

Review of Natural Capital Approaches to Marine Protected Area Management

February 2026

Natural England Commissioned Report NECR655

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Foreword

Natural England commissioned this review to explore the evidence supporting the adoption of a natural capital approach to MPA management. This report serves as a useful starting point for anyone looking to implement such an approach, it highlights key opportunities and considerations, summarises the methods used to incorporate natural capital thinking into MPA management, and provides useful references for the reader to explore further.

The findings will inform the development of advisory guidance for marine Protected Site Strategies under the Environment Act (2021). This guidance aims to support MPA management for the benefit of both people and nature and will contribute to meeting the legally binding Environmental Targets (Marine Protected Areas) Regulations (2023). These regulations require at least 70% of protected features in our MPAs to be in favourable condition by the end of 2042, with the remainder in recovering condition.

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

This project was funded by the Department for Environment, Food and Rural Affairs (Defra) as part of the marine arm of the Natural Capital and Ecosystem Assessment (NCEA) programme. Marine (m)NCEA is delivering evidence, tools, and guidance to integrate natural capital approaches into policy and decision making for marine and coastal environments.

Executive Summary

This exploratory project aims to give Natural England a clear understanding of the benefits and challenges of applying natural capital approaches to MPA management. It provides an overview of how natural capital thinking has been used to inform MPA management in the UK and internationally, highlighting the role of community and stakeholder values in shaping management and development. The review also examines methods for integrating natural capital into decision-making processes, particularly where these approaches have enhanced the benefits delivered by MPAs.

Methodology

A review was undertaken to gather an understanding of the evidence base. A four-phase methodology was employed: identification of search terms; development of an online survey to capture data; initial screening; and full review of papers.

Results

A total of 179 papers and reports were reviewed in the initial screening, of which 85 papers went through for full review. Most studies were from the peer-reviewed literature and represented MPAs from 34 countries, across 6 continents. Key findings are:

Objective 1 - An understanding of the benefits and challenges associated with implementing natural capital approaches to MPA management.

The main benefits of applying natural capital approaches include:

- Bringing together diverse interests by highlighting multiple benefits and values which can inform a broad range of MPA management questions.
- Mixed method approaches, which incorporate ecological, economic and socio-cultural values, can provide a richer narrative and can bring important values, perspectives, and challenges to the fore.
- Stakeholder engagement should be undertaken throughout the whole MPA process, allowing for early identification of benefits, values and conflicts, enabling collaborative problem solving and capacity building.
- Participatory approaches can be applied to engage society in natural capital discussions and generate shared understanding of the links between natural capital, benefits and beneficiaries.

The main challenges of applying natural capital approaches include:

- Resources are required for interdisciplinary expertise and, for some elements of a natural capital approach (e.g. detailed assessments).
- There is a lack of data on valuation of ecosystem services and societal benefits, particularly at the MPA site-level.

- There are very few examples where the findings translate into policy interventions or management instruments.
- MPA managers may need to collaborate with knowledge organisations, such as universities, to access the expertise to deliver natural capital assessments.

Objective 2 - A broad overview of where natural capital thinking has been applied to inform MPA management, both within the UK and internationally, including the role of community or stakeholder values in the management or development of an MPA:

- There is a growing literature base linking natural capital, ecosystem services and societal benefits, but limited evidence on how it is incorporated effectively into MPA management.
- There is support for the inclusion of the human dimension (social, cultural, economic, and governance aspects) in MPA management, particularly through local engagement, capacity building, and the equitable distribution of MPA benefits.
- The peer-reviewed literature lacks information on funding mechanisms for natural capital approaches.
- While emerging cases of natural capital practices exist, we see these as formative, isolated, and they require mainstreaming into policy and management practices.

Objective 3 - Insights into the methods used to integrate natural capital thinking into management decision-making processes; particularly when these have led to an increase in benefits derived from the MPA:

- The inclusion of stakeholders is essential throughout all aspects of MPA management (designation, implementation, and monitoring) to support an accurate assessment of natural capital values.
- A diverse range of methods have been applied to engage stakeholders in MPA management and assessment of benefits and values.
- Despite the combined searches, the reviewed literature was dominated by economic valuation methods and data.
- There is a growing range of methods to value social and cultural dimensions of MPAs, with an increasing number of studies applying participatory approaches.
- Only a limited number of reviewed studies applied ecological valuation methods.
- Mixed-method approaches are becoming increasingly popular as they provide a richer narrative on how society identifies and values MPA benefits.

The report also highlights the limitations of the review methodology and identifies areas for future research.

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Project Background

Policy Context

There has been increasing focus on the application of natural capital approaches to managing the natural environment. For example, the UK Government's 25 Year Environment Plan (25YEP) advocates for a natural capital approach that accounts for the different ways the environment can benefit society and inform better decision making (HM Government, 2018). With respect to the marine environment, the 25YEP states that we need to understand the full value of the marine environment and incorporate it into the decisions we take.

The Environment Act (2021) aims to improve environmental protection and restoration and under Section 110 affords Natural England the ability to prepare Protected Site Strategies (PSS). A PSS is a strategy for addressing environmental pressures in and around protected sites to help build nature's recovery. The PSS legislation is best interpreted to construct locally led, co-developed strategies that bring together stakeholders from all relevant sectors to form a shared vision for the site(s). This vision should be ambitious and include anything that Natural England considers relevant to achieving those aims.

The Environmental Targets (Marine Protected Areas) Regulations 2023 establishes a legally binding target which requires not less than 70% of protected features in our MPAs to be in favourable condition by the end of 2042, with the remaining protected features to be in a recovering condition. The Environmental Improvement Plan (Defra, 2023) sets out the actions that restore nature, tackle environmental pollution, and increase prosperity. The EIP provides a plan to deliver the 25YEP vision and implement the Environment Act (2021). The EIP recognises that the UK's natural capital is worth £1.8 trillion and is essential for securing our basic needs, maintaining our biodiversity and sustaining our economy.

Natural Capital Concepts

Natural capital concepts have received increasing attention within research and policy over recent years (Burdon and others, 2024a). For example, Natural England apply a natural capital logic chain to demonstrate the links between ecosystem assets, flows of ecosystem services, the benefits they provide and the value of these benefits (Figure 1). A natural capital approach, therefore, builds on these concepts, working in partnership with stakeholders to enhance nature and deliver multiple benefits for society both now and into the future (Natural England, 2021). Given the broad focus of a natural capital approach, it must be recognised that management practices with respect to Marine Protected Areas (MPAs) may be applying a natural capital approach without using the term 'natural capital'; the search terms used in this review therefore take this into account (see 'Identification of

Search Terms' in Annex 1). Further background to natural capital concepts is presented in Annex 2.



Figure 1: Natural Capital Logic Chain, which shows that how much, how good and where natural assets are, underpin the ecosystem services, benefits and value people get from them (Natural England, 2021).

Types of MPAs in UK and Internationally

There are many definitions for MPAs. For the purposes of this review, we take the JNCC's broad definition as a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (JNCC, 2024). A range of different types of MPAs can be designated to protect areas of the marine environment. These MPAs can be driven by national, European or international legislation. A summary of MPA designations is provided below.

- UK designations include Marine Conservation Zones (MCZs) or Nature Conservation Marine Protected Areas (NC MPAs, Scotland), Highly Protected Marine Areas (HPMAs), Sites of Special Scientific Interest (SSSI, England, Wales, Scotland), Areas of Special Scientific Interest (ASSIs, Northern Ireland), No-Take Zones, Fisheries No-Take Zones.
- European designations include, but are not limited to, Special Protected Areas (SPA) under the Wild Birds Directive, Special Areas of Conservation (SAC) under the Habitats and Species Directive and European Marine Sites (EMS).
- International designations include, but are not limited to, Ramsar sites, Marine Reserves, Other Effective Conservation Measures (OECM) (including community and non-statutory geographically defined areas of conservation and protection, which are distinct from MPAs), Ecologically and/or Biologically Sensitive Areas (EBSA), Vulnerable Marine Ecosystems (VME), and Features of Conservation Importance (FOCI).

Project Aims & Objectives

This exploratory project aims to provide Natural England with:

- (i) An understanding of the benefits and challenges associated with implementing natural capital approaches to MPA management (Objective 1).
- (ii) A broad overview of where natural capital thinking has been applied to inform MPA management, both within the UK and internationally, to assess where community or stakeholder partnerships have been involved in the management or development of an MPA (Objective 2).
- (iii) Insights into the methods used for stakeholder engagement and ecological, economic and socio-cultural valuation to integrate natural capital thinking into management decision-making processes; particularly when these have led to an increase in benefits derived from the MPA (Objective 3).

Methodology

A rapid literature review was conducted to ensure completion within a four month timeframe. The review followed a four-phase methodology:

- **Identification of search terms** for a Google Scholar search targeting relevant papers / reports / theses.
- **Development of an online** data collection tool, using an online survey platform, to enable consistent data capture from each review author.
- **Initial screening** to remove out of scope papers.
- **Full review** of papers captured using an online survey tool for data collection, supplemented by a snowballing approach to identify additional relevant literature.

The full methodology for the review is presented in Annex 1.

Results

This section provides the results of the review. It is not the intention to present all the findings here, but rather to provide an overview of the literature with respect to each of the three stated project objectives. This section initially presents a summary of the Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis (Objective 1) before presenting an overview of where natural capital approaches have been used in MPA management (Objective 2) and the methods used to integrate natural capital thinking into MPA management and decision-making processes (Objective 3). Within each section, the findings of the review are grouped under key sub-headings (bold, italics). Case study boxes are used throughout to showcase good practice examples, incorporating additional papers identified through a snowballing approach to provide richer case studies.

With respect to the current review, a total of 179 papers were reviewed in the initial screening, of which 85 papers went to the full review stage. A total of 79 papers were rejected. Reasons for rejection included a lack of focus on MPAs or their valuation, and a lack of inclusion of concepts related to natural capital approaches or management of MPAs. The authors were 'unsure' regarding the inclusion of 15 papers and therefore these papers are not included in the analysis but have been retained for reference as they may contain some relevant information within the scope of the review.

Of the 85 papers that went through to the full review, 79 of these papers were in the peer-reviewed literature (93%) and only six reports or theses were identified from the grey literature (7%). Looking at the scope of the papers which were reviewed (n=85), the majority (74%) were focussed on application, with less papers focussing on review (16%) or theory (10%). This is not unexpected given that initial screening focussed on the application of natural capital approaches in MPA management.

With respect to the current review, case studies were identified from 34 different countries, which span 6 different continents (Africa, Asia, Australasia, Europe, N. America, S. America). The majority of MPA case studies were identified from the UK (n=15) and Italy (n=6) with multiple case studies also identified in Portugal (n=5), Brazil (n=4), Australia (n=3), Canada (n=3), United States (n=3), Colombia (n=3), New Zealand (n=3), France (n=2) and Jamaica (n=2). The remaining 23 countries had one case study each within the reviewed papers. A summary of the specific MPAs identified in the full review is provided in Annex 3 and includes the MPA name, MPA Location, an indication of who manages the MPA and a reference to the study. Notably, over half the papers did not report the management structure (55%) or how they were designated (51%) and over a third of papers (35%) did not report how stakeholders and communities were involved. . The geographic locations and number of case study sites identified within the full review are presented by country in Figure 2, and by focus area for UK MPAs in Figure 3. From the initial scoping review of the literature, there were no examples of multiple studies identified for any of the MPAs.

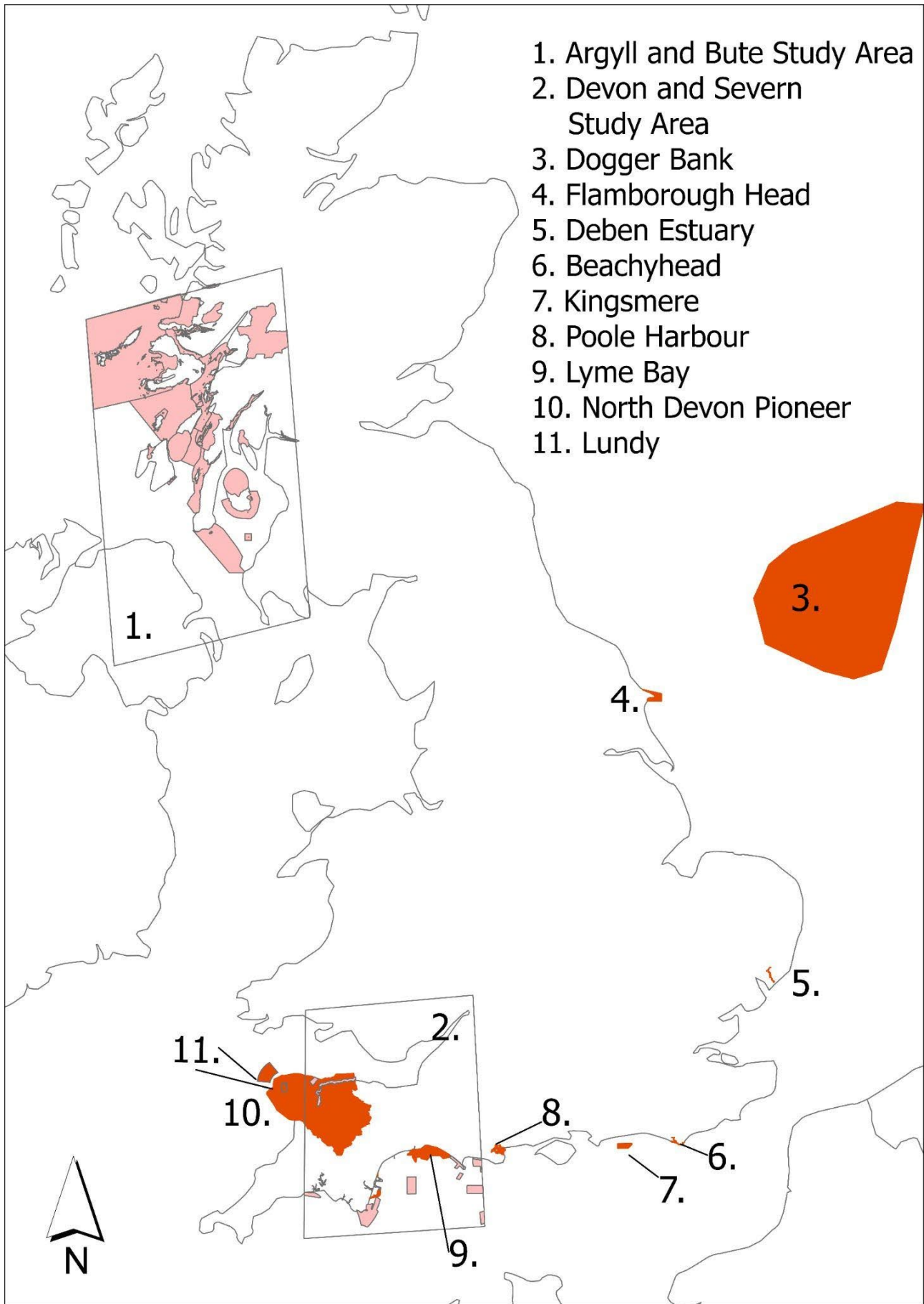


Figure 3: UK MPA case study sites identified within the review. Country and territory shapefiles available through the [OPENDATASOFT PLATFORM](#) and licensed under [Open Government Licence v3.0](#). MPA boundaries available through [JNCC MPA Mapper](#) and licensed under [Open Government Licence v3.0](#). North Devon Pioneer boundary is based on data from Ashley et al. (2019).

Benefits and Challenges of Applying a Natural Capital Approach in MPA Management (Objective 1)

To gain an understanding of the benefits and challenges associated with implementing natural capital approaches to MPA management (Objective 1), a rapid SWOT analysis was undertaken, drawing insights from the studies reviewed. The structure of the SWOT analysis is presented in Figure 4 with the Strengths and Weaknesses relating to the current pros and cons of applying a natural capital approach, and the Opportunities and Threats relating to potential pros and cons of applying a natural capital approach to MPA management in the future. The information required to populate this framework was captured during the rapid review process and therefore does not provide an exhaustive assessment of the wider literature.

A summary of the findings under each category is presented below, offering a brief overview and guiding readers to the full publication for more detailed information.

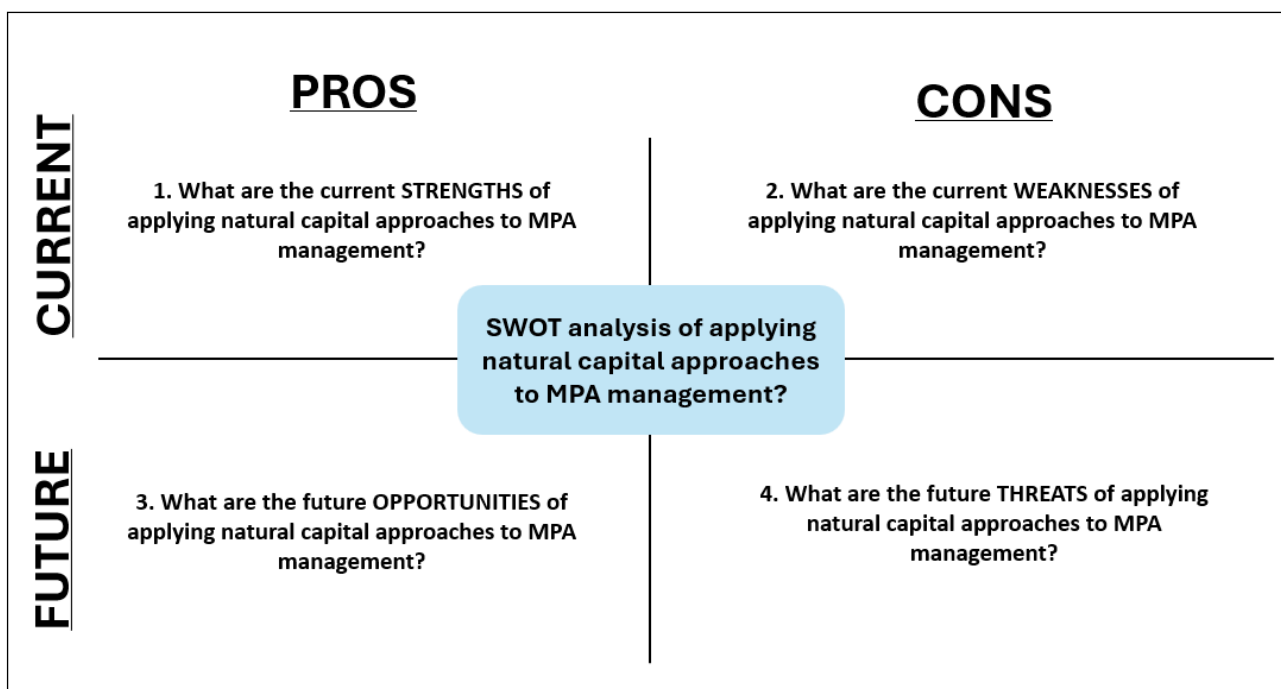


Figure 4: Structure of the SWOT analysis.

Strengths of applying a natural capital approach to MPA management

Stakeholder Engagement

- Stakeholder involvement in the MPA process creates an environment for exchange and interaction between different stakeholder groups, allowing early identification of potential conflicts, relevant issues and enabling collaborative problem solving (Casimiro and others, 2023).
- Understanding attitudes of stakeholders can help MPA managers to implement policies and strategies that meet both environmental and socio-economic objectives (e.g., local economic development) or 'co-benefits' (Niccolini and others, 2019).
- Engaging stakeholders and incorporating perceptions and opinions in all stages of the science-policy process for implementing a MPA enhances the likelihood of agreements and improves social acceptability, legitimacy, and support for future MPAs (Carcamo and others, 2014).
- Applying a natural capital approach can explore the trade-offs between different stakeholders and ecosystem services flows from natural capital (Outeiro and others, 2019).
- Where there has been strong stakeholder engagement with sea users, developers and statutory bodies, actions in management plans are most effectively implemented and sustainable development has best been achieved (Burton, 2020).

Ecological, Economic and Socio-Cultural Value Assessments

- Applying a natural capital approach to MPA management brings together diverse interests by considering multiple benefits (e.g., food provision, tourism and storm protection) (Arkema and others, 2024).
- Qualitative understanding of benefits can bring important values, perspectives, and challenges to the fore (e.g., examples of injustice, conflict, or solutions) (Chhun, 2013).
- Quantifying ecosystem services and societal benefits can inform a broad range of MPA management questions and actions to develop effective management strategies (Arkema and others, 2024).
- Mixed method approaches to natural capital assessments can provide a richer narrative to understand how the marine environment is valued by different communities, sectors, and individuals (Rojas and others, 2019).

- Many studies focus on quantifying and valuing cultural and provisioning services particularly with respect to tourism / recreation and fisheries (Carcamo and others, 2014).
- Assessing, valuing, and mapping natural capital can support local managers and policy makers in identifying where hotspots of natural capital occur and therefore where zonation schemes can be applied to support management to ensure the sustainable development of MPAs (Franzese and others, 2017).
- Participatory approaches can be successfully applied to engage society in natural capital discussions and thus generate a shared understanding of the links between natural capital, benefits, and beneficiaries (Burdon and others, 2022).

Weaknesses of applying a natural capital approach to MPA management

Stakeholder Engagement

- National legislation, and in some cases local language, can be misinterpreted and therefore care must be taken when moving between national scales and local place-based scales as legislation and/or values may be oversimplified or misinterpreted e.g., in Maldives ‘protection’ has a holistic meaning in national legislation but means ‘untouchable’ in local language (Rasheed and Abdulla, 2020).

Ecological, Economic and Socio-Cultural Value Assessments

- Placing monetary values on intangible and non-financial aspects of societal benefits, such as the well-being of tourists, is inexact and an oversimplification (Niccolini and others, 2019).
- Some of the most important intrinsic values of MPAs (such as the value of species that are rare but of little tourist interest) are not well captured in socio-economic evaluation methodologies, which in their actual application are incomplete, inaccurate and do not represent an ecosystem approach (Niccolini and others, 2019).
- The complexity and openness of marine ecosystems, along with limited data and resource availability, result in the requirement for several simplifications in the development of environmental accounting models (Visintin and others, 2022).
- Using photographic data to quantify cultural characteristics and values of protected areas has limitations, including unavoidable biases associated with capturing certain activities or publics, and uncontrollable changes in data access and quality over time (Retka and others, 2019).

- Caution is required when using benefit transfer approaches, as ecological and cultural values can be site dependent and may not directly translate to other sites. For example, variations in the ecological value of protected features or differences in demand for recreational activities may exist between sites (Paltriguera and others, 2008).

Opportunities for applying a natural capital approach to MPA management

Stakeholder Engagement

- Increasing incentives to encourage engagement and broaden stakeholder participation is deemed essential for more effective MPA management, fostering greater support and local capacity building (Niccolini and others, 2019).
- It is fundamental for MPA managers to develop collaboration competencies, enhancing partnerships with a range of external knowledge and practice providers e.g., universities, NGOs, or specialist consultancies that can provide access to this expertise (Niccolini and others, 2019).
- MPA managers need to encourage and promote communication and meaningful involvement of the community, especially when stakeholders have a strong interest in and knowledge of their local marine environment (Dehens and Fanning, 2018).
- Strengthening the participation of different users of cultural ecosystem services (such as onboard recreational fishing, spearfishing and recreational diving) in MPA decision-making is crucial for maintaining the supply of these services (Niz and others, 2023).
- Improving stakeholder engagement through participatory management of resources can improve compliance and reduce the need for enforcement via improved social networks and acceptance (Cavada-Blanco and others, 2021).
- The continuity of the participation process is crucial to building and maintaining trust with local stakeholders and engaging them effectively in MPA development (Gaymer and others, 2014).

Ecological, Economic and Socio-Cultural Value Assessments

- MPA managers can only make integrated and holistic decisions if these are based not only on ecological knowledge but also on socio-economic knowledge of those who interact directly with these environments (Niccolini and others, 2019).
- There is a need to improve the ecological knowledge base for Cost Benefit Analyses, particularly addressing the links between investment, ecosystem processes, and ecosystem services (Pascal and others, 2018).

- The assessment of ecosystem services and socio-economic benefits provided by MPAs, using qualitative or quantitative valuation methods, can provide MPA managers and policy makers with information to make more informed, evidenced-based decisions and develop effective strategies (Niccolini and others, 2019).
- Wider application of the marine natural capital approach will require increasing confidence in the metrics to define marine asset status, more directed monitoring (extent and condition) and greater accuracy in spatial fishing effort (Rees and others, 2022).
- The social value of natural capital assets can be increased through man-made infrastructure, such as visitor centres and informative signage that highlights local nature features (Paltriguera and others, 2018).
- Natural capital approaches could support the development of fund-raising schemes such as tourist taxes (Christie and others, 2015).

Threats from applying a natural capital approach to MPA management

Stakeholder Engagement

The following threats to the success of MPA management due to poor stakeholder engagement have been identified in the literature, however it must be noted that these are not limited to applying a natural capital approach.

- Many MPAs fail to achieve their management objectives because of shortfalls in understanding the level of legitimacy stakeholders attribute to them (Dehens and Fanning, 2018). In their study, legitimacy was defined as the ability of a political action to be perceived as right and just by the various people who are involved, interested, or affected by it.
- Lack of available resources hinders the intensive participation needed for meaningful, and site-based natural capital initiatives that provide a more granular understanding (Castano-Isaza and others, 2015).
- Lack of, or miscommunication between the local community and protected area management can undermine participation, trust, and quality engagement (Ivanic and others, 2017).
- The transition from community-led to government-led management can result in a loss of community trust and support, impacting overall implementation and social acceptability of MPAs (Rodriguez-Martinez, 2008).

- Local social values around wellbeing, seascape and procedural justice are cornerstone but often overlooked issues for coastal communities undergoing MPA designation and review processes (Gollan and Barclay, 2020).
- Continuity of engagement emerged as a challenge when transitioning from the planning phase to decision-making and regulatory process (Gaymer and others, 2014).

Ecological, Economic and Socio-Cultural Value Assessments

- Having sufficient and continuous budget for personnel, surveillance, and enforcement (Rodriguez-Martinez, 2008).
- A lack of accurate spatial fishing effort data greatly reduces opportunities for rational and targeted approaches to improve the condition status of marine natural capital assets (Rees and others, 2020).
- While many papers offer recommendations for MPA management, few quantitatively assess the ecosystem service outcomes of management actions or explore options for MPA siting, monitoring, and financing. Instead, most research focuses on quantifying ecosystem services and discussing their implications for management, rather than evaluating different management strategies or options for specific services and habitats (Arkema and others, 2024).

Overview of natural capital approaches in MPA management (Objective 2)

This section provides a broad overview of where natural capital thinking has been applied to inform MPA management, both within the UK and internationally, including the role of community or stakeholder values in the management or development of an MPA (Objective 2). A few recent systematic reviews have helped to shape this section. The key findings of these studies are summarised under four key themes below.

Growing literature base on linking natural capital, ecosystem services and societal benefits but limited evidence on how it is incorporated into MPA processes.

The literature on ecosystem services and societal benefits in the marine environment is expanding. Cripps (2020) identifies three key measures of marine natural capital: i) intrinsic natural capital, ii) ecosystem services derived from that capital, and iii) the value of those services, either in monetary terms for humans or ecological value for the ecosystem itself. Marcos and others (2021) identified nearly 15,000 papers on MPAs, of which 851 focused on ecosystem services, 1,722 on benefits, and 3,910 on effects. However, they found that the literature primarily focused on the role of MPAs in improving ecological quality, which inherently would increase the provision of ecosystem services. The actual application of an ecosystem services approach to support MPA management remained limited.

Arkema and others (2024), in a systematic review of 110 case studies across 54 countries (Figure 5), argue that quantifying social-ecological relationships could strengthen both MPA science and practice. However, despite many studies suggesting their assessments will have MPA management implications (see Figure 6), few explicitly demonstrate how ecosystem services are integrated into decision-making, such as in siting, monitoring, and financing. This suggests that while the theoretical understanding of ecosystem services in MPAs is advancing, evidence on the outcomes of natural capital approaches to MPA management is limited. Although this evidence may exist within the grey literature, which is more difficult to systematically search, particularly given the global scope of this review and that of Arkema and others (2024).

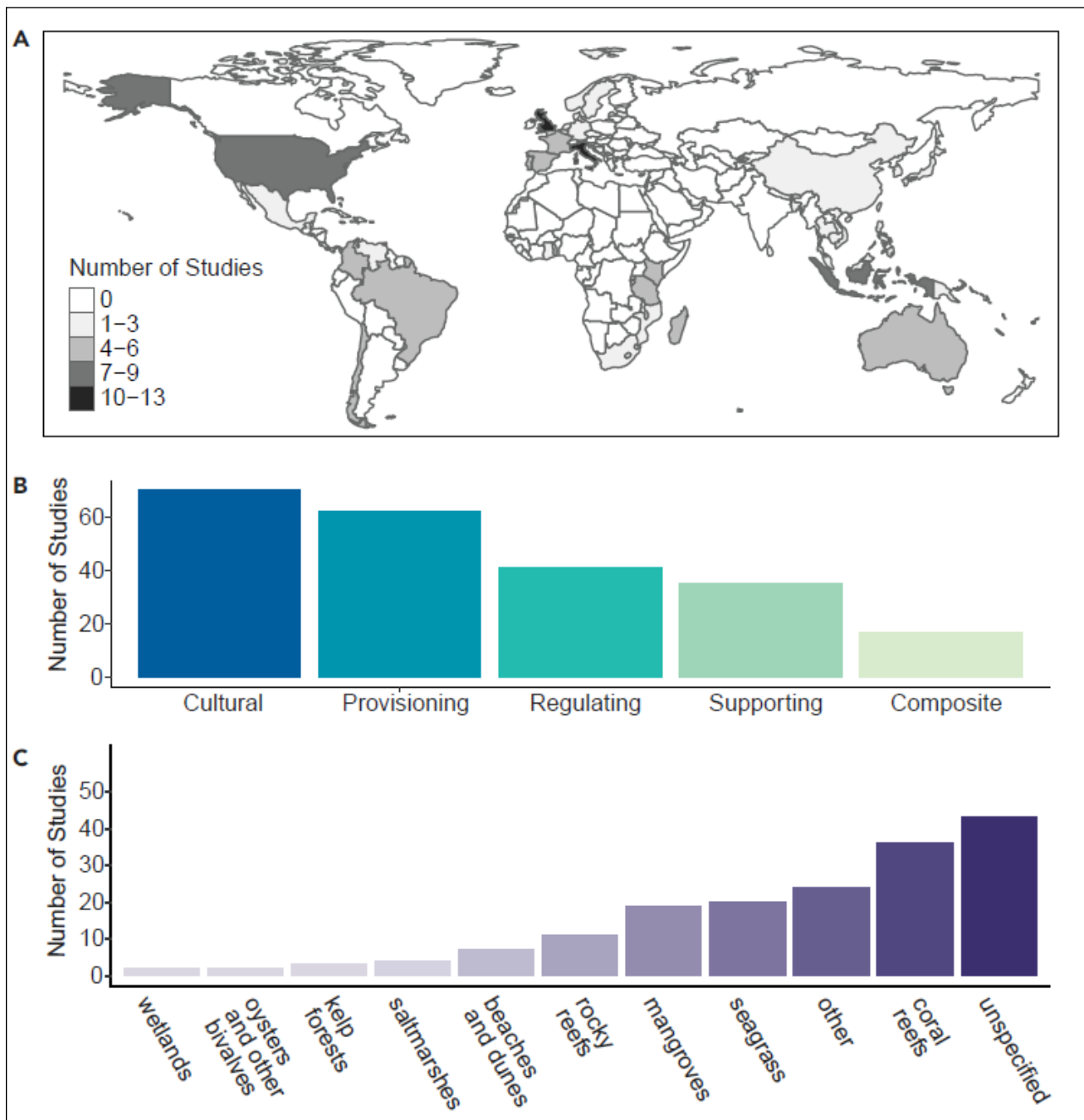


Figure 5: Number of studies with a focus on MPAs that quantify ecosystem services provided by coastal habitats (Arkema and others, 2024), republished under licence CC BY 4.0.

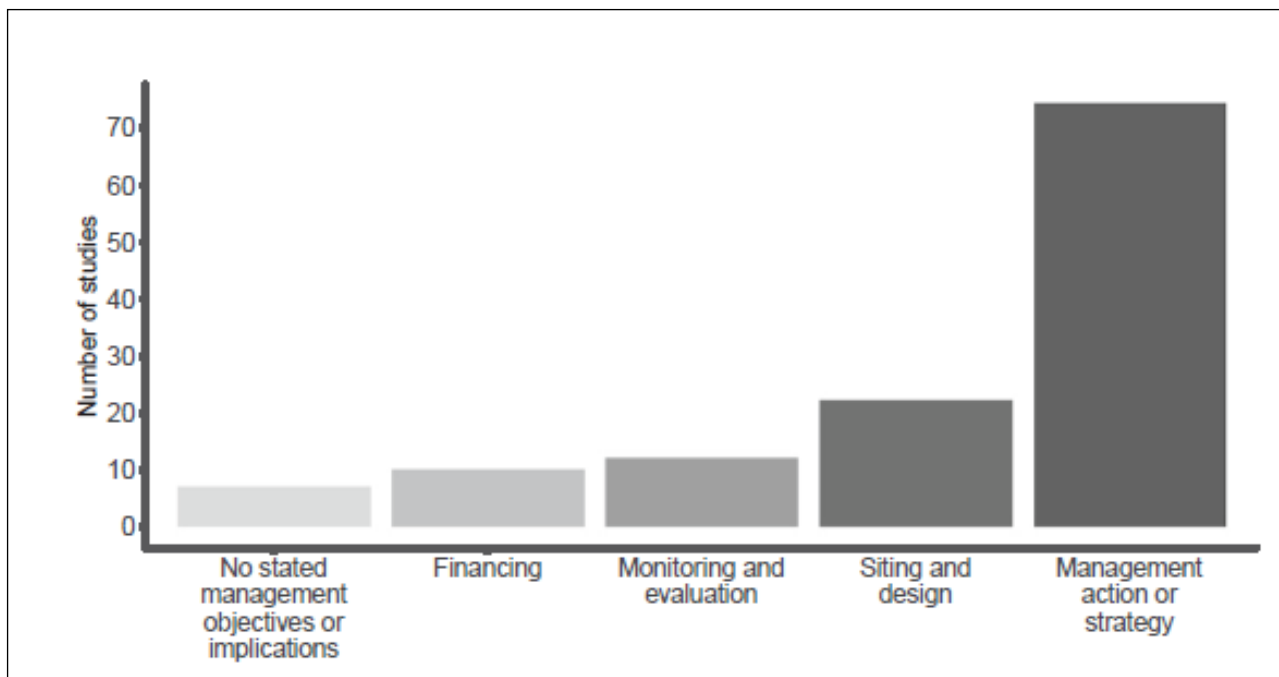


Figure 6: The number of studies that quantify ecosystem services to inform management, siting, monitoring and financing of MPAs (Arkema and others, 2024), republished under licence CC BY 4.0.

Growing support for the inclusion of the human dimension in MPA management.

Palomo and others (2014) presented an evolution of MPA management practices (see Table 1) and recognised the importance of including social changes and engaging local communities in the management of protected areas. Since then, several reviews have supported the inclusion of human dimensions, incorporating social and cultural values into MPA management, including methods and theoretical frameworks to support this. For example, Gavin and others (2015) proposed the incorporation of bio-cultural approaches into MPA design and management, and proposed eight principles which acknowledge:

1. The role of multiple objectives and stakeholders.
2. The importance of intergenerational planning and institutions for long-term adaptive governance.
3. That culture is dynamic and that it is this dynamism that shapes resource use and conservation.
4. That interventions should be tailored to the socio ecological context.
5. The need to devise and draw upon novel, diverse, and nested institutional frameworks.
6. The importance of partnerships and relationship building for conservation outcomes.

7. That the distinct rights and responsibilities of all parties are incorporated.
8. That different world views and knowledge systems are respected and incorporated into management and planning.

Clarke and others (2016) recognised the complexity in meeting both social and conservation MPA goals given that different stakeholder groups can perceive MPA success in different and conflicting ways. Understanding these differences is important when developing monitoring programs and for maintaining support. Clarke and others (2016) support the importance of an enhanced understanding of the human dimension of MPAs. Building on this, Christie and others (2017) identify best management practices for the human dimensions of large scale MPAs including: integration of culture and traditions, effective public and stakeholder engagement, maintenance of livelihoods and wellbeing, promotion of economic sustainability, conflict management and resolution, transparency and matching institutions, legitimate and appropriate governance, and social justice and empowerment.

Table 1: Evolution of the protected-area concept: From islands to networks to landscapes to the social–ecological approach (Palomo and others, 2014), republished under licence CC BY 4.0.

Attributes	Island approach (ca. 1872–1980s)	Network approach (1990s–mid-2000s)	Landscape approach (mid-2000s–today)	Social–ecological approach (today–?)
Type of management	Static: Seeks to maintain the status quo	Dynamic: Some natural changes are considered necessary	Dynamic: Some natural changes are considered necessary	Adaptive: Natural and social changes should be incorporated into management
Conservation values considered	Intrinsic values of ecosystems, biodiversity and cultural values	Intrinsic values of ecosystems, biodiversity and cultural values	Intrinsic values of ecosystems, biodiversity, ecological processes (functions, ecological integrity), and cultural values	Intrinsic and instrumental values of ecosystems and biodiversity (ecosystem services)
Knowledge involved	Scientific and technical	Scientific and technical	Scientific and technical	Scientific, technical, and local ecological knowledge
Resilience against perturbations	Reduction of variability	Moderate resilience	Moderate–high resilience	High resilience

Attributes	Island approach (ca. 1872–1980s)	Network approach (1990s–mid-2000s)	Landscape approach (mid-2000s–today)	Social–ecological approach (today–?)
Competition against other land uses	Partly competitive because of low demand for the landscape	Competitive because of high demand for the landscape	Highly competitive because of the high demand for the landscape	Cooperative: Multifunctional landscapes
Local population involvement	Managed without the local population, which is seen as a threat; managed by researchers and environmental experts	The local population is included in some participatory management processes	The local population is included in participatory management processes	Truly managed with the local population
Landscape management	No integrated landscape management	No integrated landscape management	No integrated landscape management; the landscape is managed to avoid harming the protected area	Integrated landscape management; management of the landscape as a whole

An exemplar case study which demonstrates the importance of including human dimensions in marine management decisions in Belize was presented by Arkema and others (2015). Further details are presented in Case Study One below.

Case Study One: Embedding Ecosystem Services in Coastal Planning in Belize

This case study **applies an ecosystem services framework** to understand how human activities affect the flow of benefits, to create scenarios, and to design an Integrated Coastal Zone Management (ICZM) plan for Belize. Collaboration between the Belizean Coastal Zone Management Authority and Institute (CZMAI) and the Natural Capital Project addressed three questions: (i) What is the delivery of ecosystem services now and under three future management scenarios? (ii) Do ecosystem-service values vary among coastal planning regions? (iii) Can these results be used to adjust where human activities occur to reduce risk to habitats and enhance services?

The inclusion of **extensive stakeholder engagement** in this case study demonstrates how stakeholder involvement can support natural capital assessments (Arkema and others, 2015; Verutes and others, 2017). In Belize, this in-depth engagement process involved working with relevant actors to scope objectives, gather information, and secure feedback through coastal advisory committees, composed of local representatives from maritime and coastal sectors and interests, public consultations, and expert reviews. Drawing insight from stakeholders, the study applied models (e.g., InVEST) and future scenarios for eight human activities, and quantified the ecosystem services provided by corals, mangroves, and seagrasses (Verutes and others, 2017).

The study estimated annual production of lobster, tourism, and coastal protection for the current scenario (year 2010) and three future scenarios (year 2025) in both biophysical and economic units. Through iteration of modelling and stakeholder engagement, the **outputs from this study directly informed a preferred ICZM plan** that accounted for spatial variation proposed for formal consideration by the Belizean government. By accounting for spatial variation in the influence of human activities on the provision of ecosystem services and societal benefits, such results **allow stakeholders and policymakers to refine zones of human use, consider and reduce risk to ecosystems, and enhance delivery of multiple societal benefits.**

The ICZM Plan for Belize provides an example of how a national scale spatial coastal and ocean plan can be designed using a suite of ecosystem service models and metrics, complemented by robust stakeholder engagement processes. Approved by the Belizean Government in 2016, the Belize ICZM Plan provides a framework for national action for improved management of coastal and marine ecosystems and their ecosystem services now and for future generations (CZMAI, 2016, p. 4). Application of such an approach and tools in MPA management would enable marine managers to bring natural capital approaches to bear on real-world decisions, thus directing actions that protect ecosystems and their benefits for people. Additionally, the Belizean case study highlights **the importance of effective stakeholder communication when implementing spatial management measures or assessing values and trade-offs** (Verutes and others, 2017).

The potential linkages between ecosystem services, community wellbeing and the diverse values associated with MPAs in the context of a community managed MPA are explored in Case Study Two below.

Case Study Two: Linking Ecosystem Services and Wellbeing in a Jamaican MPA

The Bluefields Bay Special Fishery Conservation Area (BBSFCA) is a community-led no-take MPA on the northwest coast of Jamaica. It was established in 2009 to promote the recovery of declining fish stocks. The Bluefields Bay Fishermen's Friendly Society, representing approximately 70 local fishers, currently manages the MPA. Despite being spearheaded by the community, the no-take element of this conservation area has sparked tensions. Chan and others (2019) explore the links between ecosystem services and social wellbeing for a small-scale fishing community, examining how these links vary within communities and how they might be harnessed to enhance conservation. The study aimed to: (1) identify the ecosystem service bundles valued by different community groups within this fishing community; (2) define how the MPA has changed access to ecosystem service bundles for these different groups; (3) examine how changes in access to these bundles have affected social wellbeing; and (4) apply understanding of ecosystem services and societal wellbeing to enhance the governance of MPAs.

This research uses a **qualitative, place-based, mixed-methods approach** which included: (1) literature review, (2) participant observations, (3) 42 semi-structured interviews (n=59 people), (4) six focus groups (n=44 people); and (5) 77 structured questionnaires (n=77 people). Notably, no economic data were collected. The study **illustrates how social wellbeing can be a valuable complementary framework for examining perceptions of the impact of conservation interventions**, capturing community views that may often be missed through other assessment approaches. It also highlights the importance of taking place-based approaches to conservation, which recognise the context and case specific needs and priorities of each community. In this study, social wellbeing encompassed three main pillars: Material wellbeing (e.g., physical or financial resources, assets, shelter); Relational wellbeing (e.g., social relations, access to public goods, personal relationships, and attitudes), and Subjective wellbeing, (e.g., individual perceptions of material, social, and human position; cultural values, including ideologies and beliefs; aspirations; and happiness). Data from semi-structured interviews indicate that a wide range of ecosystem services are important for social wellbeing in Bluefields. Community perceptions of the marine environment suggest that the presence, function, and benefits of coastal-marine ecosystem services are tacitly understood. Participants discussed all four categories of ecosystem services (provisioning, regulating, supporting and cultural) during the interview process.

Key findings include: (1) Fish must be governed as more than just material resources and provisioning ecosystem services, since they also provide vital cultural benefits, (2) Relational wellbeing is a core component in the success of MPA governance, particularly in the context of co-management, and (3) Fishing method and geospatial location are factors that perpetuate the marginalisation of certain community groups. From a policy perspective, insights from these data can facilitate the development of an **MPA model that is more inclusive of all actors in small-scale fishing and coastal communities**. Crucially, this study also highlights the importance of ongoing monitoring to assess the impact of MPA and other spatial management interventions, ensuring they account for **both tangible and intangible values** to achieve equity and effectiveness.

Lack of information on funding of natural capital approaches.

A small number of the reviewed studies provided information regarding what funding was used to facilitate a natural capital approach. Those studies which mentioned funding generally acknowledged national governments, national research councils, European Union funding, or funding from charitable organisations (e.g., Rees and others, 2015; Dehens and Fanning, 2018; Vilas and others, 2020). Several studies referred to funding as a challenge to MPA management (e.g., Rodriguez-Martinez, 2008; Castano-Isaza and others, 2015; Arkema and others, 2015). To better identify sources of funding for natural capital approaches, conducting a series of semi-structured interviews with MPA managers may be a more effective way to capture the complexities and details of the challenges related to resourcing and capacity.

Support for applying natural capital approaches.

There is support in the literature for applying the concept of natural capital in MPA management. For example, Marcos and others (2021) concludes that MPAs could be managed more cooperatively by involving different users, drawing upon natural capital approaches that support social and economic benefits. Cripps (2020) state that “natural capital can provide a common framework and strategy across a wide range of management interventions, sectors and habitats”, whilst Arkema and others (2024) recognise the power that ecosystem services assessments provide by bringing together different interests and considering multiple benefits.

However, Arkema and others (2024) also identified a lack of evidence on how natural capital approaches have been used to support site selection, monitoring, evaluation, and finance. In addition, there was a general lack of information regarding the MPA management structure, designation process, and the level of community involvement (see Annex 3). Cripps (2020) emphasise that a natural capital approach should be integrated with appropriate planning systems and funding mechanisms to support MPA designation and management. Furthermore, Arkema and others (2024) conclude that safeguarding coastal ecosystem services we will need more tools than MPAs alone. They suggest that other approaches could be weaved together such as nature-based solutions for the management of coastal disasters and climate adaptation, ecosystem restoration, and *de facto* protections in non-MPA areas.

Methods for integrating natural capital thinking into management decision-making processes (Objective 3)

This section provides insights from the literature reviewed into the methods used to integrate natural capital thinking into management decision-making processes; particularly when these have led to an increase in benefits (Objective 3). The section is divided into methods for stakeholder engagement and value assessments.

Methods for stakeholder engagement

The inclusion of stakeholders is essential throughout all aspects of MPA management (designation, implementation and monitoring) and natural capital valuation.

Any form of participation or collection of opinions and perspectives inherently captures, to some degree, the values of participants, reflecting what is important to them and their motivations. Building an understanding of stakeholder values early in the process is key to a successful natural capital approach. The importance of stakeholder engagement in MPA management has been widely recognised. Rodriguez-Martinez (2008) highlighted the success of a community-led MPA designation in the Puerto Morelos Reef in Mexico, demonstrating what can be achieved when community support is obtained and when key community leaders are involved. Similarly, Arkema and others (2015) state that engaging stakeholders is key to successful marine planning (Case Study One). Their study concluded that processes incorporating active participation, information exchange, transparency, fair decision-making, and positive participant interactions are more likely to be supported by stakeholders, meet management objectives, and fulfil conservation goals.

Gall and Rodwell (2016) further advocate that stakeholder engagement should take place through the duration of any MPA process and should have defined parameters that are transparent with stakeholder expectations managed. Finally, Rasheed and Abdulla (2020) identify inadequate engagement and participation as the strongest impediments to successful MPA development in the Maldives.

A range of stakeholders were identified in the reviews. The typology of stakeholders was dependent on the site-specific issues of interest and highlights the importance of place-based approaches that are contextual, engage with the right networks and are considerate and inclusive of marginalised and minority groups when applying natural capital approaches. It is of note that 42% of the studies reviewed (26 out of 63 papers) did not explicitly identify the types of stakeholders who were engaged. This identifies a data gap for highly relevant information which the authors would advocate including for all MPA related studies which refer to stakeholder or community engagement.

A range of methods have been applied to engage stakeholders in MPA management and assessment of ecosystem services and their values.

Of the 63 'Application' papers, the methods applied most were interviews / semi-structured interviews, surveys / questionnaires, and focus groups / round table discussions (Figure 7). With respect to stakeholder engagement methods, 'Other' methods included three methods, each applied once: a matrix approach (Geange and others, 2019), semi-structured feedback (Arkema and others, 2015) and Trinity of Voice (Rasheed and Abdulla, 2020).

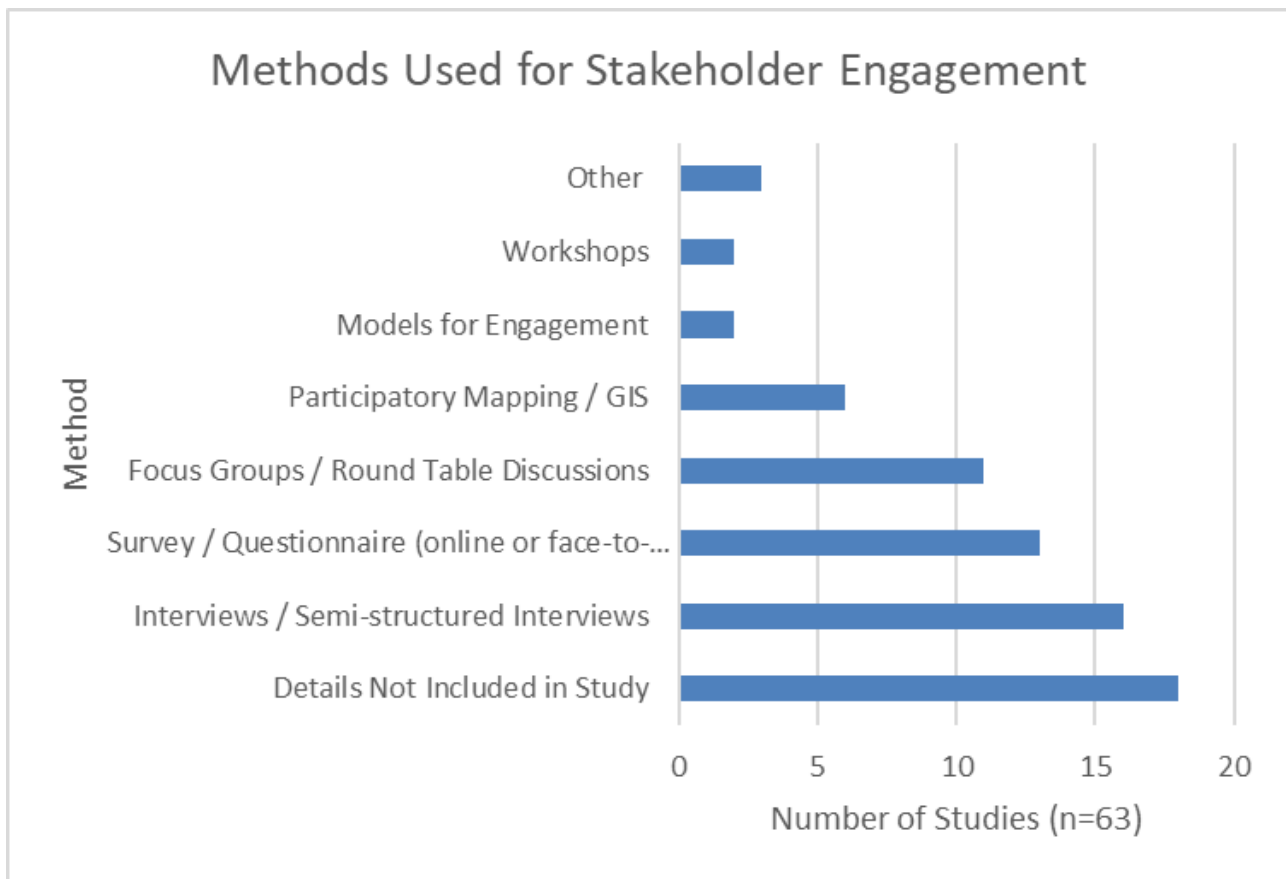


Figure 7: Methods used to engage stakeholders and communities (n=63).

Stakeholder engagement methods were often used in combination. For example, Chan (2017) used a combination of literature review, participant observations, semi-structured interviews and focus groups to examine the linkages between ecosystem services and wellbeing in a fishing community in Jamaica. The study also analysed how these linkages have changed following the implementation of a MPA (see Case Study Two above for more details).

An increasing number of studies are applying participatory approaches to engage communities (e.g., Lopes and Videira, 2019; Sagoe and others, 2021; Seijo and others, 2021; Burdon and others, 2022). These approaches combine stakeholder engagement with valuation methods to assess the benefits derived from a site and provide a platform to explore synergies and trade-offs between different stakeholder groups. These studies are discussed further in the ‘Methods for Valuation’ section below.

Rasheed and Abdulla (2020) evaluate two stakeholder workshops (local communities and tourism stakeholder) to support the development of a management plan for South Ari Atoll Marine Protected Area (Maldives). They applied the Trinity of Voice (TOV) conceptual framework (Senecah, 2004), which analyses the nature and processes involved in a participatory activity, and how the process effectively relates to its outcomes. The TOV framework provides a systematic structure to analyse participatory processes, and its components are well suited for application to MPA management.

Notably, 18 studies (30%) referred to stakeholder and community engagement in MPA management but provided no details of the methods used.

Methods for value assessments

A common aspect of applying a natural capital approach to MPA management is an assessment of values. Total social value comprises aspects of ecological value (the health of the system measured using ecological indicators), economic value (expressed and measured monetarily through market prices for benefits that are traded, especially provisioning goods, and through non-market approaches to valuation otherwise), and socio-cultural value (including shared values which we hold in common as communities, cultures and societies, and which are not easily reducible to conventional economic values) (MA, 2003). A suite of valuation methods is available to capture such evidence. A breakdown of the types of valuation methods, identified from the 85 review papers that have been applied in MPA management are illustrated in Figure 8. It is of note, that multiple (mixed) methods may have been applied within the same study and therefore these figures represent applications rather than numbers of discrete studies. A description of each method, and example references from this review, is provided in Annex 4.

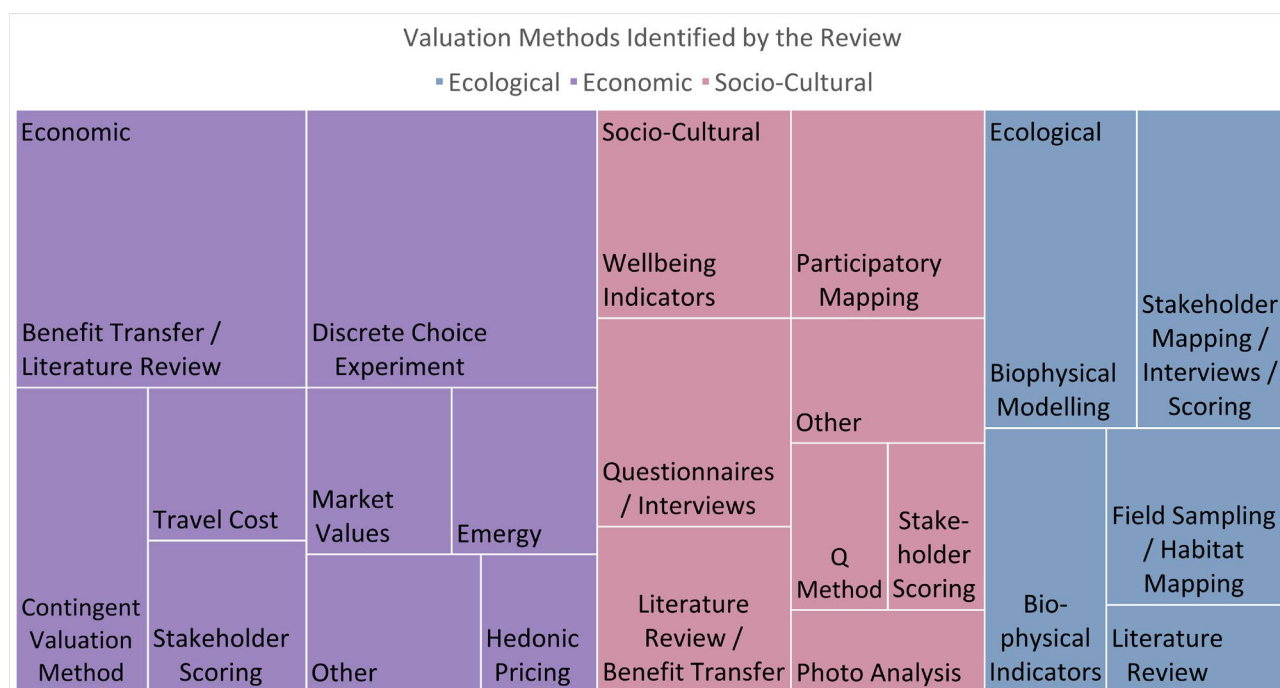


Figure 8: Frequency of valuation methods identified within the review, with frequency indicated by the size of each box (n=85).

Despite the combined searches, the literature on valuation is still dominated by economic methods.

As shown in Figure 8 above, economic valuation methods dominated the studies (n=42), with Benefit Transfer (n=10), Discrete Choice Experiments (n=10) and Contingent Valuation (n=5) being the dominant economic valuation methods employed. With respect to economic valuation methods, 'Other' methods, where only single studies were identified, included Cost Benefit Analysis (Brander and others, 2020), use of the InVEST model (Niz and others, 2023) and Opportunity Costs (Pascal and others, 2018).

Paltriguera and others (2018) used a discrete choice experiment at Flamborough Head MPA, UK, to examine visitor preferences for maximising recreational benefits. Their findings revealed that economic value is derived not only from natural features or the natural capital of an MPA but also from complementary man-made capital, such as an education centre and visitor information boards, which can create additional economic benefits. A second example is a study undertaken by Castano-Isaza and others (2015) who applied a contingent valuation method approach to estimate the economic value of beaches in the Seaflower MPA, Colombia, to support a Payment for Ecosystem Services (PES) scheme for conservation. The study not only revealed the demand for beaches but also provided insights into the potential buyers and the sellers, who might be engaged in such a scheme, an important element in the design of any PES.

Franzese and others (2017) proposed a natural capital accounting framework and applied it to the case of the Islands of Ventotene and S. Stefano in Central Italy. This study applied a biophysical and trophodynamic environmental accounting model based on emergy accounting (see Annex 4). The integration between the biophysical accounting model and a GIS tool allowed the identification of sites where natural capital stocks are more concentrated. Assessing, valuing, and mapping natural capital can support both local managers and policy makers in charge of meeting conservation objectives while ensuring the sustainable development of MPAs. Such integration represents a promising approach for developing more appropriate zonation schemes to ensure nature conservation and long-term sustainability of marine ecosystems. However, from a natural capital perspective, this approach does not consider the social and cultural values associated with the MPA.

There is a growing range of methods to value social and cultural aspects.

There was a total of 28 applications of socio-cultural valuation methods, with Wellbeing Indicators, Participatory Mapping and Questionnaires / Interviews each being applied in five individual studies (Figure 8). With respect to Socio-Cultural methods, 'Other' methods where only single studies were identified, include Social Impact Assessment (Barnes-Mauthe and others, 2015), Social Capital Through Grants / Technical Support (Pascal and others, 2018) and Community Voice Method (Ranger and others, 2016).

Some novel methods of assessing values have been identified through the review with respect to socio-cultural valuation methods, particularly those used to understand cultural

services provided by MPAs. For example, Retka and others (2019) assessed cultural ecosystem services of Área de Proteção Ambiental Costa dos Corais MPA (Brazil) through analysing 1,984 social media photographs. Their study highlights how the analysis of high volumes of crowd-sourced digital photographs extends the methodological toolbox and data sources available to researchers and provides a powerful new means to quantify and map cultural ecosystem services at broad spatial scales. In addition, Erskine and others (2021) investigated whether MPAs provide more cultural ecosystem services than other adjacent coastal areas by analysing a sample of more than 120 million Flickr photos taken at global MPA sites and comparing these with adjacent control sites. Using social media sampling, this study shows that people take more photos in MPAs, these photos are more focused on cultural ecosystem services and tend to have more likes and were described more positively. This demonstrates a clear link between cultural ecosystem services provided by MPAs and human wellbeing.

Barnes-Mauthe and others (2015) presents evidence from the locally managed Velondriake MPA (Madagascar) and establishes social capital as a multidimensional concept, including aspects of trust, community involvement, and social cohesion. Social capital is recognised as constituent of human wellbeing that is both supported by, and affects, all categories of ecosystem services. This study draws on both qualitative and quantitative data from Madagascar to assess and value social capital as an ecosystem service and explore its role in facilitating management goals. Results of a choice experiment show positive utilities associated with high levels of social cohesion, with respondents ranking social cohesion higher than some provisioning, regulating, and cultural ecosystem services. Such results offer insight into the ways in which social capital can both affect, and be affected by, the management of natural resources, and how it can be assessed and valued as an ecosystem service.

A further case study is presented below, which adopts multiple methods to both facilitate effective stakeholder engagement and as a key component of monitoring the social and cultural values of the Lyme Bay and Torbay SAC (Case Study Three).

Case Study Three: Lyme Bay and Torbay SAC

This case study draws on research that has focused on Lyme Bay and Torbay Special Area of Conservation (SAC) in south-west England. Lyme Bay offers a useful case study for highlighting the importance of adopting multiple methods, not only to facilitate effective stakeholder engagement but also as a key component of monitoring MPA value and effectiveness.

Rees and others (2015) assessed the socio-economic effects of the **Lyme Bay MPA on the cultural ecosystem service of leisure and recreation over a four-year period**, building on earlier work to understand the contribution of biodiversity in Lyme Bay to these sectors (Rees and others, 2010). By combining spatial analysis with quantitative and qualitative questionnaire, Rees and others (2015) engaged with stakeholders, including divers, anglers and boat owners and showed that the Lyme Bay MPA had varying effects on the delivery of leisure and recreation across sectors and users. Dive and boat charter businesses reported that they have increased their activity both inside and outside the MPA boundaries, while sea angling had declined outside the MPA and increased within it. The results highlight the importance for including wider business planning in MPA design and implementation (e.g., voluntary codes of conduct for divers and anglers).

In the context of natural capital valuation and asset condition assessments, a recent study by Mathews and others (2024) illustrated that while MPAs have been shown to improve the condition of marine features and assets, gaps remain in understanding as to how this translates to ecosystem functionality and ecosystem service delivery. The monitoring undertaken at Lyme Bay is an early example of the need to monitor ecological and socio-economic impacts and values of the MPA. The monitoring emphasises the need for MPA managers to take a more holistic approach, ensuring the delivery of ecosystem services provided by the MPA rather than solely being the enforcers of rules and regulations.

Several lessons can be learned through the efforts to expand the monitoring regime in Lyme Bay to be inclusive of ecological, social, and economic values (Renn and others, 2024). For example, **the adoption of a whole site approach to MPA management resulted in higher rates of recovery**, the potential role for MPAs in delivering climate resilience, as well as the importance of **meaningful engagement and establishing multi-sector partnerships** (i.e., such as those seen in Lyme Bay, including the Lyme Bay Working Group established by the Blue Marine Foundation, and the more recently established Lyme Bay Fisherman's Community Interest Company) to support management (Renn and others, 2024). Lyme Bay demonstrates that monitoring conditions inside and outside of MPA boundaries, before and after designation, is crucial to understanding the true impact and effectiveness of MPAs (Mathews and others, 2024).

There is a growing literature reporting the application of participatory approaches.

There is an increasing number of studies reporting the application of participatory mapping methods to natural capital discussions. Some examples are provided below:

- Rodriguez-Martinez (2008) emphasises the importance of participatory processes to help overcome governmental constraints (such as place-based data availability and resources) and of public education in gaining community support for the creation and management of the MPA.
- Ivanic and others (2017) applied the Protected Area Benefit Assessment Tool (PA-BAT) tool to assess stakeholder opinions of benefits in the Dinaric Arc region, SE Europe. Information on ecosystem services was collected through facilitated participatory workshops.
- Lopes and Videira (2019) developed an innovative approach for collaborative scoping processes aiming to elicit multiple values of ecosystem services in the Arra´bida Natural Park, Portugal. The approach enabled stakeholders to identify a list of ecosystem services in the MPA, establish linkages between those services and human wellbeing, recognise drivers of change, and perform a preliminary screening of the ecological, social, and economic values.
- Sagoe and others (2021) undertook participatory mapping and assessment exercises with two communities in the Greater Cape Three Points area in the Western Region of Ghana as part of an ecosystem-based approach to the establishment of MPAs in the area. Their study concludes that when participatory mapping is complemented with perspectives from direct beneficiaries of ecosystem services, managers are afforded a holistic insight into the array of issues that feed into a comprehensive management approach which addresses social, economic and ecological concerns.
- Seijo and others (2021) interviewed stakeholders in Sao Miguel Islands, Azores (Portugal) using SeaSketch, a participatory mapping tool to identify areas used for recreational fishing and scuba diving, the relative value of those areas, in terms of preference over other areas and their willingness to relinquish them for conservation. The results of this study confirmed that people attach different values to different places and generated “hotspots” of high value which can be fed into management.
- Burdon and others (2022) advocate the role of participatory mapping and logic chain developments for community engagement. Their methods involve identifying and mapping marine features and associated benefits, developing logic chains to link natural capital features with these benefits, and assessing the reliance or dependence of beneficiaries on the benefits delivered by the system. Their study applied the method to the Deben Estuary, Suffolk (England) but has subsequently

been applied to both the Solent (England) and Cromarty Firth (Scotland) as part of the UKRI-funded Sea the Value project (Burdon and others, in prep.).

Only a limited number of studies applied ecological valuation methods.

As shown in Figure 8 above, fewer studies undertook ecological valuation assessments (n=22), with Biophysical Modelling (n=6) and Stakeholder Mapping / Interviews / Scoring (n=6) being the most frequent methods used. While ecological surveys and assessments are likely to have been undertaken at all MPA sites, the peer-reviewed literature reporting these results may not directly reference the terms 'natural capital', 'ecosystem services', 'values' and/or 'benefits' and would therefore not be captured by this review. Additional ecological valuation data on the extent and quality of ecological features would likely be identified by MPA-specific searches of the peer-reviewed and grey literature; however, this was outside the scope of this rapid review.

The use of mixed methods approaches is becoming increasingly popular as it can provide a richer evidence base of values.

With respect to valuation methods, there is a growing body of literature which apply mixed methods approaches which bring together a more holistic perspective and can identify complexities, such as trade-offs between fisheries and nature conservation, when it comes to marine management (Hattam and others, 2015). One such approach from Colombia is illustrated in Case Study Four. Further support for mixed methods approaches was identified by Garcia Rodrigues and others (2024) who applied a mixed methods approach to Litoral Norte MPA (Portugal).

Case Study Four: Mixed Methods Approach to MPA Management in Colombia.

Rojas and others (2019) undertook a valuation of ecosystem services delivered by mangroves in the Protected Area DRMI Tribugá Gulf and Cabo Corrientes (Colombia), managed by the environmental authority of the Department of Chocó (Corporación Autónoma Regional para el Desarrollo Sostenible del Chocó). The study identified the ecological, socio-cultural, and economic values to assess the impact of a port development. This study provides a useful case study in **illustrating the importance of taking a mixed methods approach which incorporates ecological, economic, and socio-cultural value assessments.**

With respect to the ecological value assessment, **the InVEST habitat quality model** was used to combine information on land use/land cover and biodiversity threats to produce habitat extent and quality maps. The assessment showed there to be 2,408 ha of high-quality mangrove, and there would be a loss of 916.94 ha resulting from the port development.

Rojas and others (2019) applied a **participatory deliberative research** method to assess socio-cultural values, via a workshop with 101 participants to gather insights on community perceptions of the values and impacts of MPA ecosystem services on human wellbeing. This approach identified the services most valued by communities, including water provision, air quality, fishing, agricultural products, carbon stock, soil fertility, natural medicine, habitat quality, and raw materials.

A mixed approach was used to understand economic values of the mangroves. A literature review was undertaken to capture evidence on the state and values of Colombia's mangrove ecosystems. This assessment showed the most valuable ecosystem services were fishing (USD\$ 1.4-720 million /yr), tourism (USD\$ 50,295-1.495 million /yr) and carbon sequestration (USD\$ 21,081-32 million ton/yr). Additionally, **a contingent valuation survey** was instigated to estimate individual willingness to pay to conserve ecosystem service provision from mangroves in the Protected Area. Results from the latter suggest that there is interest from the communities and stakeholders to maintain the mangroves status quo. Based on a benefit transfer approximation, the ecological assessment data on net mangrove loss suggests that the loss of 916.94 hectares equates to an estimated economic loss of approximately USD \$232 million per year.

Notably, the deliberative process undertaken in this study found that the **ecosystem services prioritised by the community did not correspond with the economic value assessments.** This highlights the importance of undertaking natural capital assessments that consider the full range of ecosystem services, incorporating community priorities alongside those considered the highest economic value (i.e., in this case, tourism and fishing). The conclusions of this case study suggest that **adopting a mixed methods approach facilitates a more integrated assessment of ecosystem services, providing insights that can be used by decision makers to identify and prioritise areas for conservation and identify potential conflicts associated with management interventions.**

Discussion

The following section provides a brief discussion of the results presented above but also reflects on the limitations of this review approach and highlights areas for future research.

Benefits and Challenges of Applying a Natural Capital Approach in MPA Management (Objective 1)

This objective sought to develop an understanding of the benefits and challenges associated with implementing natural capital approaches to MPA management. A SWOT analysis, based on the findings of the rapid review, was undertaken. In summary, the main benefits of applying a natural capital approach to MPA management include:

- Stakeholder engagement should be undertaken throughout the whole MPA process, allowing for early identification of potential conflicts and enabling collaborative problem solving.
- Applying a natural capital approach brings together diverse interests by quantifying and valuing multiple benefits which can inform a broad range of MPA management questions.
- Participatory approaches can be applied to engage society in natural capital discussions and generate shared understanding of the links between natural capital, benefits and beneficiaries.
- Mixed method approaches, which incorporate ecological, economic and socio-cultural values, can provide a richer narrative and can bring important values, perspectives, and challenges to the fore.
- Monitoring ecological, economic, and socio-cultural values both before and after management interventions helps assess their effectiveness, providing valuable evidence to guide future decision-making.

The main challenges associated with applying a natural capital approach to MPA management include:

- MPA managers need to encourage and promote communication and meaningful involvement of the community, which is not always possible and can be difficult to achieve without adequate resources and understanding of the community - this is particularly important when the community of stakeholders have a high level of interest and knowledge of the marine environment.
- Continuity of stakeholder engagement, throughout the full MPA lifecycle, emerged as a key challenge in relation to both stakeholder time and resources.
- Recognising stakeholder perceptions of legitimacy in MPA management processes is challenging, Dehens and Fanning (2018) outline a novel legitimacy indicator

framework and demonstrate its effectiveness for assessing the legitimacy of coastal MPAs, before, during and after MPA designation (see Dehens and Fanning, 2018).

- There is a requirement for additional financial resources and interdisciplinary expertise to apply a natural capital approach at the local MPA scale.
- MPA managers may need to develop skills necessary to collaborate effectively with local knowledge holders in order to access the local expertise needed to deliver a place-based natural capital assessment.
- There is still a lack of qualitative and quantitative valuation data on natural capital, ecosystem services and societal benefits, particularly at the MPA site-level.
- Despite the growing number of studies which have applied a natural capital approach to MPAs, there are limited examples where their findings translate into policy interventions.
- There may be challenges associated with language and the translation of national level legislation into the local language/dialects spoken by coastal communities.

Overview of Natural Capital Approaches in MPA Management (Objective 2)

Objective two aimed to provide an overview of where natural capital thinking has been applied to inform MPA management, both within the UK and internationally, to assess where community or stakeholder partnerships have been involved in the management or development of an MPA. The review highlighted that there is a growing literature on linking natural capital, ecosystem services and societal benefits, however there is limited evidence on how this understanding is incorporated into operational MPA management. Overall, there is support for the inclusion of the human dimension in MPA management, recognising the importance of engaging communities and a wider range of stakeholders in the MPA process. Natural capital approaches are a useful way to bring people together to understand the diverse benefits stakeholders derive from a site. They can help determine integrated actions that deliver a range of ecosystem services and benefits, identifying overlaps, synergies, and trade-offs (Natural England, 2021).

There was a lack of information in the literature on what funding is available for MPA managers to apply natural capital approaches. However, such information may be obtainable from further searches of the grey literature or by interviewing MPA managers. Overall, there was support for applying a natural capital approach to MPA management.

Methods for Integrating Natural Capital Thinking into Management Decision-Making Processes (Objective 3)

Recognising the importance of engaging stakeholders and quantifying and valuing natural capital, ecosystem services and societal benefits, objective three aimed to gain insights into the methods used for stakeholder engagement and ecological, economic, and socio-cultural valuation; particularly when these have led to an increase in benefits. The

inclusion of stakeholders is essential throughout all aspects of MPA management (i.e., designation, implementation, and monitoring) to support an accurate assessment of natural capital values and build legitimacy. A range of methods have been applied to engage stakeholders and assess values. These methods were dominated by interviews, questionnaires and focus groups, with a growing number of studies applying participatory approaches. A key conclusion from the literature was the need to ensure that the methods used to engage stakeholders are context and location specific, considering social, economic, and cultural factors within a place-based approach. Despite the importance of stakeholder engagement in MPA management, a third of studies reviewed in this study provided no details about the methods used.

Despite the combined searches, the literature on valuation is still dominated by economic methods, particularly the use of benefit transfer, discrete choice experiments and contingent valuation studies. The limitations of applying such approaches to intangible benefits were recognised within the literature. The importance of place-based valuation studies was highlighted, given differences in ecological, social and cultural values between communities, which limits the application of benefit transfer approaches. There is a growing range of methods to value social and cultural benefits, with the use of wellbeing indicators, questionnaires / interviews and participatory approaches being the most frequently applied methods. Only a limited number of studies applied ecological valuation methods. However, it is recognised by the authors that the specific focus of the literature searches on community engagement and stakeholders may account for the lack of ecological valuation studies within this rapid review. The use of mixed methods approaches is becoming popular as it can provide a richer evidence base of multiple values. Many of the valuation papers reviewed are conducted at a wide regional or national scale with generic assessments but lack specificity on local MPA interventions.

Numerous studies were identified which engaged stakeholders and provided an overarching analysis (quantification and / or valuation) of natural capital and associated societal benefits provided by MPAs, however the findings of these studies do not translate into policy interventions. Therefore, despite the clear support of applying a natural capital approach to MPA management within the literature, and a range of studies applying components of a natural capital approach, limited evidence has been identified on cases which have applied a natural capital approach throughout all stages of the MPA management process.

Study Limitations

- The resources available for this project (both budget and time) prohibited a systematic review of the literature and evidence relating to MPAs and natural capital approaches. This review provides initial insights into the literature by providing a quick review of a smaller sample of papers.
- Whilst the online survey tool was valuable in collating the data from the review in a consistent manner, the evidence obtained from each paper was based on a rapid review of the paper, which may have resulted in some details being overlooked.

This was further exacerbated for larger documents (e.g., theses) where only the summaries could be reviewed in detail. Additionally, the lack of systematic inclusion criteria across the papers assessed may have introduced reviewer bias through selective inclusion of reports.

- The number of papers which could be reviewed within the scope of the project was restricted to the first 100 papers from each search. It must be recognised that the findings reported here represent the evidence obtained from only the 179 papers (initial screening) with 85 papers taken forward for full review and is not representative of the full literature base.
- The chosen search engine was Google Scholar as this includes sources of both peer-reviewed and grey literature. However, the studies identified were dominated by peer-reviewed papers, with limited inclusion of studies in the grey literature. Grey literature was interrogated from additional searches for the case study boxes, sending an email request through the OCTO MPA mailing list, and searching the World Database on Protected Areas. The scope of the study limited further searches of the grey literature.
- The initial search undertaken resulted in papers dominated by economic valuation studies and therefore the search was refined to focus on social aspects of natural capital. This will therefore have reduced the number of economic valuation studies and increased the number of social studies within the review.
- The SWOT analysis was undertaken solely on the findings from the 85 papers which were fully reviewed. Therefore, the findings from the SWOT analysis may not fully reflect the complete understanding of natural capital approaches in MPA management.
- The review included evidence from a wide range of global MPAs; however, limited evidence was obtained that quantified the benefits and values associated with an MPA before and after specific management interventions. For example, few studies provided comparative assessments of ecological or socio-economic outcomes, such as changes in biodiversity, fish stock recovery, or community livelihoods, linked directly to implemented management measures.

Future Research

- A full systematic review should be undertaken to provide a more complete understanding of natural capital approaches in MPA management within the current literature and evidence base.
- This review has identified a wide range of relevant case studies, and therefore additional searches of the grey literature could be targeted on these case study sites to complete the missing evidence cells within the database.

- To further understand the degree to which natural capital approaches have been applied to specific MPAs, it is recommended that a series of semi-structured interviews be undertaken with MPA managers and practitioners. These interviews would help address existing data gaps, including details on funding mechanisms.
- This rapid review revealed a lack of ecological valuation data regarding the extent and quality of identified ecological features. To address this gap, future research could adapt the search terms or include MPA-specific searches across both peer-reviewed and grey literature.
- There are opportunities for more comprehensive assessments of the full range of benefits provided by coastal habitats in MPAs – for example the work by Arkema and others (2024) highlight that only 10% of papers assess ecosystem services to monitor MPAs.

Conclusion

The literature supports the application of natural capital approaches, and this review identifies a range of management strategies from around the world that incorporate natural capital thinking. However, there is limited evidence of their practical application in directly supporting benefits and values associated with MPAs. While emerging examples exist, these remain formative, isolated, and not yet integrated into mainstream policy and practice. Additional evidence may be found through more targeted searches of grey literature, although such searches are challenging to conduct given the global scope of this review. Interviews with MPA managers could also help uncover government reports and monitoring data that document the impacts of specific management interventions.

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Annex 1: Methodology

Identification of Search Terms

Given the focus of the review on the use of natural capital approaches in MPA management, Figure A1.1 illustrates the structure of the review and highlights the long list of search terms which could be used to interrogate the literature. This full list of possible search terms related to the topic was developed by the report authors in collaboration with Natural England.

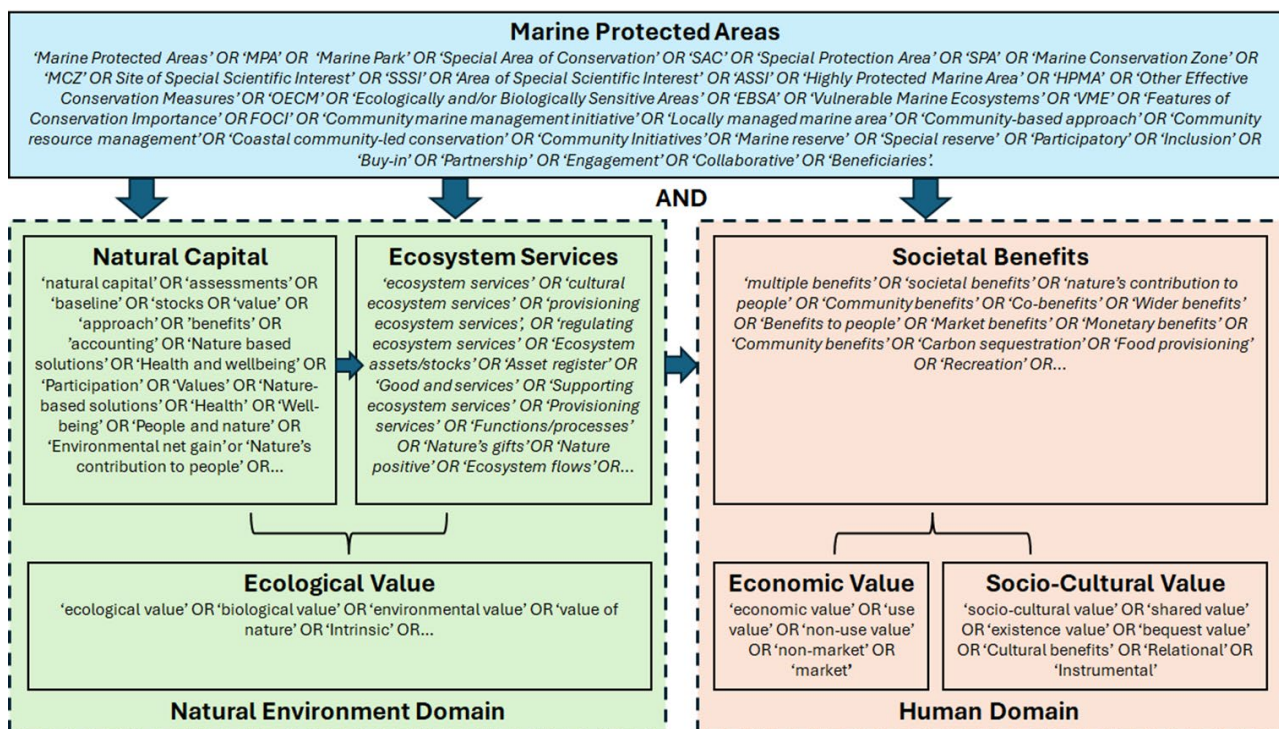


Figure A1: Schematic structure of the review including search terms for each dimension.

Drawing on the full list of possible search terms presented in Figure A1.1, the following exploratory literature search process using a series of simple searches was undertaken. As this was not a full systematic review, it was agreed that not all papers identified would be included for review and instead the first 100 papers were extracted from each search and reviewed to provide an initial insight into the literature and evidence base.

- **First Search** - simple search carried out using the following search string: "marine protected areas" OR "MPAs" AND "natural capital" AND "values" in Google Scholar. This resulted in 5,940 papers being identified. The first 100 papers were selected for an initial review; however, it was apparent that the papers were skewed to economic valuation as well as a high number of publications from the Mediterranean. It was agreed between the authors and

Natural England that this search would be discarded, and a refined search string was agreed.

- **Second Search** - used the search string - "marine protected areas" OR "MPAs" AND "natural capital" OR "ecosystem services" AND "values" OR "benefits", with a timeframe of 2014-2024 in Google Scholar. It was agreed with Natural England that taking this timeframe as an initial search period could be justified as it aligned with the publication of the UK National Ecosystem Assessment (UK NEA hereafter) follow on project in 2014. This search resulted in 14,100 papers of which the first 100 papers were selected for review.
- **Third Search** - carried out using the following terms - "marine protected areas" OR "MPAs" AND "natural capital" OR "ecosystem services" AND "values" OR "benefits" AND "community engagement" OR "stakeholder*" in Google Scholar which resulted in 7,100 papers. Again, the top 100 papers from this search were extracted and added to the database. The databases from the second and third searches were collated and checked for duplications – 57 papers were found to be duplicates, resulting in a total of 143 papers from this phase of the searches.
- **Snowball Papers** – additional papers of interest were identified during the review process using a snowball methodology, with additional papers included which had previously been identified by Natural England. In total, 22 papers were added to the list for consideration within the review with an additional four studies taken forward for inclusion in the full review.
- **Expert insights** finally, the following request was circulated via the OCTO MPA mailing list¹ *"We are looking for case study examples of MPAs that have been designated or managed by community and/ or stakeholder groups. In particular, we are interested in examples where natural capital approaches, or similar, have been used to support MPA designation or management"*. This resulted in 14 responses from which an additional 14 papers/reports were identified - four additional studies were included within the full review.

In total, 179 papers were identified, with 85 papers included in the full review process.

Development of online survey tool

A systematic approach was used to capture relevant information from each paper, drawing on the method developed by Jefferson and others (2021) to ensure consistency in data extraction across the review team. This involved the development of an online data

¹ The OCTO MPA mailing list was created by MPA news to act as an open channel for managers, researchers and others to share knowledge and information about issues relating to MPAs and their management.

collection tool (using an online survey platform), with questions aligned with each of the relevant data being extracted from the review papers. All questions were developed in collaboration with Natural England.

The final data collection tool was tested by the authors who each reviewed the same five papers to check for consistency in approach and extraction of data from the papers under review. The advantages of using an online survey data collection tool are that it captures data in a consistent manner and has the capability to download the results into a database for further analysis (Jefferson and others, 2021).

Initial Screening

An initial screening was undertaken for each paper (n=179). This stage enabled the paper details to be captured before a decision was made as to whether the paper should be included or not in the review – in some instances, this decision was not taken until the full review stage as more information was needed to judge whether the paper should be included. Papers were reviewed by one reviewer with an initial screening undertaken using the first eight questions of the online survey. These questions included:

- (1) Reviewer.
- (2) Author(s).
- (3) Paper title.
- (4) Journal / Publisher.
- (5) Publication year.
- (6) DOI.
- (7) Type of study.
- (8) Should this paper be included? (decision taken on reading of the paper abstract – when this was not clear, this decision was not taken until the Full Review stage, outlined below).

Full Review

The remaining papers/reports which passed the initial screening were reviewed in full (n=85), with the following information captured using the online survey tool. The list of questions was developed in collaboration between the authors and the Natural England project team. Once the review phase was completed, data was downloaded into an Excel spreadsheet for analysis.

- (9) Is the study mainly discussing application, review or theory?

- (10) What is the aim of the study?
- (11) MPA name
- (12) MPA location
- (13) Who manages the MPA?
- (14) Which (if any) stakeholders or communities were involved in the management or development of the MPA?
- (15) How were stakeholders or communities involved?
- (16) What methods were used to assess ecological value?
- (17) What methods were used to assess economic value?
- (18) What methods were used to assess socio-cultural value?
- (19) Were any measures used to benefit the site's natural capital?
- (20) What funding was used to facilitate the natural capital approach?
- (21) What aspects of the approach were successful?
- (22) What aspects of the approach were not successful?
- (23) What strengths of using natural approaches in MPA management can be identified?
- (24) What weaknesses of using natural approaches in MPA management can be identified?
- (25) What opportunities of using natural approaches in MPA management can be identified?
- (26) What threats of using natural approaches in MPA management can be identified?
- (27) Any other relevant papers?
- (28) Any other comments?

Annex 2: Natural Capital Concepts

Natural capital concepts have received increasing attention within research and policy over recent years (Burdon and others, 2024a). Natural capital stocks (or assets) can be defined as the elements of the physical environment, including habitats, species and processes, that directly or indirectly produce ecosystem services. Such flows of ecosystem services can provide societal benefits, often requiring the addition of complementary (built, human or social) capital to secure societal benefits (Burdon and others, 2024b).

Natural capital and ecosystem services can be assessed in ecological terms using indicators, which can inform the economic (monetary and non-monetary) and socio-cultural valuation of benefits (Hattam and others, 2015). This is illustrated in Figure A2, which emphasises that ecological valuation can be applied to define and measure state changes in the natural environment, whereas economic and socio-cultural valuation methods can be applied to value benefits (impacts on welfare) in the human domain (Elliott and others, 2017). Definitions for each type of value used in this review are provided in Figure A2. The natural capital (Figure 1) and total social value frameworks (Figure A2) provide a useful framing to structure this rapid review.

The concept of ecological value is not well defined or consistently applied across the literature. This review describes ecological value as “the health of the ecosystem measured using ecological indicators” (MA, 2003). Ecological assessment or valuation allows the state of ecosystem assets to be linked to the potential or capability to supply ecosystem services (Argüello and others, 2022). Studies that collate evidence on the quantity, quality and location of natural capital assets can pick up early signs of warning. This can be useful to understand factors affecting the long-term provision of benefits, which can be valued by socio-cultural and economic methods.

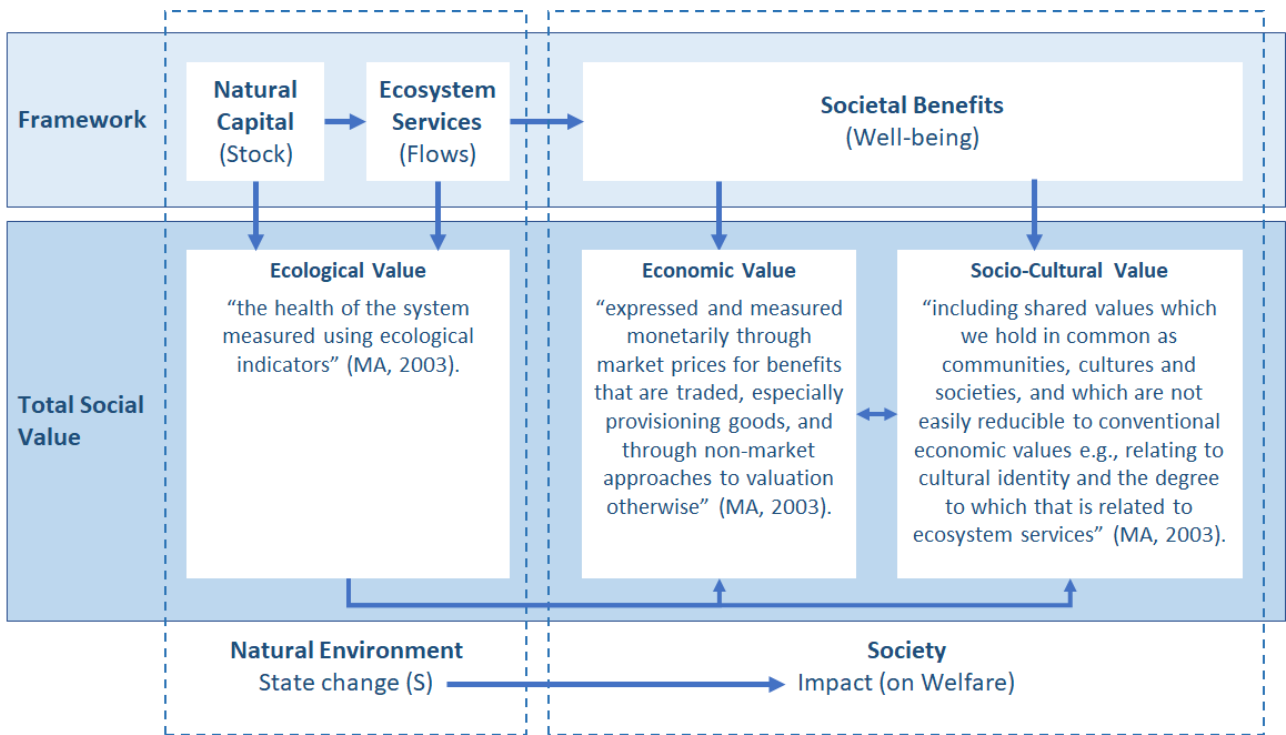


Figure A2: Total Social Value framework incorporating ecological, economic and socio-cultural values. Produced by author with definitions from MA, 2003

Annex 3: List of MPAs within the full review

The following table provides a summary of the MPAs included within the review, including the MPA name, location, management authority and reference.

* Indicates that the MPA Management Authority was not identified in the review but was subsequently identified from the World Database on Protected Areas (WDPA).

MPA Name	MPA Location	MPA Management Authority	Reference
Great Barrier Reef Marine Park	Australia	GBRMP Authority	Ban and others, 2015
Hinchinbrook Island, Queensland	Australia	The Department of National Parks, Sport and Racing has jurisdiction over the terrestrial system while the Great Barrier Reef Marine Park Authority oversees the aquatic region surrounding the park.	Johnson and others, 2019
Encounter Marine Park	Australia	Government of South Australia Department of Environment and Water*	Clarke and others, 2016
The Jurien Bay Marine Park	Australia	State Department of Biodiversity, Conservation and Attractions	MacNeil and others, 2018
São Miguel Island	Azores, Portugal	Secretaria Regional do Ambiente e do Mar*	Seijo and others, 2021
ICZM Plan for Belize	Belize	Belizean Coastal Zone Management Authority and Institute.	Arkema and others, 2015
Queimada Grande Island	Brazil	Instituto Chico Mendes De Conservação Da Biodiversidade*	Niz and others, 2023
Fernando de Noronha	Brazil	Instituto Chico Mendes De Conservação Da Biodiversidade*	Outeiro and others, 2019

MPA Name	MPA Location	MPA Management Authority	Reference
Extractive Reserve Acaú-Goiana	Brazil	Brazilian regional government	Pinheiro and others, 2021
Área de Proteção Ambiental Costa dos Corais	Brazil	Instituto Chico Mendes De Conservação Da Biodiversidade*	Retka and others, 2019
Santa Cruz Island,	California, USA	The Nature Conservancy and National Park Service	Johnson and others, 2019
Monterey Bay National Marine Sanctuary	California, USA	It is governed by the National Oceanic and Atmospheric Administration (NOAA).	Heck and others, 2022
Pacific Rim National Park, Vancouver Island	Canada	Parks Canada Agency*	Pike and others, 2015
Laurentian Channel MPA	Canada	Fisheries and Oceans Canada*	Muntoni and others, 2019
Basin Head MPA, Prince Edward Island	Canada	Managed by a group of site managers from DFO's Gulf Region Oceans and Habitat Branch, in collaboration with the Basin Head MPA Advisory Board.	Dehens and Fanning, 2018
Musquash Estuary MPA	Canada	Site managers from DFO's Oceans and Coastal Management Division in Dartmouth, Nova Scotia, in collaboration with the Musquash Advisory Committee (MAC).	Dehens & Fanning, 2018
Network of MPAs in St Vincent and the Grenadines.	Caribbean	Government of SVG	Christie and others, 2015
A small coastal islands system	Chile	not mentioned in the paper	Carcamo and others, 2014

MPA Name	MPA Location	MPA Management Authority	Reference
Network of MPAs	Colombia	not mentioned in the paper	Zarate-Barrera and Maldonado, 2015
Seaflower MPA	Colombia	Corporation for the Sustainable Development of the Archipelago of San Andres, Old Providence, and Santa Catalina (CORALINA)	Castano-Isaza and others, 2015
Protected area DRMI Tribugá Gulf and Cabo Corrientes	Colombia	Corporación Autónoma Regional para el Desarrollo Sostenible del Chocó*	Rojas and others, 2019
Santa Rosa National Park, Marino Ballena National Park and Cahuita National Park.	Costa Rica	The National System of Conservation Areas (SINAC in Spanish) is responsible for dictating policies, planning and executing processes for the sustainable management of natural resources.	Maestro and others, 2022
58 Protected Areas	Dinaric Arc region, SE Europe (Albania, Bosnia and Herzegovina, Croatia, Kosovo ¹ , Former Yugoslav Republic Macedonia, Montenegro, Serbia and Slovenia)	not mentioned in the paper	Ivanic and others, 2017
Shark Reef National Marine Park	Fiji	not mentioned in the paper	Campbell, 2016
Cerbère-Banyuls MPA	France	EEA French Ministry in charge of the environment, Ministère de l'Écologie, du Développement durable, des Transports et du Logement (MEDDTL)*	Vilas and others, 2020

MPA Name	MPA Location	MPA Management Authority	Reference
Cerbère-Banyuls Natural Marine Reserve	France	EEA French Ministry in charge of the environment, Ministère de l'Écologie, du Développement durable, des Transports et du Logement (MEDDTL)*	Picone and others, 2020
Saint Martin	French West Indies	Government managed	Pascal and others, 2018
Gili Matra Islands	Indonesia	not mentioned in the paper	Banarsyadhimi and others, 2022
The study focused on all MPAs in Italy	Italy	Managed by different organisations as this is a study of a range of MPAs in Italy	Tonin, 2018
Egadi Islands MPA (Sicily)	Italy	Municipality of Favignana and protection is enforced by the Coast Guard	Picone and others, 2017
Islands of Ventotene and S. Stefano	Italy	Ministero dell'Ambiente e della Tutela del Territorio e del Mare*	Franzese and others, 2017
Punta Campanella	Italy	Ministero dell'Ambiente e della Tutela del Territorio e del Mare*	Buonocore and others, 2020
Bluefields Bay Special Fishery Conservation Area (BBSFCA)	Jamaica	Co-management - Bluefields Bay Fishermen's Friendly Society supported by the Government of Jamaica.	Chan and others, 2019
Mida Creek Marine National Reserve	Kenya	not mentioned in the paper	Owuor and others, 2019
Velondriake LMMA	Madagascar	Velondriake Management Committee	Barnes-Mauthe and others, 2015

MPA Name	MPA Location	MPA Management Authority	Reference
South Ari Atoll Marine Protected Area	Maldives	Government endorses a Code of Conduct within the MPA.	Rasheed and Abdulla, 2020
Żona fil-Baħar bejn il-Ponta ta' San Dimitri (Għawdex) u Il-Qaliet MPA	Malta	not mentioned in the paper	Tyllianakis, 2022
Puerto Morelos reef marine protected area	Mexico	Was the local community - now the government	Rodriguez-Martinez, 2008
Akaroa Harbour and Koukourarata/Port Levy	New Zealand	Department of Conservation*	Chhun, 2013
Cape Rodney-Okakari Point Marine Reserve and the Whanganui A Hei Marine Reserve	New Zealand	Department of Conservation*	Geange and others, 2019
Banks Peninsula Marine Reserve; Whagarei Harbour, Poor Knights Islands; Te Angiangi; Piopiothani,	New Zealand	NZ Government	Van den Belt and Cole, 2014
Northwestern Mediterranean multi-zone MPAs (Cerbère-Banyuls, Cap de Creus and Medes Islands)	Northwestern Mediterranean	Ministère de l'Écologie, du Développement durable, des Transports et du Logement (MEDDTL); Ministerio de Agricultura, Alimentación y Medio Ambiente (Spain); Generalitat de Catalunya*	Corrales and others, 2020
Muluk, Wadau and Ahus (coastal communities not MPAs)	Papua New Guinea	Clan leaders	Lau and others, 2019
Reserva Marina Tres Palmas	Puerto Rico	not mentioned in the paper	Nelsen and Richter (date unknown)
Arrábida Natural Park	Portugal	Park Managers	Lopes & Videira, 2019

MPA Name	MPA Location	MPA Management Authority	Reference
Litoral Norte MPA	Portugal	A steering committee which has executive power and an advisory council.	Garcia Rodrigues and others, 2022
Arrabida Natural Park	Portugal	Nature conservation authorities	Garcia Rodrigues and others, 2024
Vanuata	South Pacific	Community-based MPA	Pascal and others, 2018
Cap de Creus and Medes Islands MPAs	Spain	Ministerio de Agricultura, Alimentacion y Medio Ambiente (Spain); Generalitat de Catalunya*	Vilas and others, 2020
No specific MPA named, but the focus is on the MPAs of Sweden	Sweden	not mentioned in the paper	Belgrano and others, 2021
Mnazi Bay-Ruvuma Estuary Marine Park	Tanzania	Tanzania's Marine Parks and Reserves Unit.	Baker and others, 2021
Argyll & Bute Region (multiple MPAs)	UK	not mentioned in the paper	Spanou and others, 2020
Area of Outstanding Natural Beauty in Chichester Harbour	UK	not mentioned in the paper	Pike and others, 2015
Dogger Bank	UK	Transnational Dogger Bank Steering Group	Borger and others, 2014
Poole Harbour	UK	not mentioned in the paper	Burton, 2020
Lyme Bay	UK	not mentioned in the paper	Gallacher and others, 2016
Lyme Bay	UK	not mentioned in the paper	Rees and others, 2015

MPA Name	MPA Location	MPA Management Authority	Reference
Devon and Severn Area	UK	not mentioned in the paper	Gall and Rodwell, 2016
North Devon Marine Pioneer	UK	not mentioned in the paper	Rees and others, 2020
Kingmere MCZ and Beachy Head West MCZ	UK	Inshore Fishery and Conservation Authorities (Sussex IFCA)	Ranger and others, 2016
Flamborough Head MPA	UK	Flamborough Head Management Group	Paltriguera and others, 2018
Deben Estuary SSSI	UK	Deben Estuary Partnership	Burdon and others, 2022
Southwest Marine Plan Area	UK	not mentioned in the paper	Tyllianakis, 2020
Hawaii	United States	not mentioned in the paper	Bremer and others, 2015
Los Roques National Park	Venezuela	National Parks Institute (INPARQUES), with an on-site superintendent	Cavada-Blanco, 2021
Cerbère-Banyuls-sur-Mer MPA; Cap de Creus MPA; LLevant de Mallorca-Cala Rajada MPA; Islas Columbretes MPA; Nord de Menorca MPA; Cabo de Palos-Islas Hormigas MPA; Tabarca MPA; Cabo de Gata-Níjar MPA	Western Mediterranean	Ministère de l'Écologie; Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente; ?; Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente*	Marcos and others, 2021

Annex 4: Valuation Method Descriptions

The following table provides a summary of the methods used to assess the different value domains and example reference(s) which have applied the method.

Value Domain	Method	Description	Example Reference(s)
Ecological	Biophysical Modelling	Modelling of biological and physical components of the system, e.g. using the ECOPATH model, to assess how food-webs may change under different levels of MPA protection.	Vilas and others, 2020; Piccone and others, 2017
Ecological	Stakeholder Mapping / Interviews / Scoring	Engaging stakeholders, using a range of methods, to generate place-based ecological values generated from local knowledge.	Burdon and others, 2022; Geange and others, 2019; Chan, 2017; Lopez and Videira, 2016; Ruiz-Frau and others, 2015.
Ecological	Biophysical indicators	Indicators can be identified and populated to show changes in state, trajectory and behaviour of biophysical attributes over time.	Gallagher and others, 2016; Arkema and others 2015.
Ecological	Field sampling / Habitat Mapping	Collection of primary ecological data from field sampling or habitat mapping.	Niz and others, 2023; Picone and others, 2020
Economic	Benefit transfer	Uses primary valuation research results from one area (the study site) to make secondary predictions about values at a different area (the policy site).	Brander and others, 2020; Marcos and others, 2021; Pascal and others, 2018; Van den Belt and Cole, 2014.
Economic	Discrete Choice Experiment	Uses experiments to reveal factors that influence choice. Discrete choice models assume the respondent	Pakalnite and others, 2021; Owuor and others, 2019; Tyllianakis, 2022; Paltriguera and others,

Value Domain	Method	Description	Example Reference(s)
		has perfect discrimination capability.	2018; Christie and others, 2015; Jobstvogt and others, 2014; Börger and others, 2014; Chhun, 2013.
Economic	Contingent Valuation Method	Creates a hypothetical market by direct surveying of a sample of individuals and aggregation to encompass the relevant population.	Castano-Isaza and others, 2015; Tonin, 2018.
Economic	Travel Cost	Cost incurred in reaching a recreation site as a proxy for the value of recreation.	Jobstvogt and others, 2014; Niccolini and others, 2019.
Economic	Stakeholder Scoring	Engaging stakeholders, using a range of methods, to score the economic value of societal benefits.	Seijo, 2021
Economic	Market Values	Where market prices of outputs (and inputs) are available. Could approximate with the market price of a close substitute. May require shadow pricing where prices do not reflect social valuations.	Rojas and others, 2019.
Economic	Emergy	Emergy accounting is an environmental accounting method measuring the cumulative environmental support to a process.	Franzese and others, 2017; Picone and others, 2017; Buonocore and others, 2020.
Economic	Hedonic Pricing	Estimates willingness to pay using price differentials and characteristics of related	Spanou and others, 2020; Banarsyadhimi and others, 2022.

Value Domain	Method	Description	Example Reference(s)
		products e.g. property (housing, hotels, land).	
Socio-Cultural	Wellbeing Indicators	Indicators in wellbeing are used to measure how healthy and happy people are. These indicators can include measures of life satisfaction, finances, health, housing, human rights and relationships.	Rodriguez and others, 2022; Banarsyadhimi and others, 2022; Spanou and others, 2020
Socio-Cultural	Participatory Mapping	The gathering and mapping of spatial information to help communities learn, discuss, build consensus, and make decisions about their communities and associated natural resources.	Burdon and others, 2022; Pinheiro and others, 2021; Sagoe and others, 2021.
Socio-Cultural	Questionnaires / Interviews	Use of questionnaires and/or interviews to assess cultural ecosystem services based on stakeholder opinion.	Baker and others, 2021; Barnes-Mauthe and others, 2015; Outeiro and others, 2019; Dehens and Fanning, 2018; Chhun, 2013; Seijo, 2021; Niz and others, 2023.
Socio-Cultural	Literature Review / Benefit Transfer	Uses primary valuation research results from one area (the study site) to make secondary predictions about values at a different area (the policy site).	Buonocore and others, 2020
Socio-Cultural	Q method	Provides insights into the range of opinions that exist about some issues within a sample population, and how those opinions differ and converge. It turns	Pike and others, 2015

Value Domain	Method	Description	Example Reference(s)
		qualitative deliberations with individuals into quantitative data.	
Socio-Cultural	Stakeholder Scoring	Engaging stakeholders, using a range of methods, to generate a score socio-cultural value.	Banarsyadhimi and others, 2022; Lopez and Videira, 2016.
Socio-Cultural	Photo Analysis	Categorisation and analysis of photographs from social media into a series of themes in relation to socio-cultural values.	Retka and others, 2019; Erskine and others, 2021.
Socio-Cultural	Community Voice	A participatory method which uses filmmaking to engage stakeholders to foster more inclusive, informed, and ongoing social dialogue in local communities.	Ranger and others, 2016

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