaluating Community Conservation Success (SPECCS), the Site-level Assessment of Governance and Equity (SAGE), MPA Guide, IUCN Green List, "How is your MPA doing?", "Guide for quick evaluation of management in Mediterranean" (Brichieri-Colombi et al., 2018; Franks et al., 2018; Grorud-Colvert et al., 2021; IUCN and World Commission on Protected Areas (WCPA), 2017; Pinto & Dehmel 2023; Pomeroy et al., 2004; Tempesta et al., 2006). These are often systematic tools which cover indicators under multiple aspects. Most of these tools were originally developed to evaluate the outcomes or effectiveness of MPAs. However, as these tools cover the indicators that MPA management should consider, and as they also evaluate both positive and negative impacts, they are included in the review. Nevertheless, some of the original documents do not provide examples of MPAs/OECMs that have applied these tools. Methodological information on the MPAs/OECMs in European seas would be needed to identify which tools have been used in Europe.

There were other collected systematic tools developed by other institutes, such as, the Marine Protected Area Management Effectiveness Assessment Tool (MPA MEAT), the Socio-Economic Assessment Tool (SEAT), Marine protected areas overall success evaluation (MOSE), periodic review of SPAMIs, the framework for social-ecological well-being (SEWB), etc (Brueckner-Irwin et al., 2019; Philippines CTI NCC, 2011; Picone et al., 2020; RAC/SPA, 2010; Rosales, 2018) (see Appendix C, sheet "Tool Review (section 1)", selecting Societal and Governance Aspect for the full list). A few of these tools have been implemented outside the European seas, but some tools require further research regarding which MPAs/OECMs have applied these tools.

The targeted activities from these tools can be classified into two types. The first focuses on fisheries and/or tourism, and the other has a broader view that covers multiple activities (i.e., they select more than 3 activities, "society in general", or "All activities" from the activity indicators in Appendix C).

5.3.3 Human Capital and Health Aspect

There is a limited amount of explicit research focused on human wellbeing or Human Capital and Health aspect in MPAs/OECMs. Additionally, empirical studies that quantify these relationships are even rarer. Only 25 tools were reviewed for the Human Capital and Health aspects, and many of

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them overlap with the examples under Cultural, Societal and Governance, or Economic aspects. More examples were found that applied these tools outside rather than within European seas.

All the indicators under the Human capital and Health aspect were identified in the reviewed tools. Some specifically investigated health indicators in the context of MPAs. The empirical studies, such as those conducted by Gjertsen (2005) and Stevenson et al. (2013), have quantified the contribution of MPAs to health human wellbeing (*Health* indicator). For example, Gjertsen (2005) examined the relationship between fish stocks and children's health in 40 community led MPAs in the Philippines, suggesting that successful alternative income projects are crucial for improving MPA performance. Stevenson et al. (2013) predicted the social-economic welfare impact, including health, of the Hawaiian MPA network on small-scale fishers. Other indicators, such as *Education* and *Human resources and capacity*, appeared as one of the indicators under those systematic frameworks that usually also covers Cultural, Societal and Governance, or Economic aspects.

The explicit systematic frameworks that directly measure or quantify impacts on the Human Capital and Health aspect include (but are not limited to) the SEAT framework, the SEWB approach, and BlueHealth Decision Support Tool. The SEAT framework (Rosales, 2018), piloted in several MPAs in the Philippines, provides guidelines for designing and managing MPAs to enhance socio-economic outcomes. The SEAT results can also contribute to a more comprehensive assessment of MPA effectiveness and human well-being at a national level. The SEWB approach critically examines the linkages between MPAs and well-being in Southwest New Brunswick, Canada, aiming to sustain ecological resilience while meeting human needs and maintaining individual quality of life (Brueckner-Irwin et al., 2019). The BlueHealth Decision Support Tool (BlueHealth, n.d.) has not been implemented in a specific MPA, but it is still able to evaluate the indicators under Societal and Governance, Human capital and Health, and Natural aspects. Other systematic frameworks also explore Human Capital and Health aspects. They can be found in Appendix C, sheet “Tool Review (section 1)”, by selecting Human Capital and Health aspect.

Overall, based on a review by Ban et al. (2019) the literature indicates that there are more positive (51%) than negative (31%) wellbeing outcomes associated with MPA/OECMs.

5.3.4 Economic Aspect

The review collected 49 tools that can evaluate the economic-related impacts. All the impact indicators listed under the Economic aspects were identified by the collected tools. Fewer collected tools evaluate the indicator of *Investments (businesses, financial security, bank savings)* and *Financial aid/donor funding and support*. Only 5 and 9 collected tools cover these 2 indicators, respectively. The remaining indicators can be evaluated by more than 10 tools that were collected in this review.

In addition to systematic frameworks and guidelines (see Section 5.3.2) that sometimes include economic indicators, the collected tools under the Economic aspect can be roughly characterised (but not mutually exclusive to each other) as: decision making-tools, monetary valuation tools,

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spatial tools, participatory tools, questionnaire tool, etc. All the selected tools are applicable to coastal and marine ecosystems but only a few have been already applied to MPAs/OECMs. More examples were found that applied these tools outside rather than within the European seas.

Decision-making tools offer the means to examine and seek the most desirable alternatives and to mediate discussions with different stakeholders. They help to allocate sea space in MSP processes, ensure the representation of biodiversity features in MPA planning and management and "guide the location and design of protected area networks and balance the competing interests of conservation and multiple socio-economic costs" (Geange et al., 2017). Therefore, the decision-making tools typically cover multiple aspects. The examples of collected decision-making tools include but are not limited to: Marxan and FishRent. Marxan can be used to present and select the most important conservation features while minimising the socioeconomic cost. It may present e.g., a spatial distribution map for different species and additionally fishing effort of the different fisheries operating in the area. Therefore, it can be used to present trade-offs of different area management options for decision-making (Rodríguez-Rodríguez et al., 2015). FishRent incorporates economic information of multiple fleets and detailed age-structured biology of multiple species simultaneously, which can be used to evaluate the consequences of restricting certain activities or types of fisheries in MPA (Rybicki et al., 2021).

Monetary valuation tools refer to those software, models or frameworks that apply monetary valuation methods to quantify the momentary value of ESs or social-economic benefits. The same tools or the same family of tools may apply different methodologies in valuation, depending on the valuation target. The review of different monetary valuation methods can be found in Chapter 3. Most of these methods require high economic competencies and high skills in econometrics; several methods require surveys to be administered to a wide sample of the population with high resource requirements in terms of money and time. The examples of collected monetary valuation tools include but are not limited to: CO$TING NATURE (Policysupport.org, 2017) and a set of InVest models (e.g., (Arkema et al., 2017; Arkema et al., 2013; Griffin et al., 2015)) that focus on different ESs or marine-related benefits/costs. Some of the InVest tools (e.g., (Arkema et al., 2021; Terrado et al., 2016)), however, do not cover economic indicators, but only the indicators under Cultural or Natural Aspects.

Many of these decision-making tools and monetary valuation tools are spatial or GIS-based, especially those which apply to valuing ESs. CO$TING NATURE are ARIES ((ARIES, n.d.; Policysupport.org, 2017)) are examples that are spatial based and provide monetary valuation. Also, some spatial tools (e.g., Zonation) that are not primarily regarded as economic tools may offer economic benefits (direct and indirect) by maximising representation of desired biodiversity features on a certain area (Geange et al., 2017) and possibly at the same time limiting the area enclosed in an MPA and taken away from other uses.

An interesting tool, the IUCN Decision Tool (Neugarten et al., 2018) for measuring, modelling, and valuing ESs, is a tool that guides MPA managers to identify the most suitable tool to apply by the following 4 steps:

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1. Introduce ESs to provide some information on the ESs concept and the assessment.
2. Assess ESs that provide some information on the importance of the assessment of ESs.
3. Map ESs that focus on the spatial extent of the area that provides the ESs and the area where beneficiaries are located.
4. Economic valuation of ESs provides indications of the methodologies and tools to calculate or estimate monetary value.

As a first step for assessment, the tool suggests three tools that support in the identification of ES: the Ecosystem Services Toolkit (EST); the Protected Areas Benefits Assessment Tool (PA-BAT); the Toolkit for Ecosystem Service Site-based Assessment v.2.0 (TESSA). All three tools are guidance tools that aim at qualitatively identifying ESs. EST and TESSA include also quantitative analysis. PA-BAT and TESSA include also stakeholder-based approaches. The three methodologies do not focus on coastal and marine ecosystems, but the PA-BAT and TESSA were included in the review due to the MPA examples being identified. For steps 3 and 4, if the users can provide spatial data or economic data for economic valuation, it will indicate some of the spatial tools or monetary valuation tools mentioned above (Neugarten et al., 2018).

The tools that are considered as questionnaire tools or/and participatory tools and, such as the SEAT and the AquaSpace tool (Gimpel et al., 2018; Rosales, 2018), often also include the indicators under the Societal and Governance or Cultural aspects. The tool classification is only mentioned under Economic aspects as it is not a pre-defined review criterion but an ad-hoc observation from the collected tools under Economic Aspects. A more compressive view of the tool classification to cover other aspects, however, can be analysed in the follow-up task (e.g., T1.4, WP2, or WP3) if it is necessary.

5.3.5 Natural Aspect

The performed review, based on the expertise of Blue4All partners and the available scientific and grey literature, resulted in a total of 58 tools with the capacity to explicitly evaluate the effects of human activities on natural values. Most of these tools (47) can consider not only natural aspects when evaluating the effects of human activities, but also social, cultural, and economic dimensions to different extents. These tools, in some cases after repurposing them, could be used for the evaluation of nature-mediated effects of MPAs on society. Blue4All partners identified 30 tools (of the 47 tools able to consider different aspects in addition to nature values) that are currently able or have promising features for evaluating bidirectional effects mediated by changes in nature values between area-based protection measures and human activities. The information gathered suggests that available tools can inform decision-making processes related to the design and management of MPAs and MPA networks from an integrative perspective simultaneously considering nature and human-related dimensions. It is particularly relevant to mention that most of the identified tools (36) have been already implemented or have been tested considering the needs of MPA processes in Europe and the around world.

From the 58 tools identified, 29 were able to provide some kind of spatially explicit output. This is a particularly relevant feature if we consider that tools able to inform MPA processes must be able to

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provide spatially defined information on nature values and their changes that can be used for the delineation of new areas-based protection measures and their potential expansion. Tools able to provide outputs in the form of maps, such as PlanWise4Blue (Vaher et al., 2022) or Marxan (Lewis et al., 2003), have provided essential insights for the development of maritime spatial planning (MSP) and MPA processes in Europe and across the world. These kinds of tools, explicitly designed to inform decision-making processes in tight collaboration with managers and policymakers, are an excellent starting point to develop the tools foreseen in the frame of WP3.

The 58 tools gathered in the revision exercise performed in T1.3 will provide the needed basis for T3.2, in which an in-detail assessment will be performed considering a set of predefined criteria that will allow us to evaluate if: (i) the tools cover the needed technical aspects, (ii) consider the demands of practitioners and stakeholders to inform MPA processes, and (iii) what are the needed developments (to be implemented in T3.3) to implement aspects such ecological functioning, connectivity and climate change predictions (aspects frequently overlooked in MPA processes).

5.4 Results of Solution Review

The detailed review of the collected tools is documented in Appendix C, sheet "Solution Review (section 2)". In total, 45 solutions are included in this review. Not all impact indicators are included in this Solution Review, but some of the impacts omitted here may be able to be 'solved' due to their connection and similarities with other impact indicators. For example, almost all the reviewed solutions can improve issues relating to *Governance & management*. Issues relating to *Community empowerment* and C*ommunity/stakeholder perception* can often be mitigated with solutions addressing Stakeholder*, community participation, resource user conflict, user relations, Education*, and *Human resources and capacity*. The issue of *Investments (businesses, financial security, bank savings)* and *Financial aid/donor funding and support* are often closely related to solutions that attempt to mitigate negative impacts on *Income, individual economic and material wealth*. To prevent too much overlap with the Business review in Chapter 4, indicators of *Investments (businesses, financial security, bank savings)* and *Financial aid/donor funding and support* are not included, here.

However, the collected solutions do not cover all the remaining impact indicators. This is the case for: *Connectivity; Trophic interactions: Other regulating service; Water quality; Social resilience and vulnerability; Trust, equity, transparency and accountability;* and *Health in all aspects*. Therefore, this can be identified as a potential gap that WP2 and 3 should address.

During the search, some very similar solutions that related to stakeholder involvement and co-management appeared repeatedly. As there are already quite a few of these types of solutions included in the review tables, some of these were omitted from the final review.

In the following paragraphs, the collected solutions are summarised as (1) Solutions to social-economic impacts, which covers the impacts listed under the Cultural aspect; Societal and Governance aspect; Human capital and health aspects; Economic aspects, and (2) Solutions to natural impacts that refer to the impact indicators listed under the Natural aspect.

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5.4.1 Solutions to social-economic impacts

In total, 34 solutions for mitigation of negative socio-economic impacts were reviewed for this section. All of them are meant to be used by MPA managers or managing entities to remedy social and/or economic issues related to the protected areas. 12 of them are spatial solutions, of which seven are partial spatial closures and five are other types of spatial solutions, while the remaining 22 solutions are other types of solutions than spatial. The majority of the reviewed solutions (28) have been implemented, the remaining six solutions had only been suggested at the time of publication or communication.

Twelve solutions are economic solutions, that offer ways for MPAs to generate new revenue streams, products or markets (e.g., (DestiMED Project, 2019; Thur, 2010)), create or benefit from funds (BlueSeeds, 2020; EU, 2021), or are methods for the better economic and financial management of MPAs (e.g., (BlueSeeds, 2020; METU, 2019)). Ten solutions are for better integration of cultural knowledge and heritage into conservation practices (e.g., (Breen et al., 2021; Gould et al., 2021; IUCN-WCPA Task Force on OECMs, 2019)). The most targeted sectors for economic solutions are tourism and leisure, and fish and shellfish harvesting. Nine solutions are for the implementation of a more inclusive governance system, by involving local stakeholders and populations (e.g., (Ignatius et al., 2019; Rossiter & Levine, 2014; Ruiz-Frau et al., 2011)) or by valorising citizen science (e.g., (Mason et al., 2020)). Finally, the remaining solutions concern technical issues, such as remediation for lack of human resources (e.g., (Freiwald et al., 2018; Teofili, 2020)) or dealing with the shipping sector around the protected area (Caric et al., 2019).

The Mediterranean Sea is the European sea that is the most often targeted by the reviewed solution (eleven cases), followed by the North-East Atlantic (five cases), and then the Baltic Sea (four cases). Three solutions were implemented in more than one regional European seas, while eleven were implemented outside of Europe. The dominance of the Mediterranean Sea could be explained by the fact that one organisation, Blue Seeds, designs economic solutions specifically for the Mediterranean context, and that all their solutions (seven) were included in this review.

5.4.2 Solutions to natural impacts

The performed review allowed the Blue4All partners to gather information on 30 solutions, either proposed or already implemented, for the mitigation of the impacts of human activities on the structure and functioning of marine ecosystems. Even when most of the identified solutions have been developed or suggested for their implementation in the European seas and transitional waters (an understandable bias considering the aims of the project and the experience of Blue4All partners), examples from different parts of the world have also been collected.

The proposed solutions can be roughly classified into those that require low levels of human intervention, such as the creation and enforcement of area-based protection measures, and those that need high levels of intervention, such as the reconstruction of reefs or the implementation of aquaculture initiatives as a strategy to mitigate eutrophication (see a revision on the mentioned classification in Inácio et al. (2023)). Examples of both types of measures have already been

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implemented in European waters in the last decade, generating relevant experiences on the effectiveness of implemented solutions to mitigate the impacts of pervasive pressures such as the decimation of natural populations by fishing, habitat modification and destruction, or nutrient loading and eutrophication (among others). The information gathered in T1.3 on existing solutions and the associated bibliography presenting evidence on their actual or potential effectiveness provide essential input for the development of T3.2, where in tight collaboration with practitioners and stakeholders, the most promising solutions for mitigating pressing conservation and restoration issues in the Living Labs will be assessed.

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6. Relations between different reviews

The relations of the three reviews in this report with T1.4, WP2 and WP3 have been mentioned in Chapter 2. In addition to that, there is a need to explain the relations between different reviews conducted within this task. In principle, the purpose of the three reviews is different and thus these reviews can be regarded independently. However, some points were considered during the design and implementation of the reviews, to prevent double works and to make the review results more integrable. This chapter discusses the relations of these three reviews and explains how they can supplement each other.

6.1 Review on ESs valuation (Chapter 3) vs. The Economic aspects under the Tool Review (Section 5.3.4)

The collected literature under the review on monetary and non-monetary ESs valuation within MPAs and MPA networks (Chapter 3) was also checked for the Tool Reviews. It was found that the valuation methods literature did not have too much overlap with the collected tools for the Economic aspect in the Tool Review (Section 5.3.4), due to the differences in review focuses. However, the two reviews can supplement each other.

Some of the collected tools under the Economic aspect may apply the methods reviewed in Chapter 3. For example, the monetary valuation tools mentioned in Section 5.3.4 use a variety of monetary valuation methods reviewed in Section 3.3.3. Also, a collected economic tool, ARIES (n.d.), consists of a set of models aiming at addressing the linked socioeconomic-environmental modelling problems. One of the models developed in ARIES (n.d.) is used for ecosystem accounting, which is related to Environmental accounting methods mentioned in Section 3.3.4.1. Another possible linkage can be observed for the participatory tools, some of which may apply the participatory techniques reviewed in Section 3.3.4.2. Other tools that can provide broader views under section 5.3.4, e.g., decision-making tools or systematic frameworks, may also need some of the valuation techniques reviewed in Chapter 3.

In short, the review on ESs valuation critically examines the methodologies, providing a scholarly exploration of their theoretical underpinnings. In parallel, the Tool review focuses on the practical aspect by extrapolating from these methodologies to develop tools. These tools not only draw from the methodologies but also enhance their utility by offering pragmatic and applicable approaches for addressing real-world scenarios.

6.2 Review on ESs valuation (Chapter 3) vs. The Cultural aspects under the Tool Review (Section 5.3.1)

In contrast to the Economic aspect, the collected tools under the Cultural aspect in the Tool Review (Section 5.3.1) possess more links to the review on ESs valuation (Chapter 3). Both reviews deal with the cultural perspective of MPA management to some extent. The Tool Review includes tools that can be used to better understand and incorporate the interplay of culture within marine spaces, while the review on ESs valuation covers cultural service valuation methodologies with MPA spaces.

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Unlike the search for tools under other aspects, there are a limited number of easily accessible and usable tools available that aim to incorporate and understand how culture (both understood as *cultural heritage* in the form of monuments and wrecks, as well as *culture as a concept* whereby 'everyday' practices and phenomena become embedded to/within places, spaces, and ways of life) is connected to the environment and environmental change. This led to a need to broaden the search for tools falling under this aspect. However, the "tools" collected under the Cultural aspects at the end became more closely interlinked with valuation methodologies on cultural ES within marine spaces.

Broadening the search for the Tool Review results to some papers that are included in the review on ESs valuation. Those papers were omitted in the Tool Review results at the end, to prevent repetition. However, between these two reviews, commonalities can still be found, including the types of methods and approaches used, as well as the geographic range of the papers. For example, participatory techniques, which can contribute to more effective engagement of different stakeholders, particularly through a bottom-up approach to MPA management, were analysed in the review of ESs valuation with references, such as Slater et al. (2020), Ainsworth et al. (2019), and Johnson et al. (2019). The Cultural aspect under the Tool Review also includes papers applying participatory techniques, including Baker et al. (2021), Gajardo et al. (2023), and Pearson et al. (2019) worked with indigenous and other groups with Traditional Ecological Knowledge, or Subiza-Pérez et al. (2019) and Roberts et al. (2021) which blend approaches used by different disciplines.

Keyword searches did not yield as many results for specific instances of non-monetary cultural ESs within MPA compared to a broader search on marine spaces. Thus, broadening the search from the Cultural aspect collected papers from a more general view at the end and can supplement the papers collected in the review on ESs valuation. However, there are some common conclusions that can be addressed from both reviews.

First, there are multiple promising examples of methods and tools which can be used to better understand these values in particular areas. As discussed, participatory methods can be highly effective in incorporating the views of stakeholders and demographic groups who often go unheard. Moreover, these techniques can help to identify the value of MPA and MPA networks to policymakers, and further nuance the discussion to reflect both the values and knowledge held by different stakeholder groups.

Second, as mentioned, there is an ethical critique of the use of the ESs concept due to its inherent 'commodification' of nature and attempt to place anthropogenic, monetary values on core ecosystem functions. Whilst this argument is often made in relation to earth system processes, the same can be extended to categorised cultural services. Conflicts, ontologically, in the application of this concept may also extend to participants: in many cultural contexts, the premise of a nature/culture binary (as largely understood in formal EU law, for instance) does not exist, or it may exist in a vastly different form. As such, the inclusion of local concepts, ontologies and cosmologies is crucial in the sense that they cannot, necessarily, be effectively reflected in subsequent designations of cultural services.

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Subsequently, issues relating to the research itself may also emerge, as some authors may not have academic training in indigenous studies or social science. The result is that these intricate local interplays may be missed or over-simplified. In response, some scholars have called for the further integration of such disciplinary knowledge into the discourse of ESs. Similarly, perceiving the complex intersections between different ESs is also highly important. As shown, cultural aspects of ESs as defined by Rasheed (2020) may well link to other indicators, such as health and wellbeing and the economy. In utilising broader approaches to cultural services study, these intersections can be made much clearer than they otherwise would be from a purely monetary approach.

In conclusion, whilst many interesting methods and approaches to the evaluation of culture and cultural services within marine MPA spaces have been done, these approaches are often conducted with a focus on tourism, recreation, and fishing. There is a gap in the development of approaches to evaluate those other indicators, such as: sense of place; aesthetics; education, and spirituality. Many of these factors can be effectively evaluated through qualitative approaches. However, integrating those approaches with monetary quantitative approaches can be difficult. So far, the topic remains largely at an academic level, where complex methods and theoretical engagement remain difficult to access for those not academically trained. With that said, more needs to be done to develop accessible 'tools' that can be used by MPA managers and other relevant regulators to better understand where and how culture comes into play within MPA areas.

6.3 Business Review (Chapter 4) vs. Social-economic solutions under the Solution Review (Section 5.4.1)

As mentioned in Section 5.4, to prevent the possible overlap between the solution collected on the Solution Review and the collected business cases under the Business Review, some economic impact indicators were dropped in the Solution Review. Even though the criteria issues have been considered, a reason for the potential overlaps comes from the sources for reviews. Two platforms/websites, Blue Seeds and PANORAMA – Solutions for a Healthy Planet, appeared as part of the sources in both reviews. Due to the differences in review criteria and the information that the follow-up tasks/WPs would like to use, most of the collected cases are different, but there are still a few cases that appear in both reviews. When the same cases appear in both review, one focus on the measure/solutions itself, another focus on its business applicability and economically viable aspects. Depending on how the follow-up tasks/WPs would like to use the review results, they can use only one review results or check the collection of both reviews.

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Appendix A

ID	Title	Author(s)	Journal	Year
1	Citizens' perspectives on marine protected areas as a governance strategy to effectively preserve marine ecosystem services and biodiversity	Tonin	Ecosystem Services	2018
2	Evaluating decision-support tools for monetary valuation of ecosystem services for Marine Protected Areas	Qu et al.	Ocean and Coastal Management	2021
3	Economic Valuation of Ecosystem Service Benefits and Welfare Impacts of Offshore Marine Protected Areas: A Study from the Baltic Sea	Pakalniete et al.	Sustainability	2021
4	The valuation of marine ecosystem goods and services in the Caribbean: A literature review and framework for future valuation efforts	Schuhmann and Mahon	Ecosystem Services	2015
5	Integrating marine ecosystem conservation and ecosystems services economic valuation: Implications for coastal zones governance	Ferreira et al.	Ecological indicators	2017
6	Public willingness to pay for alternative management regimes of remote marine protected areas in the North Sea	Brouwer et al.	Marine Policy	2016
7	A new typology of benefits derived from marine protected areas	Angulo-Valdes et al.	Marine Policy	2010
8	The Effects of Aquaculture and Marine Conservation on Cultural Ecosystem Services: An Integrated Hedonic - Eudaemonic Approach	Spanou et al.	Ecological economics	2020
9	Looking below the surface: The cultural ecosystem service values of UK marine protected areas (MPAs)	Jobstvogt et al.	Ecosystem Services	2014
10	An ex ante ecological economic assessment of the benefits arising from marine protected areas designation in the UK	Hussain et al.	Ecological economics	2010
11	Valuing conservation benefits of an offshore marine protected area	Börger et al.	Ecological economics	2014
12	Exploring dual discount rates for ecosystem services: Evidence from a marine protected area network	Vasquez-Lavin et al.	Resource and energy economics	2019

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13	Improving the management of Taiwanese fishery resource conservation zones based on public perceptions and willingness to pay for ecosystem services	Chen et al.	Journal of coastal conservation	2018
14	Assessing the Impact of Marine Tourism and Protection on Cultural Ecosystem Services Using Integrated Approach: A Case Study of Gili Matra Islands	Banarsyadhimi et al.	International journal of environmental research and public health	2022
15	Willingness to pay for marine-based tourism in the Ponta do Ouro Partial Marine Reserve, Mozambique	Daly et al.	African Journal of Marine Science	2015
16	Valuing marine and coastal ecosystem service benefits: Case study of St Vincent and the Grenadines' proposed marine protected areas	Christie, et al.	Ecosystem Services	2015
17	Twenty thousand sterling under the sea: Estimating the value of protecting deep-sea biodiversity	Jobstvogt et al.	Ecological economics	2014
18	Assessing the Benefit Produced by Marine Protected Areas: The Case of Porto Cesareo Marine Protected Area (Italy)	Visintin et al.	Sustainability	2022
19	Valuing beaches to develop payment for ecosystem services schemes in Colombia's Seaflower marine protected area	Castanzo-Isaza et al.	Ecosystem Services	2015
20	Ecosystem accounting for marine protected areas: A proposed framework	Cavalleti et al.	Ecological economics	2020
21	Community participation in assessment of fisheries related ecosystem services towards the establishment of marine protected area in the Greater Cape Three Points area in Ghana	Sagou et al.	Marine Policy	2021
22	What do we know about public acceptance of designating marine protected area? The case of Jaran Bay in South Korea	Kim and Yoo	Environmental science and pollution research	2020
23	Biological valorisation of the southern Baltic Sea (Polish Exclusive Economic Zone)	Weslawski et al.	OCEANOLOGIA	2009
24	Subjective well-being indicators for large-scale assessment of cultural ecosystem services	Bryce et al.	Ecosystem Services	2016
25	Identification and estimation of the marine ecosystem services surrounding selected offshore islands of Vietnam	Lan et al.	Environment development and sustainability	2021

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26	Effects on Willingness to Pay for Marine Conservation: Evidence from Zhejiang Province, China	Yu et al.	Sustainability	2018
27	A fulfilled human life: Eliciting sense of place and cultural identity in two UK marine environments through the Community Voice Method	Ainsworth et al.	Ecosystem Services	2019
28	Willingness to pay for expansion of the whale sanctuary in Faxaflói Bay, Iceland: A contingent valuation study	Malinauskaite et al.	Ocean and Coastal Management	2020
29	The protective service of mangrove ecosystems: A review of valuation methods	Barbier	Marine Pollution Bulletin	2016
30	“Please let me visit”: Management options for marine ecosystems in a Mediterranean Marine Protected Area	Tyllianakis	Journal for Nature Conservation	2022
31	Tourist Preferences for Seamount Conservation in the Galapagos Marine Reserve	Ison et al.	Frontiers in Marine Science	2021
32	The value of marine biodiversity to the leisure and recreation industry and its application to marine spatial planning	Rees et al.	Marine policy	2010
33	The recreational value of coral reefs in the Mexican Pacific	Robles-Zavala and Reynoso	Ocean and Coastal Management	2018
34	Cultural values of ecosystem services from coastal marine areas: Case of Taytay Bay, Palawan, Philippines	Gajardo et al.	Environmental science and policy	2023
35	Exploring gaps in mapping marine ecosystem services: A benchmark analysis	Nahuelhual et al.	Ocean and Coastal Management	2020
36	Marine biological value along the Portuguese continental shelf; insights into current conservation and management tools	Gomes et al.	Ecological indicators	2018
37	Marine Sites and the Drivers of Wellbeing: Ecosystem vs. Anthropic Services	Cavalletti et al.	Sustainability	2021
38	Assessing public preferences for deep sea ecosystem conservation: a choice experiment in Norway and Scotland	Ankamah-Yeboah et al.	Journal of environmental economics and policy	2022
39	Comparing the social values of ecosystem services in US and Australian marine protected areas	Johnson et al.	Ecosystem Services	2019

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40	Defining Cost-Effective Solutions in Designing Marine Protected Areas, Using Systematic Conservation Planning	Galparsoro and Borja	Frontiers in Marine Science	2021
41	Evidence of economic benefits for public investment in MPAs	Pascal et al.	Ecosystem Services	2018
42	Monetary evaluation of marine reserve ecosystem services in the Caribbean	Failler et al.	National accounting review	2019
43	The assessment of cultural ecosystem services in the marine environment using Q methodology	Pike et al.	Journal of coastal conservation	2015
44	Valuing Coral Reef Preservation in a Caribbean Marine Protected Area. Economic Impact of Scuba Diving in Corals of Rosario and San Bernardo National Natural Park, Colombia	Trujillo et al.	CUADERNOS DE DESARROLLO RURAL	2018
45	User willingness to pay for natural resource conservation at Bach Long Vy Island, Vietnam	Hoang et al.	Vietnam journal of earth sciences	2022
46	Assessing the value of natural capital in marine protected areas: A biophysical and trophodynamic environmental accounting model	Vassallo et al.	Ecological modelling	2017
47	The impact of information, value-deliberation and group-based decision-making on values for ecosystem services: Integrating deliberative monetary valuation and storytelling	Kenter et al.	Ecosystem Services	2017
48	Valuing Marine Reserves: A case study from two locations in central New Zealand	Rojas-Nazar et al.	Marine policy	2022
49	Assessment of Stakeholder's Perceptions of the Value of Coral Reef Ecosystem Services: The Case of Gili Matra Marine Tourism Park	Rahmadyani et al.	International journal of environmental research and public health	2023
50	Investigating acceptance of marine tourism levies, to cover the opportunity costs of conservation for coastal communities	Booth et al.	Ecological economics	2022
51	Linking modelling and empirical data to assess recreation services provided by coastal habitats: The case of NW Portugal	Cunha et al.	Ocean and Coastal Management	2018
52	Mapping Ecosystem Services for Marine Planning: A UK Case Study	Tyllianakis et al.	Resources-Basel	2020

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53	Integrating natural and social sciences to manage sustainably vectors of change in the marine environment: Dogger Bank transnational case study	Burdon et al.	Estuarine Coastal and Shelf Science	2018
54	Expanding the role of participatory mapping to assess ecosystem service provision in local coastal environments	Burdon et al.	Ecosystem Services	2019
55	Bringing stakeholders together to articulate multiple value dimensions of ecosystem services	Lopes and Videira	Ocean and Coastal Management	2018
56	Paying the price to solve fisheries conflicts in Brazil's Marine Protected Areas	Lopes and Villasante	Marine policy	2018
57	Valuation of environmental improvements in coastal wetland restoration: A choice experiment approach	Tan et al.	Global ecology and conservation	2018
58	Integrating stakeholder knowledge through modular cooperative participatory processes for marine spatial planning outcomes (CORPORATES)	Slater et al.	Ecosystem Services	2020
59	How to articulate the multiple value dimensions of ecosystem services? Insights from implementing the PArticulatES framework in a coastal social-ecological system in Portugal	Lopes and Videira	Ecosystem Services	2019
60	A Business Case for Marine Protected Areas: Economic Valuation of the Reef Attributes of Cozumel Island	Lara-Pulido et al.	sustainability	2021
61	Sustainable financing of a national Marine Protected Area network in Fiji	Ison et al.	Ocean and Coastal Management	2018
62	Trade-Offs in Values Assigned to Ecological Goods and Services Associated with Different Coral Reef Management Strategies	Hicks et al.	Ecology and Society	2009
63	The socio-economic effects of a Marine Protected Area on the ecosystem service of leisure and recreation	Rees et al.	Marine Policy	2014
64	The economic value of natural protected areas in Ecuador: A case of Villamil Beach National Recreation Area	Zambrano-Monserrate et al.	Ocean and Coastal Management	2018
65	Associated benefits of manatee watching in the Costa dos Corais Environmental Protection Area	Izidoro and Schiavetti	Frontiers in Marine Science	2022

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66	South Koreans' willingness to pay for restoration of Gomsoman Tidal Flat	Kim et al.	Ocean and Coastal Management	2021
67	Economic valuation and conservation, restoration & management strategies of Saint Martin's coral island, Bangladesh	Rani et al.	Ocean and Coastal Management	2020
68	Incorporating ecosystem services into environmental management of deep-seabed mining	Le et al.	Deep-Sea Research II	2017
69	Valuing high-seas ecosystem conservation	Xuan et al.	Conservation Biology	2021
70	Investigating public preferences for the management of native and invasive species in the context of kelp restoration	Grover et al.	Marine Policy	2021
71	PACT or no PACT are tourists willing to contribute to the Protected Areas Conservation Trust in order to enhance marine resource conservation in Belize?	Casey and Schuhmann	Marine Policy	2019
72	How do ecological protection policies affect the restriction of coastal development rights? Analysis of choice preference based on choice experiment	Wang et al.	Marine Policy	2022
73	Policy analysis for tropical marine reserves: challenges and directions	Rudd et al.	Fish and fisheries	2003

Appendix B

See attachment: Review Table of business cases, opportunities, and incubator models.xlsx

Appendix C

See attachment: Review Table for tools, knowledge and solutions.xlsm

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