Marine Coastal Ecosystems Biodiversity and Services in a Changing World

MaCoBioS

Grant Agreement No 869710

Deliverable 4.2

Stakeholders' concerns and expectations regarding climate change

WP 4 – Policy formulation

Lead beneficiary: University of Portsmouth – Deliverable beneficiary: University of Exeter

Due date of deliverable	Month 36 (May 2023)	
Actual delivery date	24th May 2023	
Revision number	02	
Revision submission date	21st November 2023	
Document status	Accepted by the EC	
Dissemination level	Public	
Role	Name	Organisation
Author/WP4-Task 4.2 contributor	Bethan O'Leary	University of Exeter (UNEXE)
Author/WP4-Task 4.2 contributor	Catarina Fonseca	Fundação Gaspar Frutuoso (FGF)
Author/WP4-Task 4.2 contributor	Louisa Wood	University of Portsmouth (UoP)
Author/WP4-Task 4.2 contributor	Torsten Krause	Lunds Universitet (ULUND)
Author/WP4-Task 4.2 contributor	Fabiola Espinoza Córdova	Lunds Universitet (ULUND)
Author/WP4-Task 4.2 contributor	Gianluca Ferraro	University of Portsmouth (UoP)
Author/WP4-Task 4.2 Leader	Callum Roberts	University of Exeter (UNEXE)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Role	Name	Organisation
Author/WP4 Leader	Pierre Failler	University of Portsmouth (UoP)
Author/WP4-Task 4.2 contributor	Julie Hawkins	University of Exeter (UNEXE)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Table of contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

1. Introduction

1.1 Overall context

Hundreds of millions of people worldwide rely on marine and coastal ecosystems for their food, livelihoods and ways of life, yet these ecosystems are subject to a variety of cumulative direct and indirect pressures (UNEP 2006, Hoegh-Guldberg 2015, IPBES 2019, Korpinen et al. 2019, WEF 2022). These pressures include climate change - one of the most urgent challenges society is currently facing (IPCC 2022), with "long-lasting or irreversible" adverse consequences for people and nature predicted as a result (IPCC 2018). Continuing ocean ecosystem services is reliant on healthy marine and coastal ecosystems and ensuring sustainable management, better use and protection of such valuable ecosystems is therefore critical (IPBES 2019).

Policy-makers are increasingly aware of the adverse effects climate change and environmental degradation have for our coasts and oceans (IPBES 2019, IPCC 2022, WEF 2022). Coupled with this, significant efforts have been made in recent years to raise public awareness of climate change and links between healthy marine and coastal ecosystems and ecosystem service provision, including their role in mitigating and adapting to climate change (e.g. Barracosa et al. 2019). However, available data on public perceptions on the interlinked effects of climate change, human impacts and the value and management of marine and coastal ecosystems are rare. Instead, most efforts have addressed climate change perceptions (Mildenberger et al. 2019, van Valkengoed et al. 2022) and marine threats perceptions (Lotze et al. 2018, Ankamah-Yeboah et al. 2020), separately.

Understanding stakeholder perspectives on climate change is critical as nations around the world raise ambitions for policy interventions that support climate change mitigation and adaptation, such as Nature-based Solutions (NBS). In environmental decision-making, a stakeholder can be defined as "*any group, organization or individual having a stake, interest, or who can affect a biological or physical resource, ecosystem service, institution or social system, or someone who is or may be affected by a public policy*" (Felipe-Lucia et al. 2015). Stakeholders relevant to marine and coastal management decision-making therefore consist of citizens and other non-state actors (such as NGOs, sectoral associations and industries) interested in or affected by a public decision, together with governmental organisations (such as elected representatives, national agencies and subnational governments) (Dietz and Stern 2008, Thomas 2012). Because the views of citizens and non-state actors can influence decision-making and steer future actions (Rasmussen et al. 2018, Schaffer et al. 2022) as well as the success of interventions (e.g. Ferreira et al. 2020), it is crucial to understand views from across a breadth of stakeholders.

1.2 Stakeholder dialogue in MaCoBioS

To gather stakeholders' feedback about their concerns facing the effects of climate change and the possible solutions that could emerge to mitigate and adapt, MaCoBioS initiated dialogue with representatives of stakeholder groups identified in Deliverable 4.1: 'Review report on Nature-Based Solutions stakeholders and policy' as well as others, including public citizens. These discussions were designed to inform MaCoBioS' work on integrated management and conservation strategies for marine and coastal ecosystems to face climate change. This report summarises the findings from this dialogue at the time of publication (May 2023), however stakeholder dialogue will continue for the duration of MaCoBioS.

Stakeholder dialogue was designed to ensure that any work undertaken and outputs produced by MaCoBioS, were based on different perspectives, standpoints and interests thereby increasing their relevance and utility. Dialogue within MaCoBioS covered a wide spectrum of forms and levels of engagement conducted in different settings, with different stakeholder groups and for different

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

reasons. MaCoBioS established a dialogue with stakeholders at the international, national and local level. Additionally, MaCoBioS worked with partners (e.g. FutureMARES https://futuremares.eu, NetworkNature https://networknature.eu/, REST-COAST https://rest-coast.eu/) aligning goals according to a shared set of research priorities (O'Leary et al. 2023). A variety of engagement channels were used by MaCoBioS to try to involve and communicate with stakeholders meaningfully (Table 1; also see Deliverable 5.2: 'Best practices in stakeholder engagement' for more information on these). Through these, MaCoBioS aimed to develop a deeper understanding of stakeholder concerns and expectations of climate change, levels of support for policy instruments such as NBS, and policy-maker and practitioner evidence needs for implementing NBS in marine and coastal ecosystems.

Table 1. *Engagement channels used within MaCoBioS.*

Channel
• Online engagement and communication (multi-level stakeholder platform, social media) • Workshops • Interviews and focus groups • Informal discussions • Online survey • Events

There is no doubt that urgent policy action is needed to address climate, biodiversity and sustainable development goals, and NBS could offer a valuable way to support the achievement of these multiple goals simultaneously (O'Leary, Fonseca et al. 2023). In this context, stakeholder dialogue aimed to generate sustained discussions to enable collaborative action among diverse stakeholders across the MaCoBioS ecoregions with the explicit aim of generating evidence that informs transformational change in the implementation of marine and coastal NBS for the benefit of society. MaCoBioS therefore used multi-level stakeholder dialogue to identify and address the barriers faced by stakeholders to effective marine and coastal NBS implementation by integrating feedback across sectors and providing for knowledge exchange between MaCoBioS and stakeholders to ultimately generate new levels of enduring outcome and impact.

Stakeholder dialogue was structured to inform future efforts to develop a theory of change for how and why an intervention (in this case a NBS) is expected to achieve its intended outcomes and goal. The purpose of a theory of change is to: facilitate intervention design as well as collaboration and communication of shared goals; define what activities should be applied and the process of change (causal pathway) expected to arise from these activities; clearly articulate the assumptions underlying causal pathways; and to act as a tool for monitoring and evaluation (Taplin et al. 2013). As MaCoBioS is not directly involved in the implementation of any interventions, it is not relevant to design an operational theory of change for NBS implementation. Instead, stakeholder dialogue was designed to help identify preconditions to promote social and institutional change and opportunities (for instance through the future use of the Nudge theory (e.g. Mackay et al. 2018, Kuehnhanss 2019, Fulton 2021) to encourage sound decisions for the mutual interest of society and environment in the context of climate change mitigation and adaptation. Nonetheless, stakeholder dialogue was conducted under the implicit theory of change that supporting effective stakeholder engagement and building the capacity of stakeholder groups to understand, identify and effectively communicate about climate change mitigation and adaptation strategies, including NBS, will have a positive impact on the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

attainment of socially desirable outcomes from future decision-making in marine and coastal management.

1.3 Objectives of this report

Understanding stakeholder perceptions of climate change, the value of marine and coastal ecosystems and the threats facing them, and potential management options is essential to ensure effective policy advice in line with environmental protection and social objectives. It will also, ultimately, be key to the successful implementation of NBS and other climate change mitigation and adaptation strategies.

This report aims to synthesise concerns and expected solutions to mitigate and adapt to climate change brought up by the stakeholders dialogue. In particular, this report summarises the findings from an online survey conducted to better understand public perceptions of climate change, human impacts and the value and management of marine and coastal ecosystems. Descriptions of the barriers to, and enablers of, NBS uptake and implementation in marine and coastal ecosystems identified by faced by policy-makers and practitioners and obtained from more in-depth engagement activities are then provided. Finally, this report concludes by summarising stakeholder concerns and expectations for climate change and environmental management, and policy-maker and practitioner evidence needs for implementing NBS in marine and coastal ecosystems.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

2. Public awareness of climate change, its effects and solutions in marine and coastal environments

To better understand public perception of climate change, human impacts and the value and management of marine and coastal ecosystems a self-administered online survey was conducted between November 2021 and February 2022. The survey was released in four languages (English, French, Spanish and Italian, the languages of MaCoBioS) and comprised 20 questions across four main parts: (1) perceptions about climate change; (2) perceptions about the value of, and threats to, coasts, oceans and their wildlife; (3) perceptions about climate change responses; and (4) socio-demographic information.

The survey targeted individuals interested in marine and coastal ecosystems, climate change and ecosystem management. In particular, it aimed to target those stakeholders who mostly interact with marine and coastal ecosystems in one of the following ways: (1) tourism and/or recreation; (2) conservation, management and/or scientific advice; and (3) fishing and/or seafood production.

Results from this survey represent the opinion of the 709 respondents from 42 countries who chose to complete it. Only results from the MaCoBioS Case Studies and questions asked relevant to stakeholder concerns and expectations are reported here. Full details of the survey design, methodology, and resulting dataset are presented in Fonseca et al. (2023); results from the full dataset are summarised in Figure 1. Respondents represent all of the MaCoBioS ecoregions and Case Studies (Western Mediterranean [France, Italy, Spain], Northern Europe [Ireland, Norway, UK], and Lesser Antilles [Barbados, Bonaire, Martinique]) with 576 respondents from these Case Studies (Figure 2).

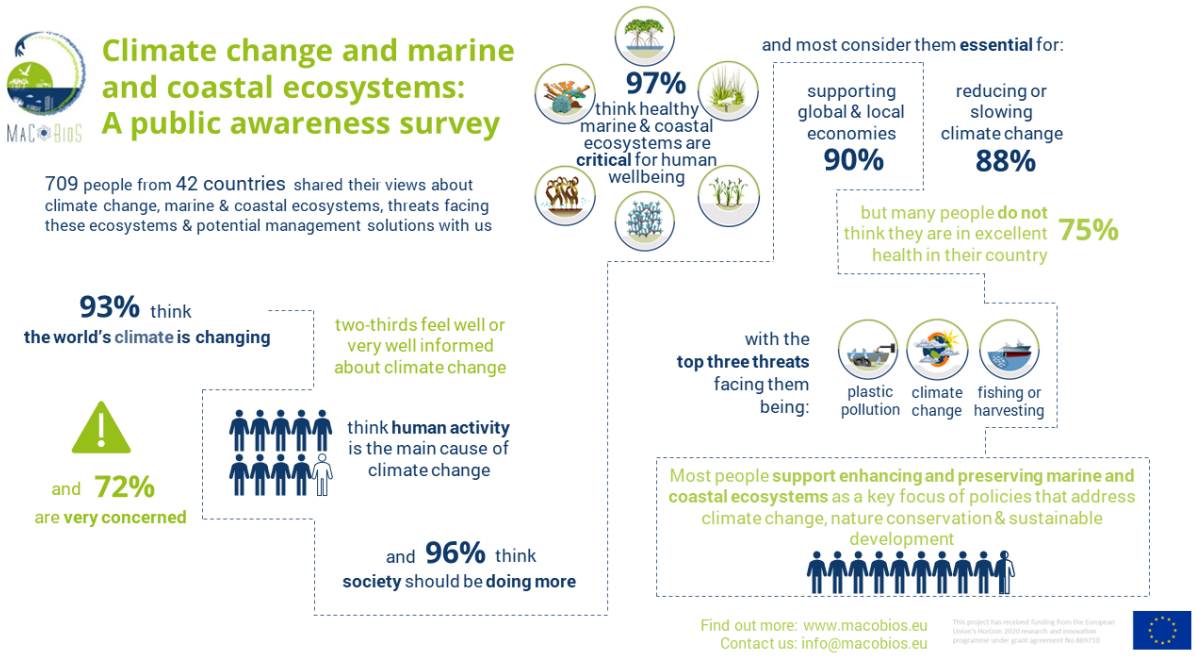


Figure 1. *Summary of results from all survey respondents (n=709).*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

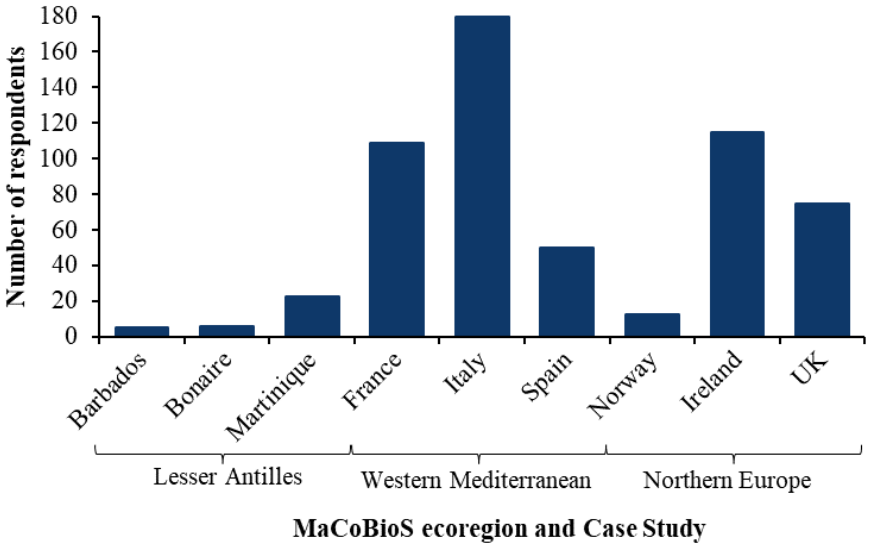


Figure 2. *Number of respondents from MaCoBioS ecoregions and Case Studies (n=576).*

2.1 Stakeholder knowledge of climate change and perceptions of the marine environment

2.1.1 Awareness of climate change

Climate change can be a polarising issue (van Eck et al. 2020), however respondents overwhelmingly agreed that the world's climate is changing and that it is caused by human activities in all Case Studies (Figure 3 and Figure 4). Overall, 92.9% of respondents from all Case Studies reported that climate was "*definitely changing*" and 6.8% "*probably changing*". No respondents thought climate was "*definitely*" or "*probably not changing*". The majority (64.2%) of respondents considered that the cause of climate change was "*mainly human activity*". 26.4% of respondents answered that climate change was caused by "*entirely human activity*"; 8.3% "*about equally natural processes and human activity*". Only 1.1% of respondents agreed that the cause of climate change was "*mainly*" or "*entirely*" natural processes.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

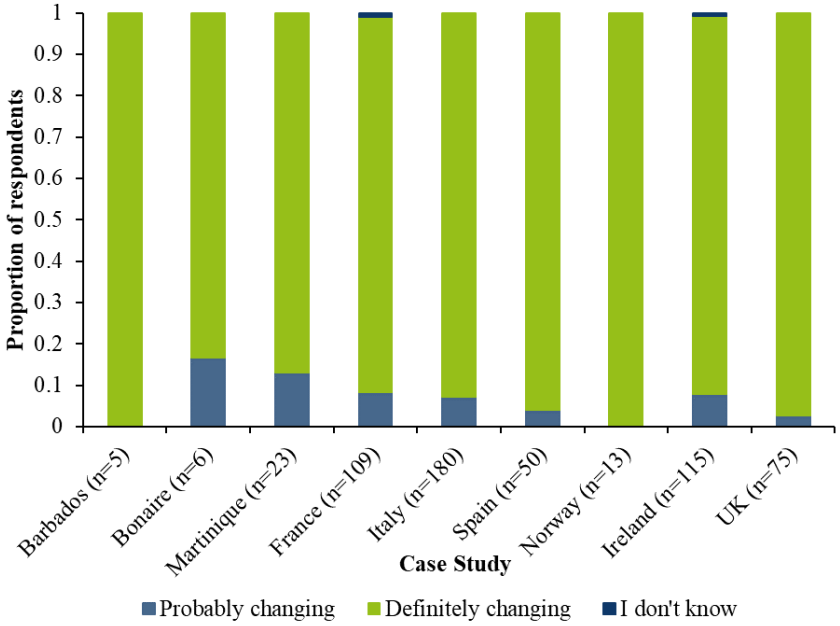


Figure 3. *Summary of responses to the question 'do you think the world's climate is changing?' (proportion of total respondents per Case Study). No respondents agreed with the statements that the world's climate is 'definitely not' or 'probably not' changing.*

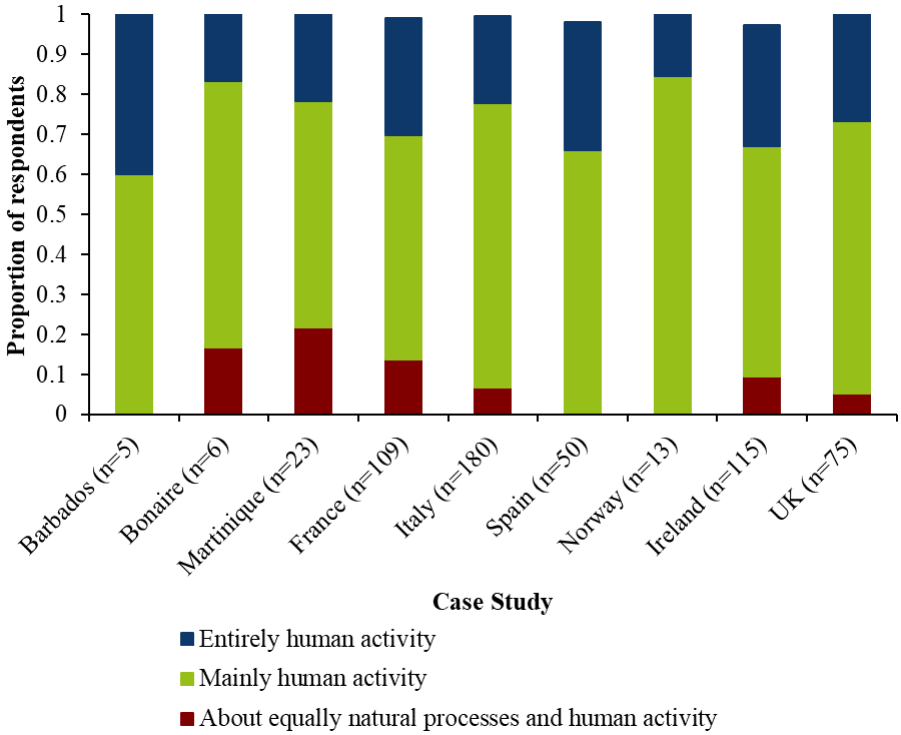


Figure 4. *Summary of responses to the question 'based on your understanding, which of the following best describes what is most responsible for causing climate change?' (proportion of total respondents per Case Study). No respondents answered: 'I don't know', 'I don't think climate change is happening', 'Entirely natural processes', or 'Mainly natural processes'.*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

For the most part, respondents reported feeling "*somewhat*" (27.4%), "*well*" (44.3%), or "*very well*" (18.9%) informed about climate change. However, 9.4% of all respondents said they felt "*not well informed*", "*not at all informed*", or that they didn't know. The fact that some respondents deem it likely but not certain that climate is changing, are unsure that human activities are the main cause of climate change, and that a substantial number of respondents consider themselves only somewhat or ill informed suggests that continued efforts to share the climate change evidence base are still needed.

2.1.2 Perceived value of marine and coastal ecosystems

Overall, respondents perceived marine and coastal ecosystems as: being critical for human well-being (97%); having a major influence on weather and climate (91%); and as being essential for reducing or slowing climate change (88%) and supporting global and local economies (89%) (Figure 5). These views were common for the majority of respondents for all Case Studies, however, disagreements were reported for each statement particularly for those countries with greater sample sizes (e.g. France, Italy, Ireland, UK), likely reflecting the greater diversity of respondents captured by the survey.

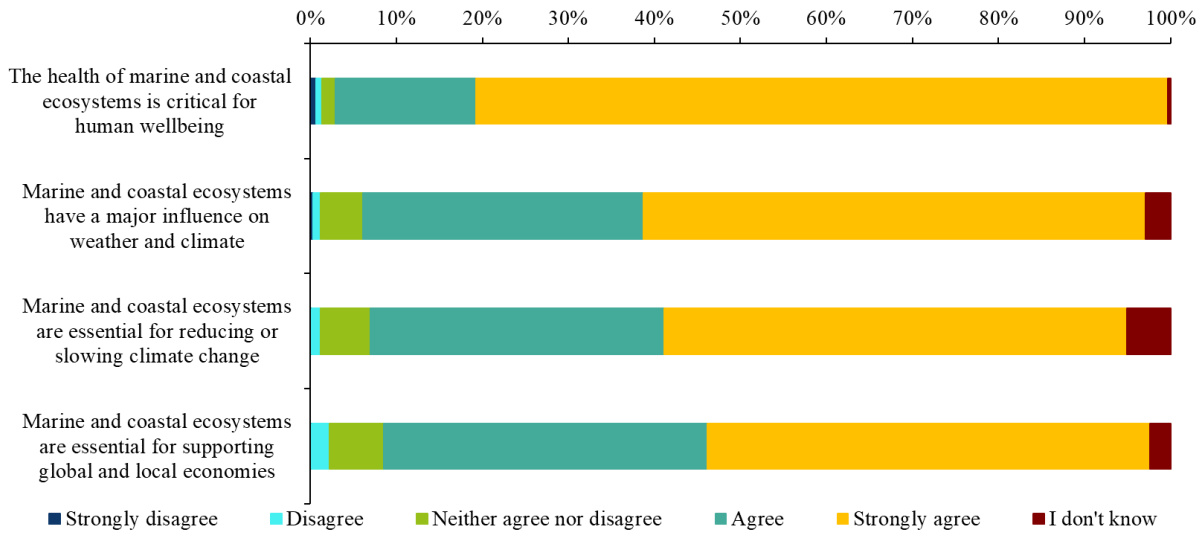


Figure 5. *Perceived value of marine and coastal ecosystems across all Case Studies (percentage of all respondents, n=576). Respondents were asked to what extent they agreed or disagreed with these statements.*

Respondents were asked to select the three most important benefits provided by marine and coastal ecosystems that people in their country gain from the coast and oceans, including their wildlife. Most frequently selected were "*food*" (19.2%), "*recreation and tourism*" (18.8%), and "*places to support diverse marine plants and animals*" (14.6%) across all Case Studies (Figure 6), although benefits did vary by Case Study (Figure 7). Other benefits that people specified were oxygen production, CO_2 capture, employment and contribution to ecosystem services. One respondent highlighted the importance of systems thinking, stating: "*The ocean is a "system" that connects and provides. It provides sustenance for Life on the planet: it distributes heat, provides water, oxygen, food, captures CO_2, etc., connects cultures and can be conferred from economic to sacred value, all in an interconnected and indivisible way.*"

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

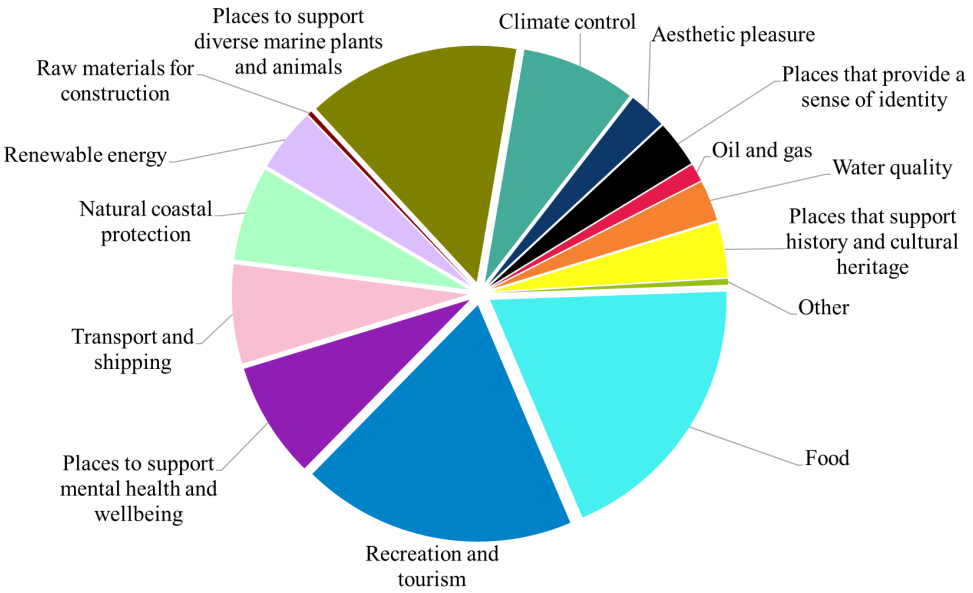


Figure 6. *Perceived benefits of marine and coastal ecosystems. Percentage of respondents (n=576) selecting each benefit from a list of potential benefits offered in response to the question "In your opinion, what are the three most important benefits that people in your country gain from the coast and oceans, including their wildlife?".*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

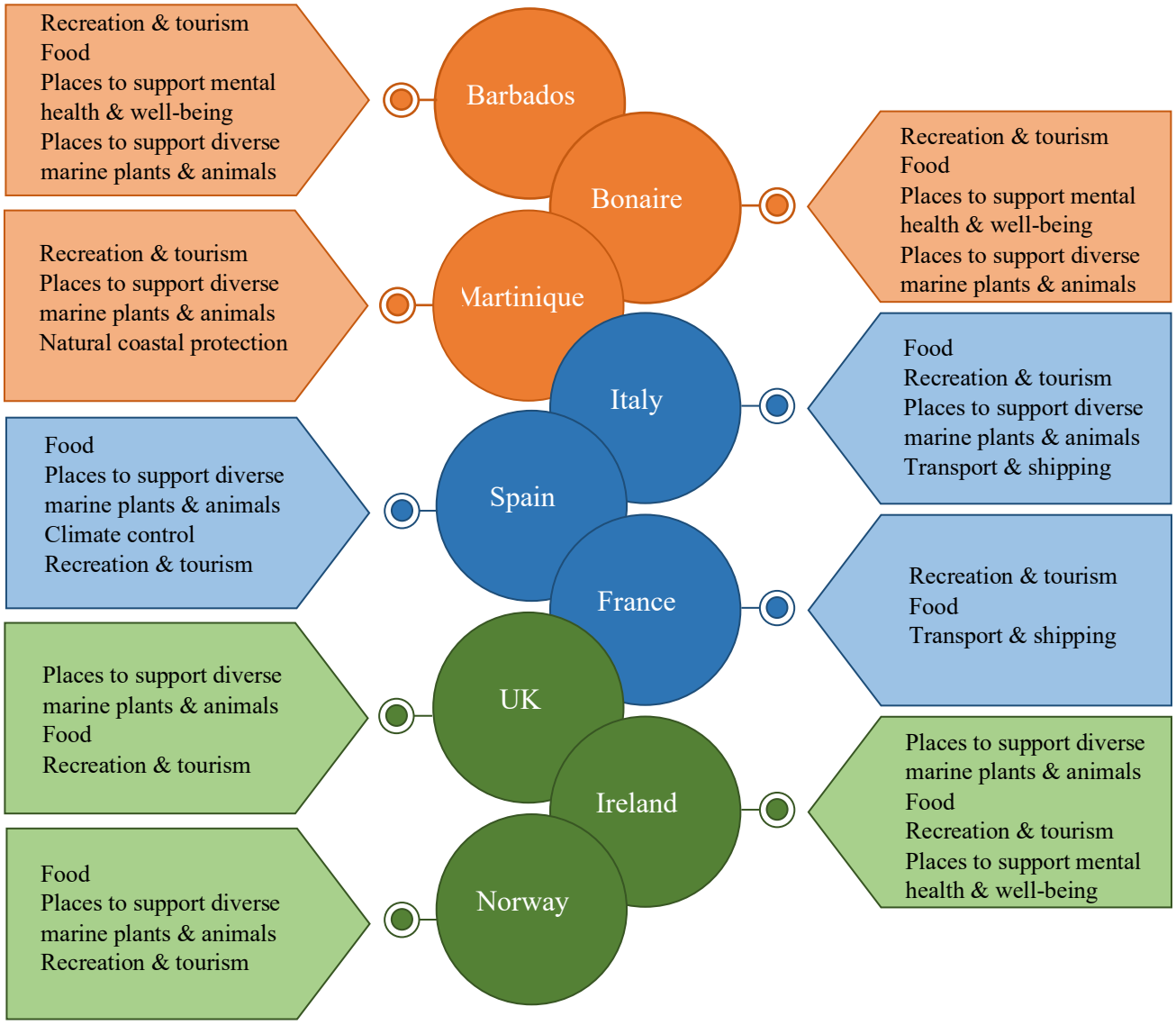


Figure 7. *Top three perceived benefits by Case Study. Where more than one benefit is listed per ranking it was equally selected by respondents. Respondents were asked "In your opinion, what are the three most important benefits that people in your country gain from the coast and oceans, including their wildlife?" and provided a list of fourteen potential benefits and the option of specifying one other benefit not on the list.*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

2.2 Stakeholder concerns regarding climate change and marine and coastal ecosystems

2.2.1 Perceived concern regarding climate change

Levels of concern about climate change were high across all MaCoBioS Case Studies with 70.1% of respondents stating that they were "*very concerned*" and 25.5% "*somewhat concerned*". Concern was highest in the Northern European ecoregion, with more than 80% of respondents from these Case Studies (Norway [85%], UK [84%], Ireland [80%]) reporting they were "*very concerned*" (Figure 8). Other Case Studies reporting high levels of concern were Barbados (80% of respondents were "*very concerned*"), Bonaire (93%), and Spain (80%). Respondents reporting that they were "*not at all concerned*" were from Bonaire (17%), Spain (2%) and Ireland (1%). Only two respondents from Italy answered that they did not know how concerned they were.

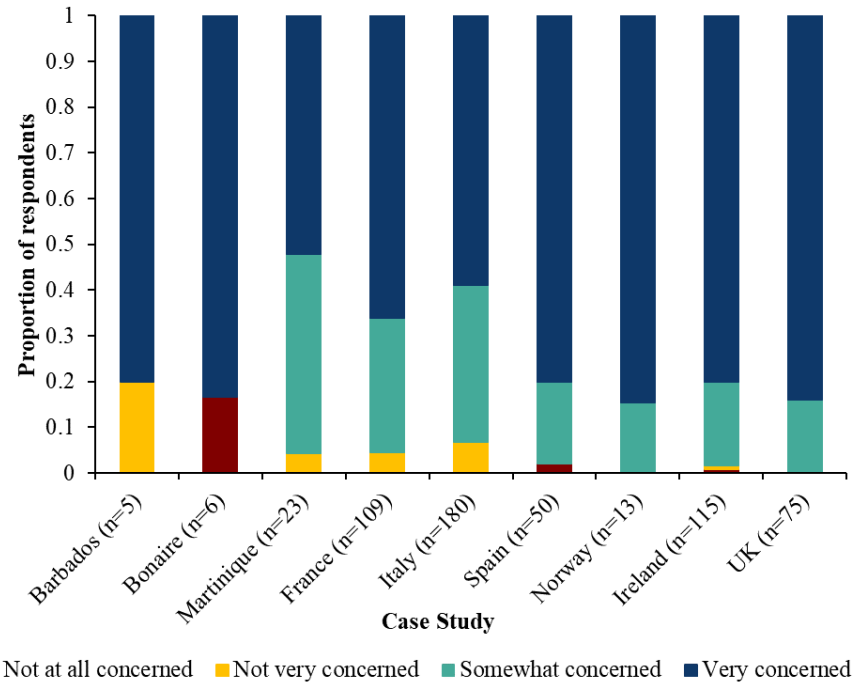


Figure 8. *Level of concern about climate change by Case Study (proportion of total respondents per Case Study)*

While respondents in all Case Studies clearly felt that the negative effects of climate change would be important within their lifetimes, they reported feeling more strongly that it would hurt future generations (Figure 9). Overall, 74.7% of respondents agreed or strongly agreed that climate change will harm them personally in their lifetime however this increased to 95.7% when asked whether climate change would hurt future generations.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

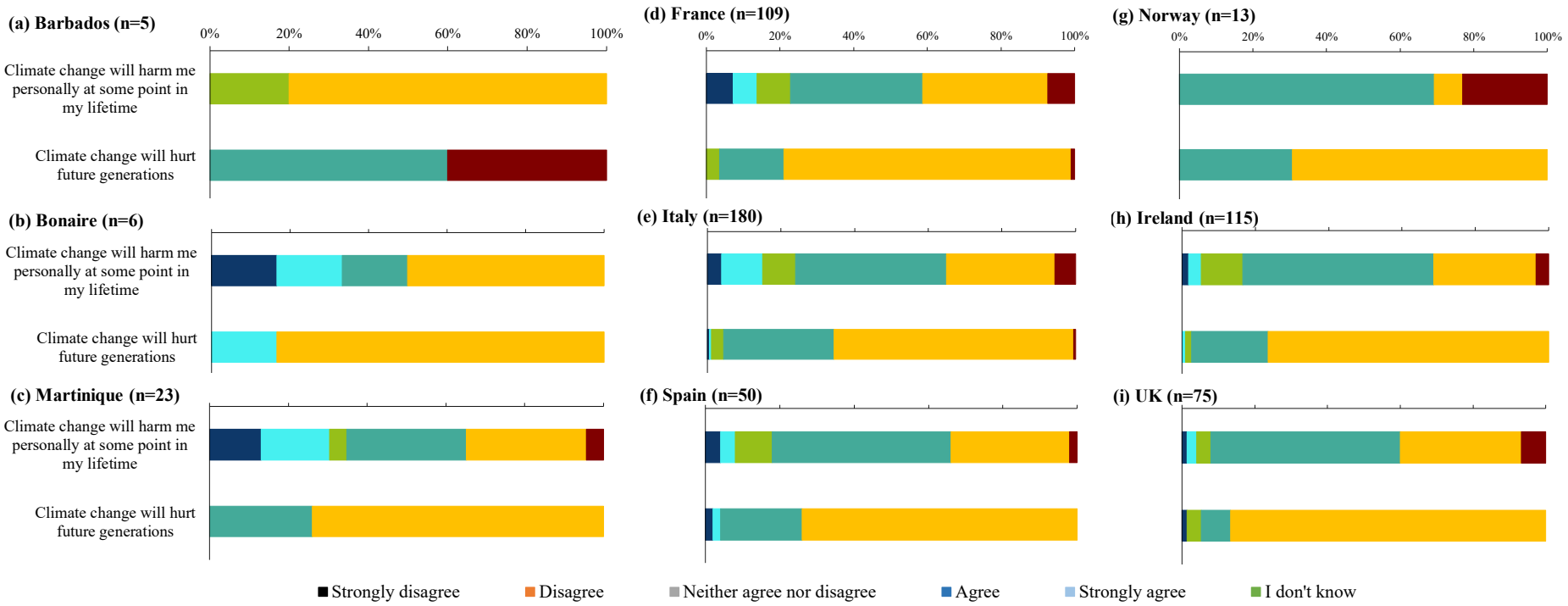


Figure 9. *Perceived impact of climate change on people today vs future generations by Case Study (% of respondents).*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

2.2.2 Perception of threats facing marine and coastal ecosystems

Respondents ranked "*plastic pollution*", "*climate change*", and "*fishing / harvesting of marine and / or coastal life*" as being the top three threats to marine and coastal ecosystems in their country (Figure 10). This concurs with results from previous perception surveys on marine threats (e.g. Lotze, Guest et al. 2018). Climate change featured as a top three threat to marine and coastal ecosystems in all Case Studies apart from Bonaire (Figure 11). However, perceived severity of threat did change between Case Studies suggesting that local context is important to consider when designing interventions such as NBS to address stakeholder's concerns.

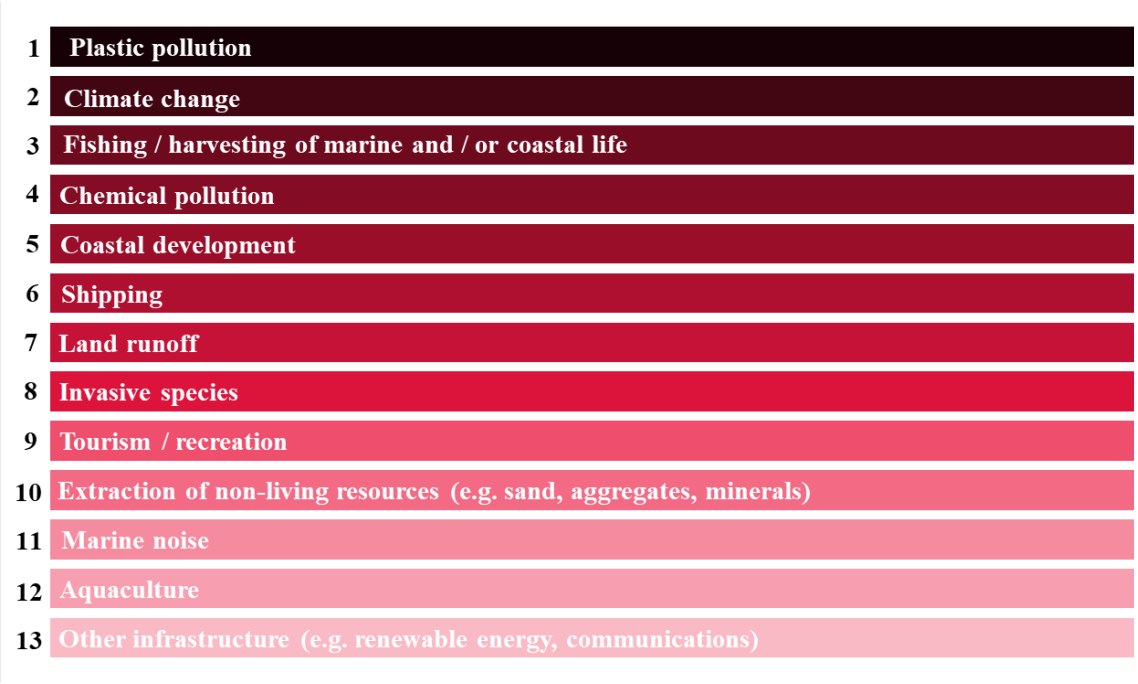


Figure 10. *Thirteen threats ranked by severity of threat to marine and coastal ecosystems. Respondents were asked to rate these threats from "very low" to "very high" according to their severity for marine and coastal ecosystems in the country they live in. Rankings are based on the number of respondents that reported threats as being "high" or "very high".*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Lesser Antilles	**Bonaire** 1. Plastic pollution 1. Coastal development 1. Land runoff	**Barbados** 1. Coastal development 2. Fishing/harvesting of marine and/or coastal life 2. Plastic pollution 2. Climate change 2. Land runoff 2. Chemical pollution	**Martinique** 1. Plastic pollution 2. Climate change 3. Chemical pollution
Western Mediterranean	**France** 1. Plastic pollution 2. Climate change 3. Coastal development	**Italy** 1. Plastic pollution 2. Climate change 3. Chemical pollution	**Spain** 1. Plastic pollution 2. Climate change 3. Coastal development
Northern Europe	**Norway** 1. Climate change 2. Aquaculture 2. Invasive species	**Ireland** 1. Climate change 2. Fishing/harvesting of marine and/or coastal life 3. Plastic pollution	**UK** 1. Climate change 2. Plastic pollution 3. Fishing/harvesting of marine and/or coastal life

Figure 11. *Top three threats to marine and coastal ecosystems respondents identified by Case Study. Numbers refer to ranked position amongst all threats provided. Where more than one threat is listed per ranking it was equally selected by respondents.*

Across all Case Studies, 75% of respondents disagreed or strongly disagreed with the statement "*marine and coastal ecosystems are in excellent health in your country*", and 81% felt that climate change is causing irrevocable damage to marine and coastal ecosystems in their country (based on those respondents who agreed or strongly agreed with these statements) (Figure 12). Less than 1% of respondents felt that the oceans are too large for humans to cause lasting damage, instead 96.9% of respondents disagreed or strongly disagreed with this statement. No pattern was observed amongst those that felt the oceans were too large for humans to cause lasting damage – they were distributed across five out of the nine MaCoBioS Case Studies and across all ecoregions.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

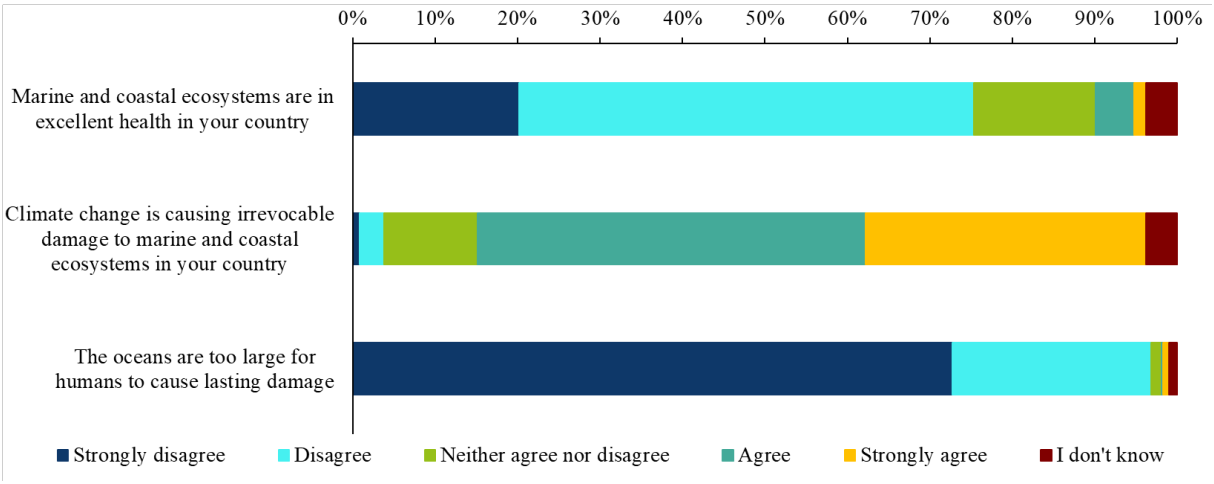


Figure 12. *Perceived status of marine and coastal ecosystems and the impact of climate change and other threats across all Case Studies (percentage of all respondents, n=576). Respondents were asked to what extent they agreed or disagreed with these statements.*

Respondents most frequently selected "*changes in the frequency of extreme weather events*" (17.3%), "*sea level rise*" (15.4%) and "*coastal erosion*" (13.2%) as the effects of climate change on coasts, oceans and marine wildlife that concerned them the most in their country (Figure 13). Perceived concerns varied by Case Study likely reflecting the different experiences of climate change in each place and uses and awareness of marine and coastal spaces (Figure 14).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

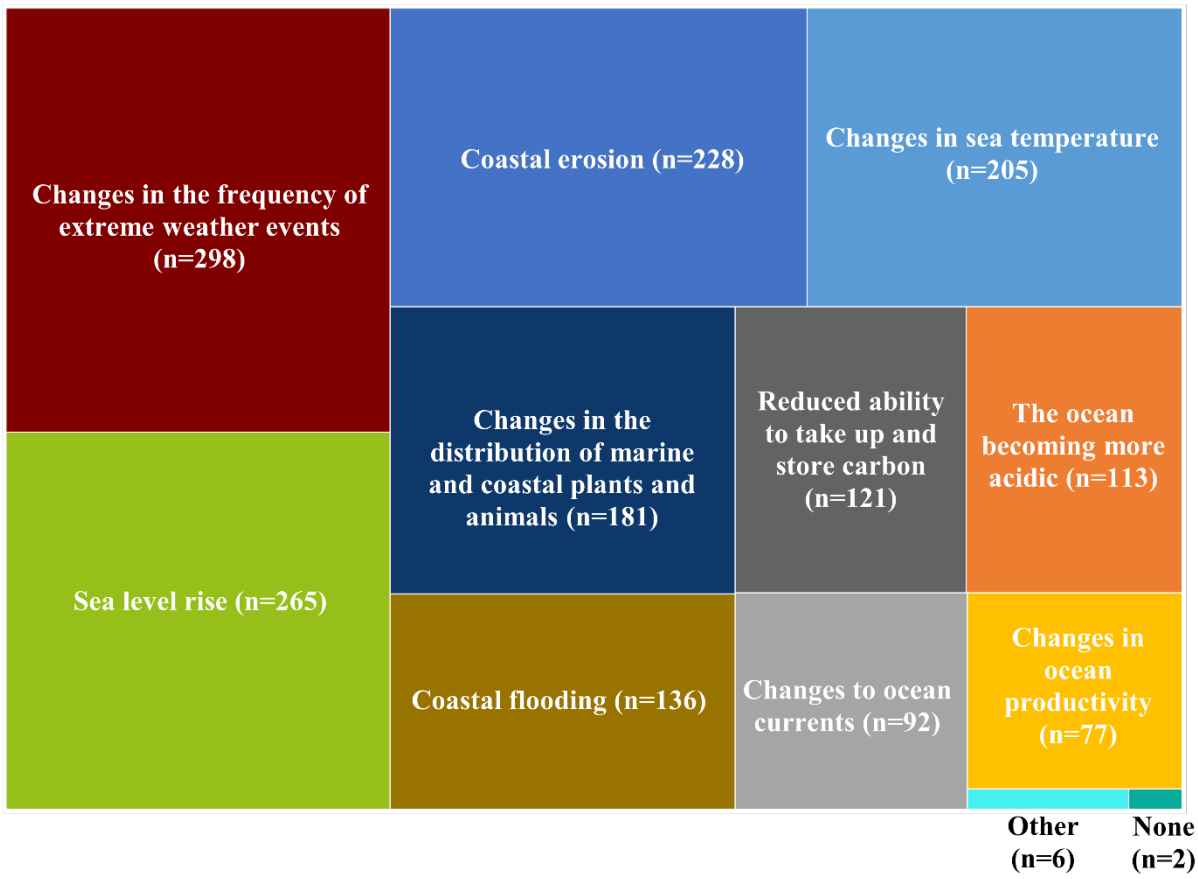


Figure 13. *Frequency by which respondents selected provided effects of climate change according to their level of concern.*

	Bonaire (n=5)	Barbados (n=6)	Martinique (n=23)	France (n=109)	Italy (n=180)	Spain (n=50)	Norway (n=13)	Ireland (n=115)	UK (n=75)
Changes in the frequency of extreme weather events	1	1	3	1	1	1		1	2
Sea level rise	2	3	2	3	1	2		2	1
Coastal erosion		2	1	2	2			3	
Changes in sea temperature	2	3				3	2		
Changes in the distribution of marine and coastal plants and		3					3		
Changes in ocean productivity							1		
Coastal flooding									3

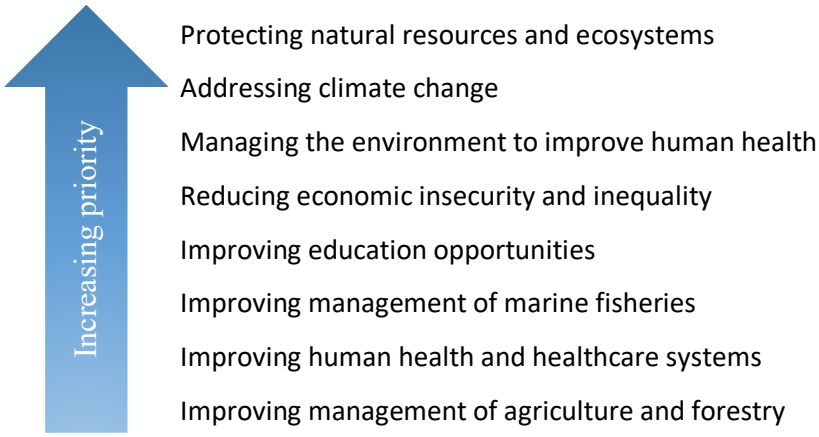
Figure 14. *Top three effects of climate change on coasts, oceans and marine wildlife respondents felt were of most concern in their country. Where more than one effect is listed per ranking it was equally selected by respondents. Respondents were provided a list of ten potential effects and the option of selecting "none" or specifying one additional threat.*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

2.3 Stakeholder perceptions of possible solutions

Out of key societal goals provided, respondents ranked "*protecting natural resources and ecosystems*", "*addressing climate change*" and "*managing the environment to improve human health*" as the top three priorities for governments to address (Figure 15).

Figure 15. *Priorities for governments to address ranked by respondents (n=576). Respondents*



were asked "In your opinion, which three of the following key goals should be of greatest priority for governments to address?". These eight priorities were provided, with the option for respondents to select "none".

Views were consistent across Case Studies with "*protecting natural resources and ecosystems*" and "*addressing climate change*" ranked in the top three priorities for all. Indeed, these were the top two priorities for all Case Studies except Bonaire, for which "*addressing climate change*" was ranked third with "*reducing economic insecurity and inequality*" second, and Martinique, which jointly ranked these with "*improving education opportunities*".

Respondents felt all groups shared responsibility for acting on climate change however most responsibility was assigned to higher level organisations and agencies (United Nations, regional organisations, national and local governments, and business and industry) (Figure 16).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

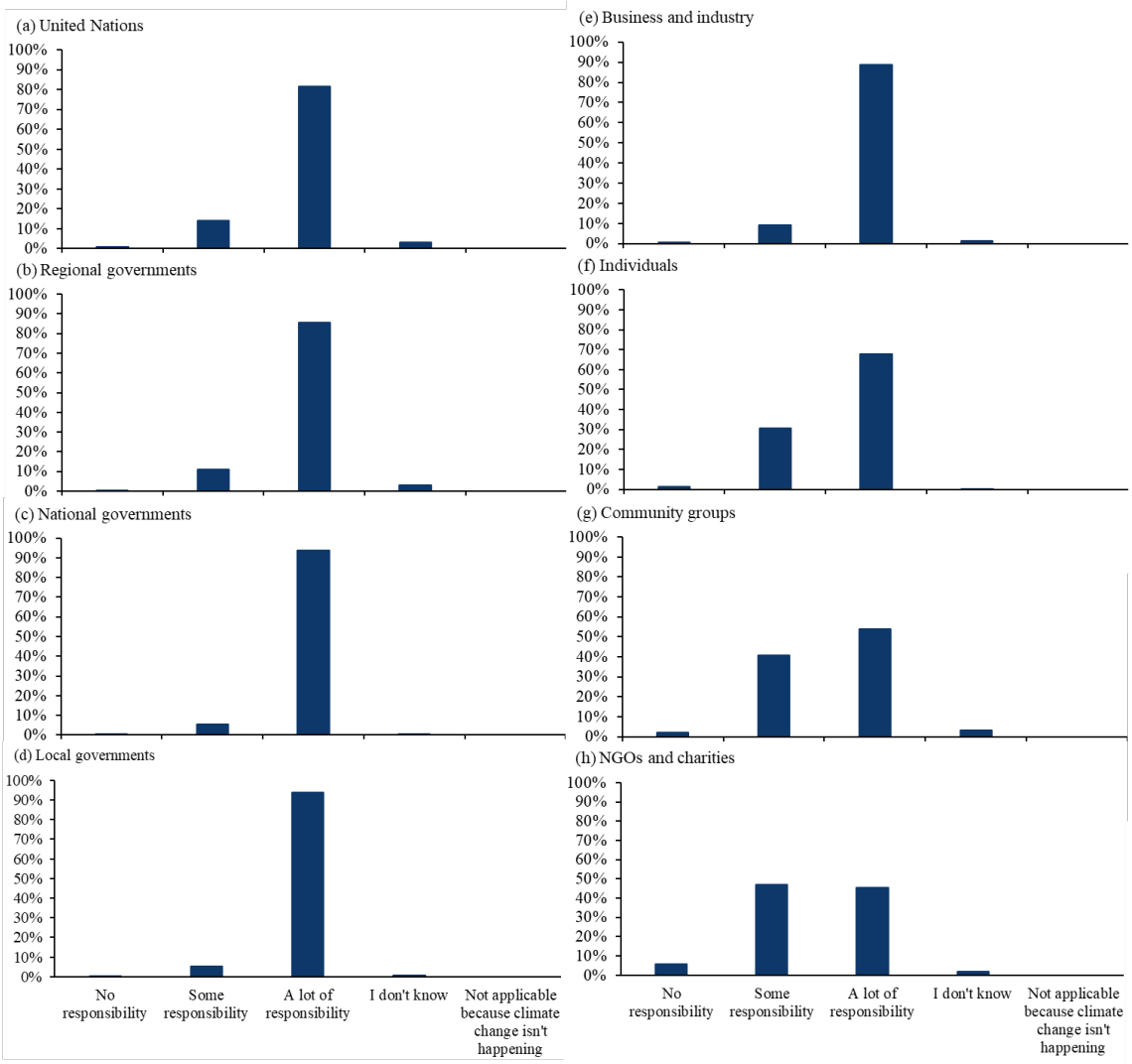


Figure 16. *Perceived level of responsibility for acting on climate change (percentage of all respondents, n=576).*

Figure 17 summarises responses to a series of statements aimed at identifying how the public perceive action on climate change and levels of support for policy actions directed at protecting and sustainably managing marine and coastal ecosystems. Most respondents think that society is not doing much to address the impacts of climate change (74%) and that we should be doing more (96%). Technological advancement was not perceived by respondents to mean that people do not need to worry about climate change (89%). Indeed, the majority of respondents (90%) replied that they would support actions to protect the oceans, even if it meant eating less seafood and paying more for it suggesting individuals are willing to apply personal constraints to support environmental actions. Similarly, respondents did not generally feel that their country's economy would be damaged by taking action on climate change (70%) or that there is too much uncertainty in scientific evidence to know how best to act on climate change (74%). Marine and coastal protection was considered as being likely to improve environmental health and benefit people (73%), and solutions working with nature were strongly supported by respondents (97%) and were felt to offer benefits to people by contributing to climate change mitigation and adaptation (90%). Most respondents support enhancing and preserving marine and coastal ecosystems as a key focus of policies that address climate change, nature conservation and sustainable development (95%).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

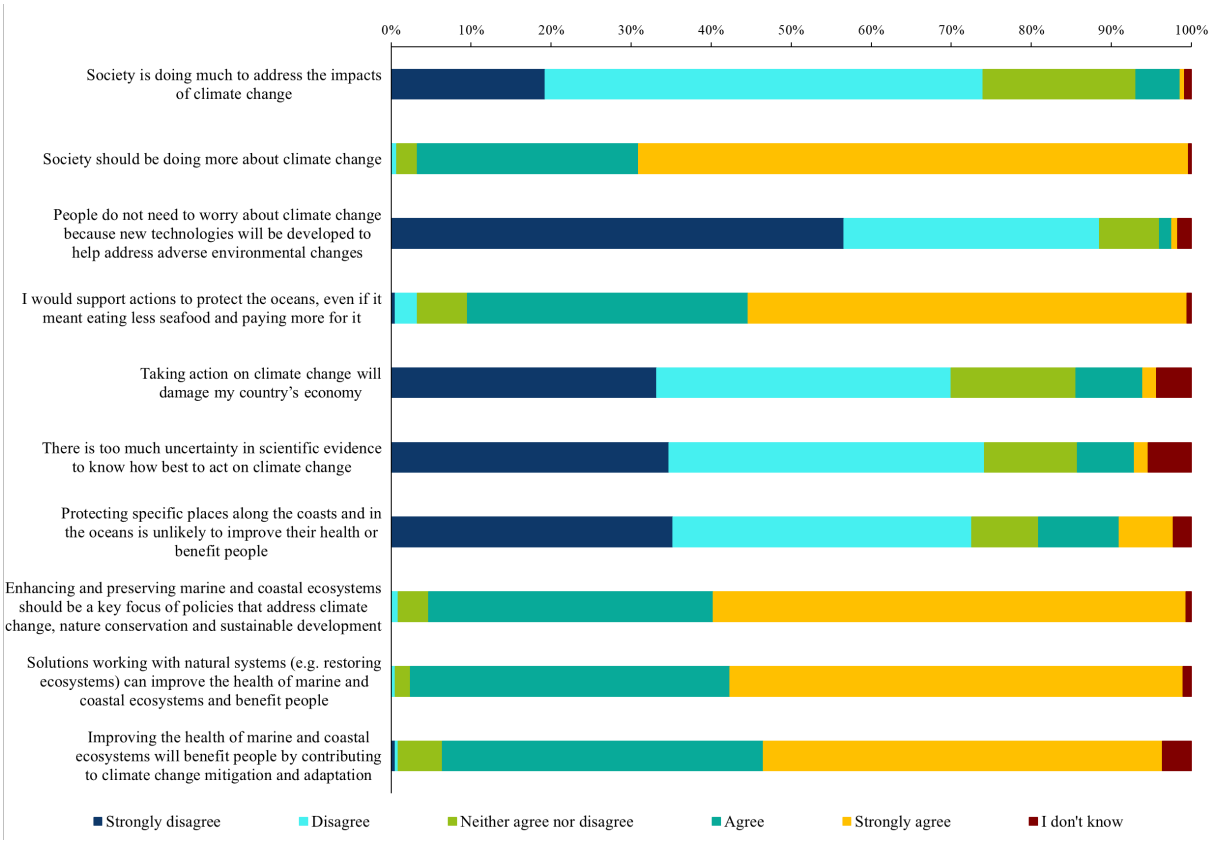


Figure 17. *Perceptions of respondents regarding climate change action and environmental protection across all Case Studies (percentage of all respondents, n=576). Respondents were asked to what extent they agreed or disagreed with these statements.*

2.3.1 Awareness of NBS

Recently, Nature-based Solutions (NBS) have been proposed as systemic actions that work with and enhance nature to provide environmental, social and economic benefits that simultaneously address multiple societal challenges (Eggermont et al. 2015, Cohen-Shacham et al. 2016, Gómez Martín et al. 2020, Seddon et al. 2020, O'Leary, Fonseca et al. 2023). Successful NBS are likely to require appropriate stakeholder engagement and involvement, and social factors are likely to be key determinants of success (e.g. Oldekop et al. 2016, Ban et al. 2019, DeAngelis et al. 2020, Ferreira, Barreira et al. 2020). Within MaCoBioS Case Studies, the majority of respondents reported having either heard of (41.0%), or that they know a lot about (17.4%) NBS, although there is some variation across Case Studies (Figure 18). Nonetheless, while these findings suggest that the NBS concept is becoming recognised in wider society, a substantial number of respondents (41.7%) remain unaware of the concept and level of knowledge varies. Continued efforts to raise awareness of the NBS concept and its approaches, and integrate public knowledge into the evidence base for NBS, are therefore required across all MaCoBioS Case Studies.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

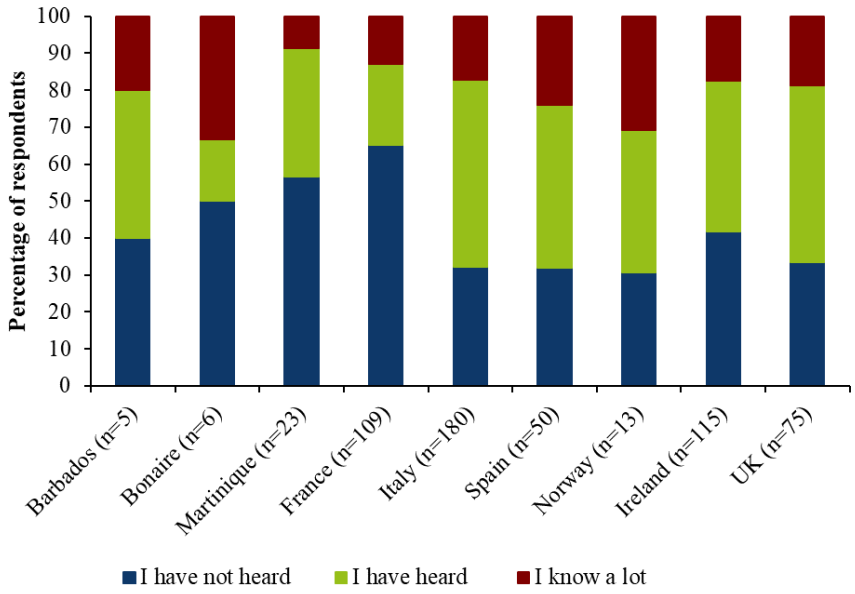


Figure 18. *Reported awareness of NBS (%). Summary of responses by Case Study to the question "have you heard about Nature-Based Solutions?"*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

3. Policy and practitioner stakeholder needs to adapt to climate change through Nature-based Solutions

To support the identification of evidence needs for advancing NBS in marine and coastal environments, MaCoBioS organised regional workshops, focus groups, interviews and informal discussions with representatives of key policy representatives and practitioner stakeholder groups. Stakeholder engagement activities were tailored to the three ecoregions and Case Studies of MaCoBioS (Northern Europe, Western Mediterranean, Caribbean). Activities were also tailored according to the specific groups that were invited, and the particular objectives for their respective engagement. Through these discussions our aim was to identify barriers to (Table 2) and enablers (or preconditions for success, Table 3) for, the design, uptake and implementation of NBS in marine and coastal environments. The premise was that recognising barriers is a crucial first step in identifying enablers. Barriers and enablers described in Table 2 and Table 3 are those specifically mentioned by the policy and practitioner stakeholders.

Table 2. *Barriers to the uptake and effective implementation of marine and coastal NBS identified by representatives of policy and practitioner stakeholder groups from MaCoBioS Case Studies. Barriers are not presented in any particular order.*

Category	Barrier	Brief description
NBS concept	Clarity of NBS definition and applicability of actions	Various definitions have been proposed for NBS (IUCN 2016, EC 2020, UNEA 2022) which all emphasise the importance of working with nature to tackle societal challenges by producing benefits to biodiversity and human well-being. However, these broad definitions do not provide an operational categorisation of actions that can be considered a NBS in order to allow case-by-case assessments and future innovation. The existence of multiple broad definitions can also potentially be misused or abused thereby facilitating greenwashing. While broad definitions may be useful at a strategic policy level, at the operational level they present a challenge. All of the policy-makers and practitioners we consulted with had heard of, and supported, the NBS concept, however, during discussions there was considerable uncertainty and confusion about the definition of NBS, what counts as a NBS, and what the added value of NBS is above previous and existing ecosystem approaches. Lack of clarity regarding NBS affects all challenges, hindering, for example, design, institutional coordination and cooperation, clarity of communication, consistent evidence, and access to funding.
Stakeholder awareness and support	Lack of understanding of cultural and social barriers to NBS	Society's relationship with nature is dictated by a set of values that directs how people behave. These values differ by culture and context. NBS reflect an expansion in societal focus from conserving nature for nature's sake (intrinsic considerations) to conserving nature also for its value to people (instrumental), emphasising the inseparable interdependencies in human-nature

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Category	Barrier	Brief description
		relationships. In the Global North at least, there has been a dominant paradigm of perceiving human beings as separate from nature and laws, policies, regulations, societies and economies have developed in this context. Before developing the vision for NBS, a more profound and systemic need for change must be recognised and accepted. NBS demands much greater understanding of the social and cultural factors that need to change to influence human mindsets to work with nature rather than technology is required.
Stakeholder awareness and support	Lack of awareness, potential for trade-offs and multi-sectoral working	The success of any policy depends on the local human context, with local stakeholders participation and buy-in vital. Marine and coastal ecosystems and the spaces they occupy are often used for a variety of activities, including fishing, shipping, and recreation. Implementing NBS can impact and sometimes conflict with these other uses, which can make it challenging to find a balance between conservation and development goals. Marine and coastal NBS therefore present a challenge because they require uniting stakeholders from diverse groups that may not typically work together. It also requires public awareness of the value of marine and coastal ecosystems to nature and people, the pressures facing these ecosystems, and support for actions that may help relieve these pressures. The number and diversity of stakeholders that need to be involved in NBS means that substantial improvements in education to enhance ocean literacy and stewardship are required.
Design	Limited social-economic-ecological evidence base on which to design and locate marine and coastal NBS	There is a lack of information and understanding on the mechanisms by which marine biodiversity and ecosystems provide ecosystem services for human well-being, and how the health of the ecosystem is affected by human activities. There are important gaps in knowledge on the individual and cumulative effects of climate change and how particular human stressors affect ecosystem service provision. Moreover, while NBS rely on the ecological foundations of the ecosystem on which they are built being integral to management, by definition they must address human dimensions too. This includes considering, among other things: the kind of activities and practices taking place within the land- and seascape where NBS will be implemented; the social and economic drivers of anthropogenic pressures; and the consequences of management choices. Social and economic data is

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Category	Barrier	Brief description
		increasingly collected and used by those working in marine and coastal management, however this data frequently focuses more on economic activities and social data is typically locally context-specific making transferability of lessons challenging. Together, the often limited locally-relevant social-ecological-economic evidence base means there is uncertainty in how to best design and implement effective marine and coastal NBS.
Design	Uncertainty in future environmental, social and economic conditions	There is great uncertainty about the future. This uncertainty can make it difficult to design and implement NBS that can withstand future changes. Scenario modelling can help understand predicted environmental and ecological changes to marine and coastal ecosystems from climate change and its associated effects. This can help inform NBS selection and design under uncertainty. Policy-makers and practitioners we consulted placed caution on model interpretation given the underlying assumptions and resulting limitations these may have and the reliability of data available for model input. However, they did value models for their ability to inform and frame decisions under possible future scenarios. How social and economic conditions might change is, however, difficult to predict in the long-term. Understanding the social costs and benefits of different alternatives, behavioural responses to changing conditions and management, changing social norms, networks and governance therefore presents a challenge to designing NBS which rely on a long-term perspective being taken due to the lag time between implementation and delivery of anticipated benefits.
Design	Uncertainty in how grey infrastructure can be combined with NBS	Historically, traditional engineered infrastructures – also called 'grey infrastructure'– have been implemented to address various challenges, such as coastal flooding or erosion (for instance sea walls and dykes). However, grey infrastructure can be expensive to implement, non-adaptive to changing environments, negatively impact ecosystems and biodiversity, and entail significant financial costs to maintain under future climate change scenarios. Emerging evidence demonstrates that NBS can be effectively used in place of grey infrastructure in some cases, while enhancing biodiversity and human well-being, and potentially being cheaper than engineered ones (for instance managed realignment schemes). Where grey infrastructure is required, combining this with coastal

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Category	Barrier	Brief description
		vegetated habitats such as mangroves and salt marshes into hybrid solutions could deliver more sustainable and financially attractive coastal protection strategies. However, there are considerable uncertainties and governance challenges as to how and when NBS should be combined with grey infrastructure in marine and coastal environments, and this can limit public support and access to sustainable finance for hybrid solutions.
Design	Opportunity	The successful selection, design and implementation of any intervention, including NBS, is determined by human factors such as political willingness, financial resource availability, ecological understanding of ecosystem complexities and responses to future changes, local capacities to implement and monitor, existing and future human activities, and stakeholder support. While the ecological evidence base is critical, many of the policy-makers and practitioners we consulted did highlight that management actions are often driven by a matter of opportunity and that while ecological data, mapping and simulation tools can help choose what intervention might be best suited and where it might be placed, ultimately this can only inform what actions are implemented. For example, restoration activities can only take place where you have the space to do it, where species already exist or have previously existed, where drivers of loss can be addressed, and where there is political and local support for the action.
Monitoring and evaluation	Uncertainty in the expected short- and long-term effects and effectiveness of marine and coastal NBS, and timeline for effects to be realised	Existing evidence for NBS is largely concentrated in urban systems and although there is a growing body of knowledge of NBS in marine and coastal systems, there are challenges accessing this information. In particular: information may be scattered and difficult to access; be presented in a way that is challenging for non-experts to understand; may not be at a scale relevant for practitioners; or may not be tailored to the local presentation of the societal challenge a practitioner wants to address. Policy-makers and practitioners reported that they often need to make decisions fast and therefore need timely science that informs the management task at hand. Even where evidence exists from elsewhere, it may not be transferable to a new location due to context-specific social or environmental constraints. There is also considerable uncertainty in how to measure ecosystem services and attribute changes in those services

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Category	Barrier	Brief description
		to NBS. Policy-makers and practitioners identified a clear need for standardised data and monitoring protocols for evaluating effectiveness, including effects, performance, and trade-offs. Generally, there is poor availability of consistent, reliable and locally-relevant ecological, social and economic datasets as a basis on which to evaluate marine and coastal NBS outcomes.
Monitoring and evaluation	Requirement for multi-dimensional analysis of the costs/benefits of NBS	NBS are systemic actions that work with and enhance nature to provide environmental, social and economic benefits that simultaneously address multiple challenges. As such, they work to maintain or recover nature in a holistic and sustainable way that supports human well-being. The idea is that their implementation results in the provision of co-benefits to human well-being alongside nature conservation. Co-benefits might include aspects such as improved place attractiveness, creation of jobs and more sustainable economic/income opportunities, and increased quality of life. Evaluations of effects and effectiveness therefore need to be multidimensional and integrate all elements of social-ecological systems, including cultural considerations. Implementation of NBS can lead to both costs and benefits to different elements of a system and to different stakeholders and it is important to understand these but most evaluations do not encompass this complexity. There is a need to move beyond narrow framings and assessments of effects of an intervention loosely based on limited indicators.
Capacity and policy levers	Lack of available policy drivers / political commitment	Policy and regulatory environments can influence the feasibility and attractiveness of implementing NBS. In marine and coastal systems there is often a fragmented and dynamic policy landscape that does not always support the implementation, or scaling up, of effective NBS. In addition, incentives for implementation and private funding of NBS interventions are often weak. There are also challenges for quickly updating policy or legislation to reflect current aspirations, and given the lag between NBS implementation and outcome delivery, NBS require a long-term planning perspective which is often at odds with short-term political foci. Moreover, given the challenges surrounding clarity and low mainstreaming of the NBS concept, there is also institutional fragmentation and inconsistencies in goals, terminology and regulations that pose real barriers to NBS design and implementation. This, together with the wide variety of policies and the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Category	Barrier	Brief description
		spatial scales and actors they affect, can result in a lack of cohesion at regional, national and international levels.
Capacity and policy levers	Lack of institutional coordination and the difficulty of multidisciplinary action and engagement	NBS require an integrated perspective across policies, objectives, governance structures, and stakeholder groups that facilitates trade-offs to be balanced. In practice, this can lead to fragmented delivery, a lack of clarity over responsibility, budgetary challenges, and challenges associated with working across different government agencies with different remits and objectives. There is a need to mainstream NBS across stakeholder groups, institutions and government agencies, and industry sectors that have not previously considered environmental management as part of their remit. Practitioners suggested that providing evidence of effectiveness, quantitative and qualitative cost-benefit analyses, and sharing success stories will be key to supporting NBS mainstreaming and increasing institutional coordination.
Capacity and policy levers	Inadequate resources	For any intervention to be successful, there needs to be sufficient material and non-material resources to design, implement, monitor and evaluate it, as well as for effective and meaningful stakeholder engagement. This includes long-term sustainable financing mechanisms and adequate incentives for NBS implementation. Financial opportunity and availability of budget to leverage change was identified as a key challenge to advancing marine and coastal NBS by many practitioners we consulted. In particular, several of them also identified limited political support for projects and few resources as presenting a particular problem for selecting between NBS projects. Moreover, identifying values and measuring effectiveness is inherently difficult due to social-ecological complexities and uncertainties as well as the geographical scale, and range of habitats and problems that NBS may be able to address. This makes comparing and choosing amongst a range of possible options difficult. Implementing marine and coastal NBS can be expensive and resource-intensive. If there are limited resources available to support these efforts it will make it difficult to scale up NBS or implement them. Many of the policy-makers and practitioners we consulted highlighted a need to increase private sector funding and to ensure NBS have access to blended finance mechanisms to improve their long-term financial sustainability.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Table 3. *Enablers for the uptake and effective implementation of marine and coastal NBS identified by representatives of policy and practitioner stakeholder groups from MaCoBioS Case Studies. Enablers are not presented in any particular order.*

Category	Enabler	Brief description
Education and collaboration	Increasing societal education and awareness about the value of marine and coastal ecosystems for society and human well-being	The implementation of NBS requires societal awareness of the multiple values and importance of marine and coastal ecosystems for society and human well-being. One of the main challenges is to overcome issues of 'out-of-sight, out-of-mind' and shifting baselines, where people get used to an impoverished or degraded ecosystem and use this as their reference point. Improving ocean literacy and stewardship would help drive political will and more sustained investment, including increasing the potential to leverage funds from non-traditional sources (e.g. business). Moreover, education and awareness plays a crucial role to address and reduce the underlying drivers of degradation and ecosystem change, for instance pollution, irresponsible tourism, climate change, unsustainable fisheries, etc. Policy-makers and practitioners felt that education should not only cover why the rules are in place but should also be designed to generate more appreciation of nature, particularly local nature, to help set a cohesive nature vision and stewardship approach carried by all. It was highlighted that education needs to emphasise nature's economic values too, in order to reorientate perceptions from nature costing money to nature creating money through jobs, tourism, recreation and by supporting other services (e.g. food).
Education and collaboration	Mainstreaming of the NBS concept	To facilitate implementation of marine and coastal NBS, it is key to mainstream the concept in civil society, stakeholder groups, government agencies and the private sector. Mainstreaming needs to be across broader groups of society and not focus solely on those traditionally considered responsible for environmental management. To facilitate mainstreaming, there is a need to gather success stories and knowledge about how NBS are being implemented in different contexts. While knowledge of the economic and ecological costs and benefits can be difficult to obtain, knowledge about good practices, and social inclusion, equity, and justice would be beneficial to gather and share. This information would increase the potential for political commitment, facilitate institutional coordination, be useful for education, and support access to funds from non-traditional sources.
Education and collaboration	Collaborative relationships and partnerships	NBS are designed to address challenges that affect multiple stakeholders in different ways. These challenges may also be affected by stakeholder groups differently. Stakeholders therefore need to be actively involved in

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Category	Enabler	Brief description
	among stakeholders	decision-making, including in dialogue about funding priorities and co-design of NBS. Local stakeholders are most aware of the prevailing needs in their surroundings, the challenges faced and the acceptability of management options. Their early and active engagement will embed local history and culture into management and regulations, and facilitate innovative strategies for local implementation (e.g. community projects), co-funding, and co-management. Supporting local communities to champion NBS will also increase the potential for success of interventions. Collaboration among government agencies (beyond those directly responsible for environmental management), the private sector and civil society (including local communities and invested stakeholders) will be needed for effective NBS. Together, this will help develop objectives for NBS, selection of appropriate approaches, and manage expectations of possible outcomes.
Education and collaboration	Collaborative relationships and partnerships among practitioners and researchers	Research provides knowledge to inform decisions made about, for example, how to manage and reconcile human activities in marine and coastal environments with a vision of ecosystem stewardship under changing climatic conditions. However, there was a perception amongst many of the practitioners we consulted that the value of research outputs for use in decision-making could be improved by involving practitioners in research and early in the process of project design to ensure that the utility of NBS to stakeholders is strengthened. There is a clear need to go beyond a linear science-policy approach. Instead, policy and practice need to be integrated with research to facilitate actionable science, and practitioners and policy-makers need to advise on the best approach for a specific context. To facilitate dissemination of research findings, accessible outputs, including lay person summaries or interactive online decision-support tools need to be developed with, and clearly communicated to, target end users.
Education and collaboration	Interdisciplinary research	Given the systemic approach NBS requires, collaboration. multi- and interdisciplinary research teams, sharing, and dissemination of knowledge across research disciplines as well as an improved dialogue between research, policy and practice is needed. NBS will require silos being broken down among research disciplines. In particular, policy-makers and practitioners we consulted emphasised a

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Category	Enabler	Brief description
		particular need to integrate social science into NBS research, design, implementation, and evaluation. Collaboration and interdisciplinary thinking, combined with involvement from stakeholders, will help catalyse creative solutions that address local challenges.
Design	Combine short-term and long-term objectives	Some benefits from NBS are likely to take a long time to materialise, especially when implemented in places where marine and coastal ecosystems have been highly degraded or where cumulative pressures, including from climate change, are particularly high. Because of the societal and economic costs NBS management actions may require to encourage ecosystem recovery, designing NBS that seek both short-term and long-term benefits for local communities and stakeholder groups may achieve greater support.
Design	Drivers of loss have been or can be addressed	Ecological degradation is caused by a variety of drivers, including human activities and climate change. For a NBS to have significant positive impacts, it is paramount that the underlying drivers of degradation have been or can be effectively addressed.
Capacity and policy levers	Political mandate for NBS	Having a clear political mandate for NBS to be included in marine and coastal management will help encourage their implementation and support access to emerging funding mechanisms. This could be through, for example, tender and procurement processes, policy instruments (e.g. guidance documents) and, where possible, within regulatory frameworks. Constant and consistent messaging and use of terminology is required.
Capacity and policy levers	Adequate resources	Inadequate resources were identified as a key barrier by the policy-makers and practitioners we consulted. Conversely, many also emphasised that having adequate resources for continuous stakeholder engagement, monitoring and evaluation programmes, and effective enforcement was a pre-requisite for success. Community engagement, involvement and support provides some potential to overcome barriers to NBS implementation and, in particular, monitoring, evaluation and adaptive management beyond limited project and funding periods. However, implementing a NBS requires the availability of adequate financial resources, people, expertise, and capacity to be in place.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

4. Summary of ecoregional perspectives

A one-size-fits-all solution does not exist for the challenges confronting ecosystems, people and economies around the world. The interplay of social, economic and ecological conditions will define how conservation, restoration and management interventions are balanced in a particular land- and seascape. Local knowledge and social-ecological contexts will, therefore, be extremely important in defining options and designing and implementing NBS.

MaCoBioS operates in nine Case Studies across three ecoregions. These are: France, Italy and Spain representing the Western Mediterranean; Ireland, Norway and the UK representing Northern Europe; and Barbados, Bonaire and Martinique representing the Lesser Antilles. Each of these Case Studies have their own social, economic, institutional and ecological contexts in which stakeholder perspectives, awareness and concerns are grounded (for example, for details regarding NBS governance in each see Deliverable 4.1: 'Nature-based solutions stakeholders and policy').

The loss and degradation of marine and coastal ecosystems can severely affect the wellbeing of people who depend on the services that these ecosystems offer (IPCC 2021, IOC-UNESCO 2022) although changes will affect people differently, depending on their ability to adapt or take advantage of them. Given this, together with local contexts, different stakeholder groups are likely to have different views regarding the same challenge or solution. The dynamic contexts of marine and coastal social-ecological systems within each country and the broader ecoregions in which they are situated makes it difficult to draw broad country and regional-specific conclusions regarding stakeholder concerns and expected solutions to mitigate and adapt to climate change. It cannot be assumed that perspectives shared with MaCoBioS by stakeholders are shared by all in that region, even within the same stakeholder group. Recognising this, results, interpretations and conclusions should be interpreted based on the respondent/participant sample and not generalised to entire stakeholder groups in each country. Here, we provide a brief summary of the perspectives told to MaCoBioS focusing on ecoregional similarities and differences. However, for future research and intervention design it will be important to integrate stakeholders fully into the design process to help create socially acceptable interventions that aim to maximise benefits while managing and minimising risks.

Results from the online survey suggest there is little ecoregional difference in awareness or perceived concern regarding climate change. Survey respondents considered climate change a major challenge facing their country throughout MaCoBioS ecoregions (Figure 3, Figure 4, Figure 8, Figure 11). Indeed, respondents from all ecoregions placed climate change in their top three threats to marine and coastal ecosystems (Figure 11, Table 4). Interestingly, there were ecoregional differences in where climate change ranked across threats (Figure 11): respondents from each Case Study in Northern Europe ranked climate change as the top threat; respondents from each Case Study in the Western Mediterranean ranked climate change second; and while respondents from Barbados and Martinique ranked climate change second, it didn't feature in the top three threats reported by respondents from Bonaire. These differences in ranking may be due to a number of reasons including the visibility of direct local threats such as coastal development or pollution bringing it to the fore of public awareness, or awareness and capacity building campaigns. However, reasons to explain these differences were not explored in this survey and future research should focus on locally-specific exploration of these issues to meaningfully inform future education, research or policy and practice.

The only threat, other than climate change, that featured across all ecoregions was plastic pollution (Table 4). This is likely due to (1) the direct visual connection with plastic litter on shorelines; and (2) awareness and capacity building campaigns that have raised the problem of plastic pollution, including microplastics, in marine and coastal environments and their implication for human health (Thushari and Senevirathna 2020, Davison et al. 2021). Top threats identified by respondents in the Lesser Antilles and Western Mediterranean showed greater similarity than with Northern Europe with coastal development and chemical pollution being raised as concerning in the former two. This may

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

be because both the Lesser Antilles islands and the Western Mediterranean Case Studies have long coastlines that are culturally and economically important which leads their respective populations to concentrate on the coasts. The Lesser Antilles and Northern Europe did, however, share concerns regarding fishing/harvesting of marine and/or coastal life not highlighted by respondents from the Western Mediterranean.

Table 4. *Summary of threats reported by survey respondents as being in the top three threats facing marine and coastal ecosystems. Based on information presented in Figure 11.*

Threat	Ecoregions reported within	Case Studies reported within
Climate change	All ecoregions	All Case Studies
Plastic pollution	All ecoregions	All Case Studies
Coastal development	Lesser Antilles Western Mediterranean	Bonaire, Barbados France, Spain
Chemical pollution	Lesser Antilles Western Mediterranean	Barbados, Martinique Italy
Fishing/harvesting of marine and/or coastal life	Lesser Antilles Northern Europe	Barbados Ireland, UK
Land runoff	Lesser Antilles	Bonaire, Barbados
Aquaculture	Northern Europe	Norway
Invasive species	Northern Europe	Norway

Changes in the frequency of extreme weather events was presented as the primary concern in all ecoregions by at least one Case Study, but was particularly highlighted by the Lesser Antilles (Bonaire, Barbados) and the Western Mediterranean (France, Italy, Spain) (Figure 14). Sea level rise and coastal erosion were similarly dominant concerns highlighted across all ecoregions by most Case Studies. Norway (Northern Europe) was a clear outlier when compared with other Case Studies with largely different perceptions of the top threats (Figure 11) and effects of climate change on coasts, oceans and marine wildlife (Figure 14).

General views regarding barriers and enablers for the design, uptake and implementation of NBS in marine and coastal environments were generally consistent amongst the policy and practitioner stakeholders MaCoBioS consulted across all ecoregions (Figure 19). Policy and practitioner stakeholders across all MaCoBioS's ecoregions highlighted the lack of clarity regarding the definition of NBS as particular problem that hindered progress. Stakeholders' felt that the strength, and challenge, of NBS is that they draw together many diverse actors and a broad range of approaches, however more effort is needed to ensure standards and consistency if they are to realise their full potential. Ultimately, it was felt significant investment to reduce uncertainty in the definition and concept of NBS is needed to accelerate NBS deployment in complex marine social-ecological systems and integrate NBS into existing marine management measures.

Differences in ecoregional concerns largely related to locally-specific contexts and the weight placed on different barriers. For example, stakeholders representing Bonaire were predominately concerned about how NBS can integrate into existing measures given that the Bonaire National Marine Park surrounds the island. Because of the connectivity of island life with the marine and coastal environment, they were also particularly aware of the importance of defining a collective vision and working towards inclusive participation. While these issues were also identified by stakeholders

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

across Northern Europe and the Western Mediterranean, the former particularly considered policy and regulatory environments as being barriers to NBS by influencing the feasibility and attractiveness of NBS. Stakeholders in the Western Mediterranean highlighted that management through NBS needs to focus on reducing local direct pressures that hinder recovery or restoration efforts. Financial opportunity and availability of budget to leverage change was identified as a key challenge to advancing NBS in Northern Europe and the Western Mediterranean but was less focussed on during discussions in the Lesser Antilles.

There was broad consensus among ecoregions that overcoming the current barriers to implementing marine and coastal NBS will require collaborative efforts from a diverse range of stakeholders, including researchers, practitioners, policymakers, industries, and local communities. Furthermore, stakeholders emphasised the importance of several key principles for advancing marine and coastal NBS effectively. These principles included: embedding NBS within the specific social, economic and ecological conditions of each locality; establishing robust partnerships through extensive and inclusive stakeholder engagement and participation; and planning NBS at land- and seascape scales. By integrating marine and coastal NBS into their unique local contexts, stakeholders felt it would become possible to design interventions that not only address local challenges but also contribute to global risk management.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

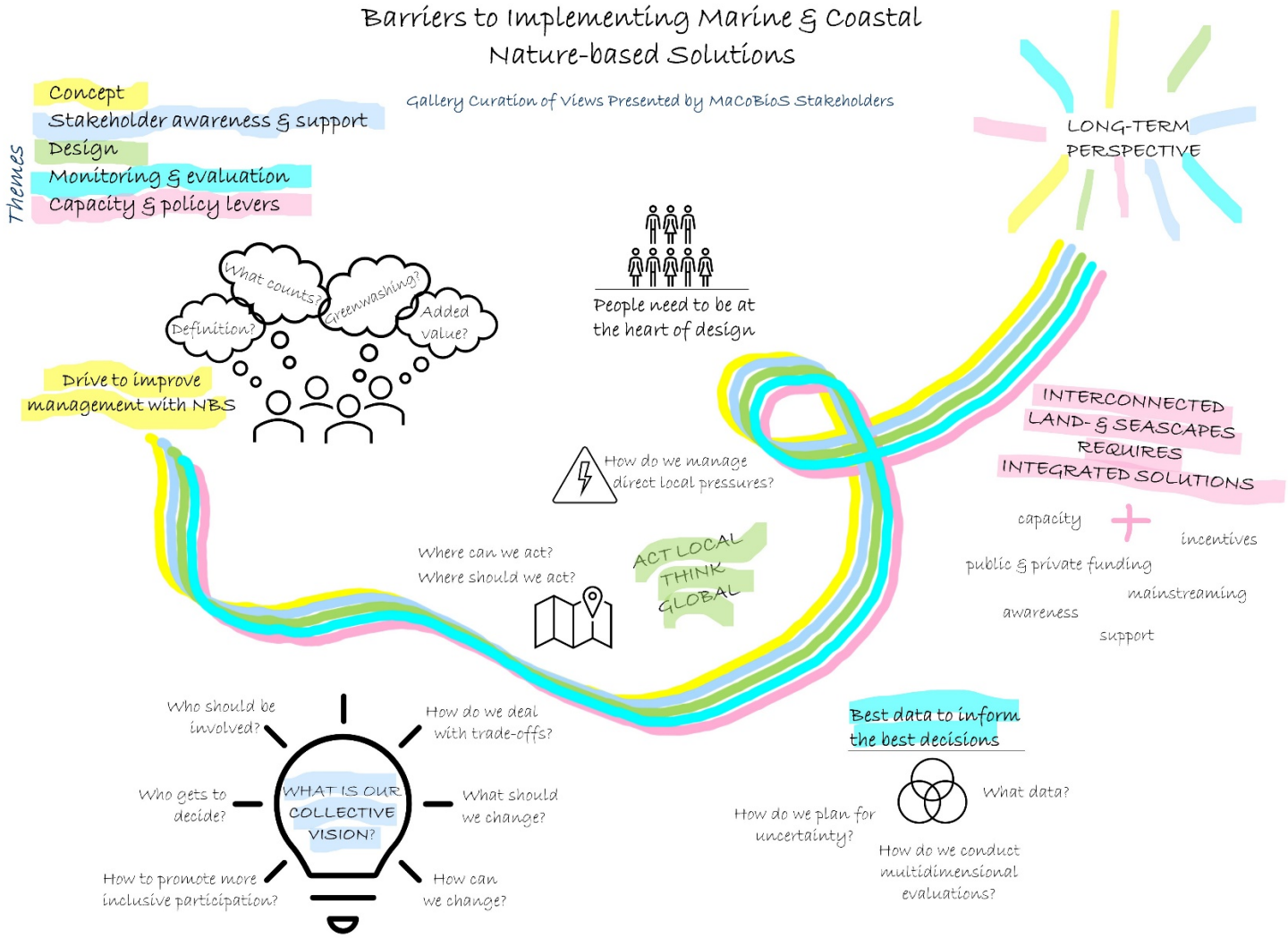


Figure 19. *Gallery curation of policy and practitioner views presented by stakeholders in all MaCoBioS ecoregions on barriers to implementing marine and coastal NBS. Based on information presented in Table 2.*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

5. Conclusions

There is now strong recognition of the multiple values marine and coastal NBS can have as a component of the response to societal challenges, including climate change mitigation and adaptation (Cohen-Shacham, Walters et al. 2016, Gómez Martín, Giordano et al. 2020, Seddon, Chausson et al. 2020, O'Leary, Fonseca et al. 2023). However, designing and implementing NBS requires a change in how society perceives social-ecological systems, and a movement to regard environmental challenges as also being social challenges. As such understanding stakeholder concerns and expectations regarding climate change and environmental management is key to ensure interventions are appropriate to the challenge and acceptable and supported by stakeholders.

Our online survey highlighted strong consensus and high levels of concern about climate change amongst respondents from across the Case Studies MaCoBioS works (Figure 3, Figure 4, Figure 8). It also showed that respondents highly valued marine and coastal ecosystems for human well-being, their economic importance, climate regulation, and climate change mitigation (Figure 5). Despite this, many felt marine and coastal ecosystems were degraded and unhealthy in their country (Figure 12), being threatened particularly by plastic pollution, climate change and fishing/harvesting (Figure 10, Figure 11). Survey respondents also reported a perception that more action should be taken to address the impacts of climate change (Figure 17), and that "*protecting natural resources and ecosystems*", "*addressing climate change*" and "*managing the environment to improve human health*" should be the top three priorities for governments to address (Figure 15). Responses to the survey also suggest that the concept of NBS is gaining traction amongst the public (Figure 18), and that there is broad consensus that "*enhancing and preserving marine and coastal ecosystems should be a key focus of policies that address climate change, nature conservation and sustainable development*" (Figure 17).

The broad public support for nature protection our survey identified is encouraging. However, it also showed uncertainty among some respondents about climate change and NBS suggesting it is important to find effective ways to continue to disseminate the evidence base to the public. Variation in responses across Case Studies also suggest that local context is important when designing NBS interventions to ensure they address the concerns of stakeholders.

Policy-makers and practitioners we consulted identified a broad range of cross-cutting evidence needs to support delivery of marine and coastal NBS and their objectives. These were:

- Greater clarity on the definition of NBS, what counts as a NBS, and what the added value of NBS is above existing ecosystem approaches. Uncertainty in the NBS concept affects all challenges, hindering, for example, design, institutional coordination and cooperation, clarity of communication, consistent evidence, and access to funding.
- Improved knowledge of the links between biodiversity, climate change, human impacts, ecosystem function and delivery of ecosystem services, and how management through NBS interventions can affect these.
- Enhanced understanding of current and future potential benefits to coastal communities and invested stakeholders, including cultural and social benefits. This includes better understanding of the causal mechanisms between marine and coastal NBS and effects on human health and well-being.
- Increased understanding of the potential short- and long-term ecological, social, and economic outcomes of marine and coastal NBS.
- Improved understanding of how and when NBS should be combined with grey infrastructure in marine and coastal environments and the effectiveness of different interventions in different contexts.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

- Development of standardised data and monitoring protocols for evaluating effectiveness of an intervention, including effects, performance, and trade-offs.
- Actionable and accessible guidance on how to best design and implement effective marine and coastal NBS underpinned by an improved social, economic, and ecological evidence base.

- Actionable and accessible guidance on how to better communicate about marine and coastal NBS, how to tailor communication to different audiences, and how to better engage with stakeholders.

Finally, it is important to acknowledge that NBS is only one solution amongst others and policy-makers and practitioners highlighted the need to remain open to a broad range of actions to tackle biodiversity loss and climate change, as well as other societal challenges. Prior to implementing NBS, it will be important to understand the problem that needs to be addressed, the vulnerability of a social-ecological-economic system to biodiversity loss and climate change, the drivers of change, the stakeholders involved, and the potential trade-offs different interventions and approaches may involve. Once the problem is defined and potential solutions evaluated, the usefulness and feasibility of NBS can be considered. Addressing the identified evidence needs will help inform this decision.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

6. Acknowledgements

MaCoBioS would like to thank all those who have participated in our stakeholder engagement activities and their generous sharing of their time, knowledge and expertise.

We are grateful for the various contributions, comments and reviews that we have received from the scholars and experts involved in MaCoBioS at several stages in the development of this report and stakeholder engagement activities. We are particularly thankful to Justin Ahanhanzo, Elena Allegri, Mialy Andriamahefazafy, Gema Casal, Tomas Chaigneau, Cindy C. Cornet, A. Karima Degia, Stein Fredriksen, Elisa Furlan, Firdaous Halim, Silvia de Juan, Francesc Maynou, Tim McCarthy, Erik Meesters, Alicia N'guetta, Géraldine Pérez, Vuong Pham, Christian Simeoni, Rémy Simide, Daisy Taylor, and Ewan Trégarot.

7. Ethics statement

The online survey was approved by the Research Ethics Committee of the College of Life and Environmental Sciences at the University of Exeter on 2nd November 2021 (Ref. No.: 491857). Informed consent was obtained from all respondents prior to their completion of the survey. Respondents were presented with an initial information screen which included a link to the participant information form which provided more information about the research project and survey. This was followed by an initial question which asked the respondent to confirm they had read and understood the participant information form and that they voluntarily agreed to participate in the study. Only respondents who agreed to this were permitted to complete the survey.

Ecoregional workshops were approved by the Faculty of Business and Law Ethics Committee of the University of Portsmouth (Ref. No.: BAL/2022/35/CORNET). Informed consent was obtained from all participants prior to their attendance at any workshop. Participants were provided with a participant information form which provided more information about the research project and workshop objectives. They were then asked to sign a consent form to confirm they had read and understood the participant information form and that they voluntarily agreed to participate in the workshop. Only participants who agreed to this were permitted to attend workshops.

The other stakeholders' engagement activities conducted independently by partners followed the ethical procedures of the partner's institution to ensure the researchers respected the research participants' human dignity and consider their personal integrity, safety and well-being, and that participation to the research was based on informed consent.

8. References

Ankamah-Yeboah, I., B. B. Xuan, S. Hynes and C. W. Armstrong (2020). "Public Perceptions of Deep-Sea Environment: Evidence From Scotland and Norway." Frontiers in Marine Science **7**.
Ban, N. C., G. G. Gurney, N. A. Marshall, C. K. Whitney, M. Mills, S. Gelcich, N. J. Bennett, M. C. Meehan, C. Butler, S. Ban, T. C. Tran, M. E. Cox and S. J. Breslow (2019). "Well-being outcomes of marine protected areas." Nature Sustainability **2**(6): 524-532.
Barracosa, H., C. B. de los Santos, M. Martins, C. Freitas and R. Santos (2019). "Ocean Literacy to Mainstream Ecosystem Services Concept in Formal and Informal Education: The Example of Coastal Ecosystems of Southern Portugal." Frontiers in Marine Science **6**.
Cohen-Shacham, E., G. Walters, C. Janzen and S. Maginnis (2016). Nature-based solutions to address global societal challenges, IUCN: Gland, Switzerland. **97**.
Davison, S. M. C., M. P. White, S. Pahl, T. Taylor, K. Fielding, B. R. Roberts, T. Economou, O. McMeel, P. Kellett and L. E. Fleming (2021). "Public concern about, and desire for research into,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

the human health effects of marine plastic pollution: Results from a 15-country survey across Europe and Australia." Global Environmental Change **69**: 102309.
DeAngelis, B. M., A. E. Sutton-Grier, A. Colden, K. K. Arkema, C. J. Baillie, R. O. Bennett, J. Benoit, S. Blitch, A. Chatwin, A. Dausman, R. K. Gittman, H. S. Greening, J. R. Henkel, R. Houge, R. Howard, A. R. Hughes, J. Lowe, S. B. Scyphers, E. T. Sherwood, S. Westby and J. H. Grabowski (2020). "Social Factors Key to Landscape-Scale Coastal Restoration: Lessons Learned from Three U.S. Case Studies." Sustainability **12**(3): 869.
Dietz, T. and P. C. Stern (2008). Public Participation in Environmental Assessment and Decision Making, The National Academy Press, Washington DC.
EC (2020). Biodiversity and nature-based solutions: analysis of EU-funded projects, Directorate-General for Research and Innovation, Publications Office.
Eggermont, H., E. Balian, J. Azevad, V. Beumer, T. Brodin, J. Claudet, B. Fady, M. Grube, H. Keune, P. Lamarque, K. Reuter, M. Smith, C. van Ham, W. Weisser and X. Le Roux (2015). "Nature-based Solutions: New Influence for Environmental Management and Research in Europe." GAIA - Ecological Perspectives on Science and Society **24**(4): 243-248.
Felipe-Lucia, M. R., B. Martín-López, S. Lavorel, L. Berraquero-Díaz, J. Escalera-Reyes and F. A. Comín (2015). "Ecosystem Services Flows: Why Stakeholders' Power Relationships Matter." PLOS ONE **10**(7): e0132232.
Ferreira, V., A. P. Barreira, L. Loures, D. Antunes and T. Panagopoulos (2020). "Stakeholders' Engagement on Nature-Based Solutions: A Systematic Literature Review." Sustainability **12**(2): 640.
Fonseca, C., L. E. Wood, M. Andriamahefazafy, G. Casal, T. Chaigneau, C. C. Cornet, A. K. Degia, P. Failler, G. Ferraro, E. Furlan, J. Hawkins, S. de Juan, T. Krause, T. McCarthy, G. Pérez, C. Roberts, E. Trégarot and B. C. O'Leary (2023). "Survey data of public awareness on climate change and the value of marine and coastal ecosystems." Data in Brief **47**: 108924.
Fulton, E. A. (2021). "Opportunities to improve ecosystem-based fisheries management by recognizing and overcoming path dependency and cognitive bias." Fish and Fisheries **22**(2): 428-448.
Gómez Martín, E., R. Giordano, A. Pagano, P. van der Keur and M. Máñez Costa (2020). "Using a system thinking approach to assess the contribution of nature based solutions to sustainable development goals." Science of The Total Environment **738**: 139693.
Hoegh-Guldberg, O. (2015). Reviving the Ocean Economy: the case for action-2015. WWF International. Gland, Switzerland, Geneva.
IOC-UNESCO (2022). State of the ocean report 2022: pilot edition. Paris, IOC-UNESCO.
IPBES (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. E. S. Brondizio, J. Settele, S. Díaz and H. T. Ngo. Bonn, Germany, IPBES secretariat**:** 1148.
IPCC (2018). Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. V. Masson-Delmotte, P. Zhai, H.-O. Pörtner et al.
IPCC (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. V. Masson-Delmotte, P. Zhai, A. Pirani et al., Cambridge University Press.
IPCC (2022). Climate Change 2022: Impacts, Adaptation and Vulnerability.
IUCN (2016). Resolution 69 on Defining Nature-based Solutions (WCC-2016-Res-069). IUCN Resolutions, Recommendations and Other Decisions 6–10 September 2016. . World Conservation Congress Honolulu, Hawai'i.
Korpinen, S., K. Klančnik, M. Peterlin, M. Nurmi, L. Laamanen, G. Zupančič, C. Murray, T. Harvey, J. H. Andersen, A. Zenetos, U. Stein, L. Tunesi, K. Abhold, G. Piet, E. Kallenbach, S.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710

Agnesi, B. Bolman, D. Vaughan, J. Reker and E. Royo Gelabert (2019). Multiple pressures and their combined effects in Europe's seas. ETC/ICM Technical Report 4/2019, European Topic Centre on Inland, Coastal and Marine waters**:** 164pp.
Kuehnhanss, C. R. (2019). "The challenges of behavioural insights for effective policy design." Policy and Society **38**(1): 14-40.
Lotze, H. K., H. Guest, J. O'Leary, A. Tuda and D. Wallace (2018). "Public perceptions of marine threats and protection from around the world." Ocean & Coastal Management **152**: 14-22.
Mackay, M., S. Jennings, E. I. van Putten, H. Sibly and S. Yamazaki (2018). "When push comes to shove in recreational fishing compliance, think 'nudge'." Marine Policy **95**: 256-266.
Mildenberger, M., M. Lubell and M. Hummel (2019). "Personalized risk messaging can reduce climate concerns." Global Environmental Change **55**: 15-24.
O'Leary, B. C., C. Fonseca, C. C. Cornet, M. B. de Vries, A. K. Degia, P. Failler, E. Furlan, J. Garrabou, A. Gil, J. P. Hawkins, D. Krause-Jensen, X. Le Roux, M. A. Peck, G. Pérez, A. M. Queirós, G. Różyński, A. Sanchez-Arcilla, R. Simide, I. Sousa Pinto, E. Trégarot and C. M. Roberts (2023). "Embracing Nature-based Solutions to promote resilient marine and coastal ecosystems." Nature-Based Solutions **3**: 100044.
Oldekop, J. A., G. Holmes, W. E. Harris and K. L. Evans (2016). "A global assessment of the social and conservation outcomes of protected areas." Conservation Biology **30**(1): 133-141.
Rasmussen, A., L. K. Mäder and S. Reher (2018). "With a Little Help From The People? The Role of Public Opinion in Advocacy Success." Comparative Political Studies **51**(2): 139-164.
Schaffer, L. M., B. Oehl and T. Bernauer (2022). "Are policymakers responsive to public demand in climate politics?" Journal of Public Policy **42**(1): 136-164.
Seddon, N., A. Chausson, P. Berry, C. A. J. Girardin, A. Smith and B. Turner (2020). "Understanding the value and limits of nature-based solutions to climate change and other global challenges." Philosophical Transactions of the Royal Society B: Biological Sciences **375**(1794): 20190120.
Taplin, D., H. Clark, I. Collins and D. Colby (2013). Theory of change technical papers: a series of papers to support devlopment of theories of change based on practice in the field. New York, ActKnowledge.
Thomas, J. C. (2012). Citizen, Customer, Partner: Engaging the Public in Public Management. Oxon and New York, Routledge.
Thushari, G. G. N. and J. D. M. Senevirathna (2020). "Plastic pollution in the marine environment." Heliyon **6**(8).
UNEA (2022). Resolution on Nature-based solutions for supporting sustainable development, United Nations Environment Assembly of the United Nations Environment Programme Fifth session.
UNEP (2006). Marine and coastal ecosystems and human wellbeing: A synthesis report based on the findings of the Millennium Ecosystem Assessment., UNEP**:** 76pp.
van Eck, C. W., B. C. Mulder and A. Dewulf (2020). "Online climate change polarization: Interactional framing analysis of climate change blog comments." Science Communication **42**(4): 454-480.
van Valkengoed, A. M., G. Perlaviciute and L. Steg (2022). "Relationships between climate change perceptions and climate adaptation actions: policy support, information seeking, and behaviour." Climatic Change **171**(1): 14.
WEF (2022). The Global Risks Report 2022, World Economic Forum.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869710