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Key components of sustainable climate-smart ocean planning

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Planning of marine areas has spread widely over the past two decades to support sustainable ocean management and governance. However, to succeed in a changing ocean, marine spatial planning (MSP) must be 'climate-smart'— integrating climate-related knowledge, being flexible to changing conditions, and supporting climate actions. While the need for climate-smart MSP has been globally recognized, at a practical level, marine managers and planners require further guidance on how to put it into action. Here, we suggest ten key components that, if well-integrated, would promote the development and implementation of sustainable, equitable, climate-smart MSP initiatives around the globe.

Marine spatial planning (MSP) is an ecosystem-based process for balancing multiple human demands with the ecological requirements for a healthy ocean that delivers multiple ecosystem services[1,2]. MSP is one component of integrated ocean management strategies that focuses on spatial aspects of management and is intended to support local, regional and global ocean sustainability goals — e.g., the United Nations (UN) Sustainable Development Goal 14. However, to deliver these outcomes in a changing ocean, MSP must be 'climate-smart', that is integrate climate-related knowledge, be flexible and adapt to changing conditions, and support climate adaptation and mitigation actions[3,4]. Aligned with the Paris Agreement and the European Green Deal goals of reducing greenhouse gas emissions and adapting to climate impacts, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) and the European Commission recently launched a joint MSP roadmap that identifies the development of climate-smart MSP as one of the six key priority areas for 2022–2027[5]. Several other international documents highlight the need for climate-smart MSP, including those produced by the World Bank[6], UNESCO[7], and UN Global Compact[8]. Awareness of the benefits of climate-smart MSP is also growing globally, with countries such as Barbados, Sweden, Mozambique, and Ireland identifying the need to incorporate climate considerations into their ocean plans[9]. At the scientific level, studies have used modeling approaches to unravel the potential benefits of adopting climate-smart MSP (e.g.[10,11]). Although recognition of the need for climate-smart MSP in these policies and studies is timely and welcome, at a practical level, managers and planners require further guidance on how to put it into action.

To overcome this challenge, we suggest ten key components that, if well-integrated into MSP practices, would promote climate-smart MSP (Fig. 1). The proposed components draw from discussions held at a dedicated scientific session at the 11th biennial 'People and the Sea Conference'[12] further enriched with most recent debates (e.g. refs. 9, 13) and topical literature. The ten components are interrelated and function best as a coherent whole. However, we recognize that the components are context-

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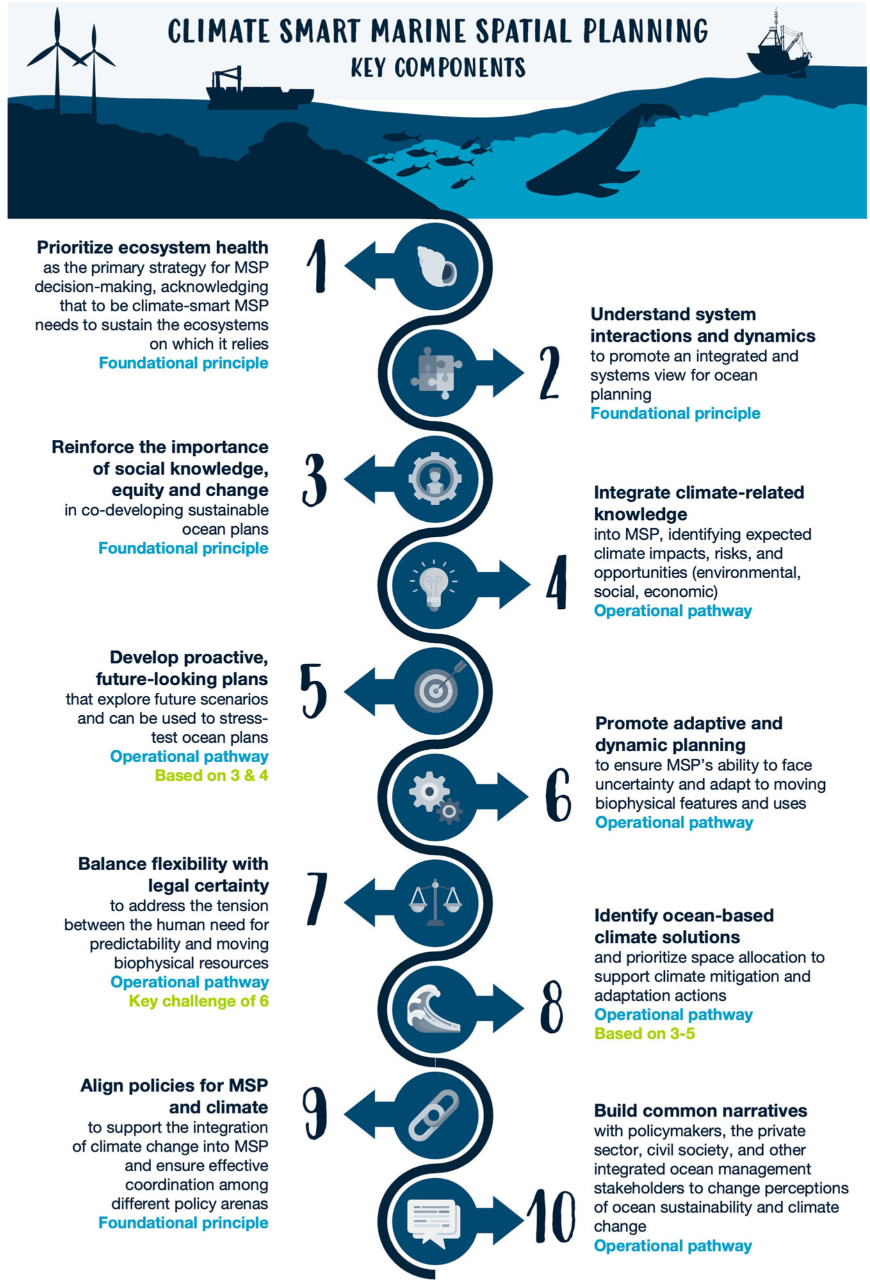

Fig. 1 | Key components of sustainable climate-smart marine spatial planning. To be sustainable, equitable, effective and robust under a changing ocean, MSP should be guided by a number of key components, some of a more operational nature, others more conceptual.

dependent (e.g., influenced by social, economic, political, environmental contexts), with some being more prevalent than others. In developing climate-smart MSP initiatives, some components can be perceived as 'foundational principles' underpinning the development of the plans (e.g., components 1, 2, 3 and 9; Fig. 1). Others are of a more practical nature (e.g., components 4, 6, 8 and 10), being seen as operational pathways to effectively integrating climate considerations into MSP[4]. Each component, therefore, has a specific entry point into the planning process (Table 1). With this Perspective, we aim to promote further debate and advance a highly relevant topic for the future health of our ocean. Identified components are also intended to support the assessment and monitoring of the level of 'climate-smartness' of different MSP initiatives (Box 1).

Prioritizing ocean health

The debate on finding the right balance between socioeconomic development and biodiversity conservation is not new; it is a widespread challenge in MSP development that goes far beyond a climate-related context[14–16]. Yet, it gains renewed relevance in the context of a changing ocean. It is increasingly recognized that the ocean plays a critical role in addressing climate change[17,18] and that biodiversity conservation efforts can support climate adaptation and mitigation[19,20]. Thus, having MSP processes that support marine ecosystem function and the delivery of ecosystem services will contribute to climate resilience. To be climate-smart, MSP must first be 'conservation ready'[21] or 'ecosystem-based'[22]. This means recognizing conservation as enabling ocean use and enhancing benefits to society in the long term[23,24], rather than simply as a spatial constraint to socioeconomic development. Furthermore, not only must marine spatial plans be guided by the general goal of supporting biodiversity conservation and ecosystem health (among other values), but there must also be the political will and the legislative mechanisms in place to have those plans implemented. We must not only be conservation-ready, we must act on that readiness.

Table 1 | Entry points for implementing climate-smart consideration into marine spatial planning (MSP)

Key component	Stage of planning according to the UNESCO MSP guide[2]
Component 1. Prioritizing ecosystem health	Foundational to the entire planning process
Component 2. System interactions and dynamics	Foundational to the entire planning process
Component 3. Social knowledge, equity and change	Foundational to the entire planning process
Component 4. Climate-related knowledge	Defining and Analyzing Existing Conditions (step 5) Defining and Analyzing Future Conditions (step 6) Monitoring and Evaluating Performance (step 9)
Component 5. Future-looking plans	Preparing and Approving the Spatial Management Plan (step 7) Monitoring and Evaluating Performance (step 9)
Component 6. Adaptive and dynamic planning	Monitoring and Evaluating Performance (step 9) Adapting the Spatial Management Process (step 10)
Component 7. Balance flexibility and legal certainty	Preparing and Approving the Spatial Management Plan (step 7) Implementing & Enforcing the Spatial Management Plan Measures (step 8) Adapting the Spatial Management Process (step 10)
Component 8. Ocean-based climate solutions	Defining and Analyzing Existing Conditions (step 5) Defining and Analyzing Future Conditions (step 6) Preparing and Approving the Spatial Management Plan (step 7)
Component 9. MSP and climate policies	Foundational to the entire planning process
Component 10. Building common narratives	Organizing Stakeholder Participation (step 4) Preparing and Approving the Spatial Management Plan (step 7) Implementing & Enforcing the Spatial Management Plan Measures (step 8) Adapting the Spatial Management Process (step 10)

Conservation planning can be used to create an effective strategy for all spatial allocation decisions — the levels of ocean use that are allowed, where, and when. In short, ocean health, and the role of conservation in supporting that, needs to be prioritized as the foundation for MSP (*component 1*; Fig. 1). However, to accomplish this, a paradigm shift is needed[4]. Conservation cannot continue to be (mis)perceived as 'only another sector' at the decision-making table, nor can it be equated simply to implementing marine protected areas (MPAs)[14], or as a limitation to socioeconomic development. A new narrative[25] or 'planning logic' is needed to overcome traditional debates that pit conservation against development. Sustainability will be possible only if and when this false dichotomy is dispelled (e.g., tourism and fisheries depend on healthy ecosystems and their proximity to land to be successful), and when unsustainable forms of resource use are limited to avoid irreversible harm to the marine environment. A new paradigm that prioritizes ocean health will require communicating deeply with MSP decision-makers and stakeholders, raising awareness, building capacity, and changing minds and 'hearts' through ocean literacy (see component 10). It will also require the recognition of complex social-ecological systems, the human dependency on the ocean, and a 'systems view' of planning (see components 2 and 3). A transformation in ocean governance is needed, based on principles that recognize the feedback links between human and ocean health[26].

System interactions and dynamics

Sustainable, equitable, climate-smart MSP is not 'just' MSP. It includes marine, coastal, watershed, and terrestrial planning and management, and all the interconnections in between[27]. It needs to consider how climate change will affect all elements linked to the ocean and its health[28]. For example, what do managers and planners need to address in estuaries experiencing climate change impacts to boost the management and conservation of key interconnected marine species, habitats, and ecosystem processes? How can a marine spatial plan influence the protection of linked habitats across the land-sea interface, or even the restoration of degraded habitats, to maximize[29,30] resilience in a climate change future? We cannot look through any single sectoral, focal habitat or disciplinary lens. Decision-makers, managers, and planners need 'systems approaches' that view entire social-ecological systems[31] through transdisciplinary lenses (*component 2*; Fig. 1). They need to think through connections, cause-effect relationships, and the functional relationships between multiple causes and related multiple effects[32]. MSP needs to be integrative, incorporate social with ecological knowledge and data (from multiple sources), and address cumulative impacts from human stressors affecting marine management areas (e.g., climate change, coastal development, shipping, pollution, recreational use)[32,33]. This 'systems view' requires the recognition of complex social-ecological dynamics and interactions that support the delivery of ecosystem goods and services, and an integrated vision of planning that crosses biophysical (e.g., ocean-land), social, economic, and political boundaries (e.g., national marine waters). The inseparability of land, sea and people is characteristic of community approaches to management in Oceania[29,30], and lessons from traditional forms of marine management in this region could provide a blueprint for how to holistically consider the social-ecological system to sustainably manage resources.

Social knowledge, equity and change

The impacts of climate change are experienced unequally around the world, with different sectors and groups of society being affected in a multitude of ways, and with various levels of adaptive capacity[34]. Past MSP processes have tended to exclude social considerations, as social science and data tend to be qualitative and not spatial in orientation and, therefore, challenging to integrate into technocratic and data-driven MSP processes[35,36]. However, when social considerations, data and knowledge (e.g., on culture, values, perceptions, traditional knowledge, human well-being, socioeconomics, governance, tenure, rights, important places) are neglected, communities can be marginalized and MSP can lead to 'ocean grabbing' (i.e., processes of "dispossession or appropriation of use, control or access to ocean space or resources from prior resource users, rightsholders or inhabitants (…) by public institutions or private interests"[37]). By contrast, including diverse ways of knowing by incorporating place-based perspectives and traditional knowledge may help to address justice

Box 1 | Checklist for measuring 'climate-smartness' of marine spatial planning (MSP) initiatives

A number of simple queries can be made to any particular MSP initiative to rapidly assess the extent to which climate change is being recognized and integrated (or not) into planning. Such queries — which link to the ten key components proposed — can be further used as a baseline to develop a more detailed system of 'SMART indicators' (i.e., specific, measurable, achievable, relevant, and time-bound) to be used in the monitoring and evaluation of marine spatial plans, and on the assessment of their the 'climate-smartness'.

Some examples are provided below:

- Does the plan address climate change in its objectives?
- Does the plan prioritize ecosystem health, contributing to biodiversity conservation and climate action? *(component 1)*
- Do plans address land-ocean interactions? *(component 2)*
- Does the plan include social considerations, data, and diverse knowledge systems? (component 3)
- Does the plan have equity considerations and concerns? *(component 3)*
- Is the plan co-produced with stakeholders and rightsholders? *(component 3)*
- Is the plan using climate-related modeling tools to assess current/future spatial temporal changes in ocean uses? *(component 4)*
- Is the plan using climate-related modeling tools to assess current/future spatial temporal changes in ecosystem goods and services? *(component 4)*
- Is the plan using climate-related vulnerability and risk tools to assess environmental, social, economic, and governance consequences of change? *(component 4)*
- Is the plan using scenario building processes (e.g., 'visioning' or 'foresighting') to assessing planning alternatives? Does the plan clearly outline the planning timeframe and the likely climate-scenario(s) (e.g., 'business-as-usual') to be considered over that timeframe? *(component 5)*
- Does the plan have adaptive mechanisms for management decisions? *(component 6)*
- Does the plan include monitoring indicators related to climate change effects? *(component 6)*
- Does it allow for areas allocated to a certain use to move following shifting conditions? *(components 6 and 7)*
- Does it prioritize space for ocean-climate solutions? *(component 8)*
- Does the plan identify nature-based approaches for climate change, such as conservation and restoration of blue carbon ecosystems? *(component 8)*
- Does the plan identify areas for renewable ocean energy production? *(component 8)*
- Does the plan refer to other instruments (plans, policies, strategies) that relate to climate change? *(component 9)*
- Does it promote ocean-climate literacy close to stakeholders? *(component 10)*

and equity issues in MSP[38,39]. The co-production of knowledge must be foundational to any MSP process through the mapping of ocean space and human activities with stakeholders and rightsholders (see component 10). Incorporating social considerations into MSP can ensure that benefits deriving from ocean use are equitably distributed among stakeholders and rightsholders, and not concentrated among those who are wealthy and powerful (e.g., private sector and governments). Additionally, by more effectively involving stakeholders and rightsholders[40,41], MSP can further address power imbalances, being mindful that processes are not choreographed to achieve a predetermined outcome, thereby promoting equitable decisions[42,43]. In other words, equitable processes are an 'entry point' for MSP to achieve equitable outcomes.

Recent years have seen advances in both theory and practice of incorporating social knowledge into MSP[44,45], which creates new opportunities and possibilities for communities and rightsholders to articulate human-ocean relations and maintain claims to spaces and resources in the marine environment[46,47]. These advances highlight how climate-smart MSP might integrate a range of human dimensions, diverse knowledge systems and co-production processes, and consider social equity and change (*component 3*; Fig. 1). The 'missing layers' of, for example, human rights, activities and values at sea must be considered alongside biophysical data, to ensure MSP processes are led by the best-available information[48,49]. In a rapidly changing climate and ocean, social changes in some contexts are even more dramatic than ecological ones[50]. Linked to this is the challenge of equity in ocean use[51,52] that is further exacerbated by climate change. Climate-related impacts and conflicts tend to disproportionately affect marginalized human communities when compared with those that are well-resourced[53]. Careful consideration and incorporation of the variety of social impacts to, and contexts of, different people in different places into MSP efforts can therefore help to promote and achieve climate and social justice[54]. Further, an 'equity lens' can change narratives and resolve the conservation-development false dichotomy (see components 1 and 10).

Climate-related knowledge

Integrating knowledge on climate impacts, risks, and opportunities (*component 4*; Fig. 1) is one of the main pathways to ensuring climate-smart MSP. By definition, MSP builds on the analysis of existing and future conditions in marine management areas and in the wider seascape[2] — such as ecologically or biologically important areas (e.g., high biodiversity areas, nursery areas), ocean uses and users (e.g., fishing grounds, shipping routes), and spatial conflicts, compatibilities and opportunities. Understanding how climate-related drivers affect marine biophysical features and how people use them is part of such an analysis[3]. To be effective, MSP requires predictions on what will change (e.g., how, when, and where), and the expected consequences of such change — at social, economic, political, and environmental levels[55]. MSP, therefore, requires knowledge and data across disciplines, scales, and knowledge types[56]. At the forefront of existing approaches, there are modeling tools, such as climate models, ecosystem (trophic) and species distribution models that are used to identify spatial-temporal changes in marine social-ecological systems[10,11]; and spatially explicit vulnerability and risk analyses (social and ecological, qualitative and quantitative)[57–59] that can be used to investigate the consequences of climate-driven changes. For example, models of the movement of fish stocks can be used to predict future risks and conflicts of fisheries resources[60] (see also component 5). There are, however, bottlenecks to the collection and integration of climate information into MSP, resulting in few marine spatial plans explicitly doing so[3]. Limitations can relate to insufficient financial and human resources[3], conceptual resistance to address the topic (e.g., climate denial, climate delay)[61,62], lack of fit-for-purpose data, or the issue of uncertainty in climate projections[63,64]. The latter is of particular concern as scientists will never be able to provide zero-uncertainty projections[65,66]. Practitioners and decision-makers must learn, instead, to proceed under such uncertainty and high complexity. Promising approaches to this purpose include decision theory, thresholds approach, resilience thinking and scenario planning[67] (see component 5). At the same time, even when managers and planners are data-limited, and complex models or data-heavy analyses cannot be developed, they should still take part in climate-smart MSP. Incorporating qualitative knowledge sources, fostering climate-literacy, and changing stakeholders' perceptions on the topic's relevance (see component 10) is a way forward, in addition to building better models and assessment tools.

Forward-looking plans

Adapting to a changing ocean requires an entirely new way of thinking — because humans largely rely on past and essentially local experiences to make decisions[68]. With climate change, however, the past is no longer the sole reference, and there is an urgent need to anticipate future changes[69]. Without future-looking planning, ocean users and stakeholders are left reacting to changes after they occur, a substantially more expensive and disruptive approach[70]. Under a changing ocean, MSP needs to explore trajectories, forecasts, and diverse visions for the future. Proactive, future-looking marine spatial plans (*component 5*; Fig. 1) must be developed[10] based on climate-related knowledge from multiple sources and types (see component 4), and with strong social equity considerations (component 3). For this purpose, a valuable technique is scenario planning[71]. Scenarios are a set of imagined, possible, plausible, and alternative 'futures' that can be linked with scientific predictions, and which are frequently used by managers and decision-makers to stretch perceptions and identify solutions in advance. Creatively describing futures is also referred to as 'visioning' or 'foresighting'[72]. In the ocean, emerging foresighting applications include the *Ocean Futures* research program[73] and the *Radical Ocean Futures* art-science program[74]. Other relevant initiatives include the *Seeds of Good Anthropocenes* project[75] and the *Nature Futures Framework* of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[76]. Imagined futures (from optimistic to catastrophic[57]) can be used to stress-test marine spatial plans, assessing their robustness and adequacy to respond to the range of possible futures. They allow for the identification of new/different areas to be used, new spatial conflicts, new cumulative environmental pressures, and new opportunities for ocean sustainability. However, there is a real need for tools that bridge the gap between data-intensive future climate scenarios, and the maps, indicators, and other visualizations that are needed within the planning process. As mentioned in the previous section, planners and managers must become more comfortable exploring alternative scenarios under uncertainty — expanding awareness of potential states and outcomes, and the probabilities and consequences of outcomes under alternative decisions[67] — rather than waiting for quasi-perfect models and data that may never come. While modeled data on future climates exists within many research organizations, translating such information into usable knowledge requires an understanding of end-user needs and substantial expertise and effort[77]. However, many organizations lack the capacity to effectively consider climate because such tools are not available (e.g. refs. 78, 79). Efforts must be pursued by relevant entities to make climate data usable[80].

Adaptive and dynamic planning

Adapting to change is fundamental in planning[81]. Even with proactive marine spatial plans (see component 5), ecological, social, and economic unexpected developments are inevitable and will require adaptive systems that can appropriately respond to them[10]. Another main operational pathway to climate-smart MSP is, thus, linked to developing mechanisms that are flexible and adaptive to change[82,83] (*component 6*; Fig. 1). Marine spatial plans have traditionally focused on designing 'static' latitude and longitude 'boxes', lacking the flexibility to follow dynamic ocean processes, particularly when boxes are entrenched in legislation (component 7). As climate change affects the ocean, the places where we need to 'draw the lines' in MSP will likely be different than they are now and will continue to change over time. Most ocean uses will need to follow moving biotic resources (e.g., species) and abiotic factors (e.g., currents, winds). In this context, creating management boundaries that move according to such resources and conditions may enable more effective management. Dynamic ocean management (DOM), which changes in space and time at scales relevant to species movements and human use[84,85], has been identified as a potential solution. Using near real-time data, DOM allows for the designation of management areas whose boundaries change in response to shifts in ocean resources (biotic and abiotic) and uses. It provides flexibility, promotes increased adequacy and efficiency in ocean use and narrows spatial-temporal requirements. Practical examples tend to be sectoral, such as fisheries management in the United States and Australia, offshore aquaculture operations in Tasmania, or marine mammal protection in Canada and the United States[84,86,87]. DOM can further allow for the development of MSP at broader scales, such as the high seas, where species and habitats often move[85]. Adaptive management and governance approaches (revising decisions based on obtained results) are also key to ensuring MSP adaptation[88,89]. Most MSP initiatives invest many resources (e.g., time, human, financial) into developing a plan as if it were the endpoint, with little to no investment in an ongoing process that includes public education as well as periodic monitoring and evaluation, or knowledge generation[90,91]. However, without effective monitoring, we cannot tell success from failure. MSP initiatives must be built so the entire planning process, including management, generates the information needed to deal with uncertainty. For this, we need to build mechanisms and indicators that are better able to detect changes induced by the plan as well as natural ones — including in the context of cumulative effects from other human stressors[32] — and integrate them into improved monitoring programs. It is also important that decision-making processes and fora are established to ensure that scientific and local knowledge are effectively communicated and incorporated (see component 10)[92].

Balancing flexibility and legal certainty

In line with the need to be adaptive, MSP needs to find effective ways to manage dynamic systems with rules and regulations, balancing flexibility and legal certainty (*component 7*; Fig. 1). There is a tension and contrast between the human need for predictability and static lines on a map and the dynamic nature of biophysical features. At the same time, for some ocean activities, it is challenging to adapt dynamically through time (e.g., semi-permanent installations such as wind turbines or tidal power are 'stuck in place' for decades). This is why scenario planning and stress-testing are so important; they allow decision-makers to plan ahead carefully for those uses (see component 4). While MSP needs to be designed for change (see component 6), it also needs to ensure legal certainty for ocean users. At a strategic level, the foundation upon which MSP builds needs to be 'set in stone' and robust to changing circumstances (e.g., so that decision-makers cannot go back and overrule established decisions when governments or ministries change)[93]. At the same time, at an operational level, managers need the flexibility to adapt and 'move things around' when needed without disrupting the strategic design. For example, Canadian protected areas are entrenched via legislation, which ensures their contribution to long-term conservation; however, amending such legislation is a complex, often long, process that limits the ability to adapt to change[94]. Planning processes that allow rapid decision-making and adaptation need to be put into law (see component 6) — e.g., in air traffic control, decisions are made about reallocating air space and landing directions in near real-time based on environmental conditions[12,95]. Because integrating uncertainty into a legally binding document is challenging, a potential solution is to set up the rules for making decisions in advance — rather than prespecifying the decisions themselves. For example, MSP can establish that some boundaries must follow an oceanographic feature or a particular species. The latter implies, however, that we establish a set of sound ecological, social, economic and governance indicators, and keep track of feedback loops and monitoring (see component 6). The critical question is, what kind of plan, or what set of rules (for adapting), do we need that work well in any of the future scenarios we envision (see component 5)? We need to decide on those rules in advance so that amendments can be implemented quickly when change happens.

Ocean-based climate solutions

Another important pathway to enable climate-smart MSP is the identification of spatial opportunities to support ocean-based climate adaptation and mitigation solutions (*component 8*; Fig. 1). Climate mitigation actions (human interventions to reduce emissions or enhance the sinks of greenhouse gases[55]) can be supported through MSP in multiple ways, from nature-based approaches to industrial ones[3,4]. For example, the restoration and conservation of blue carbon ecosystems[96,97] — particularly seagrasses, mangroves, and coral reefs — has been largely discussed as a climate mitigation action. Blue carbon ecosystems are large carbon sinks that allow for significant carbon capture and storage. Future-looking ocean plans (see component 5) can identify these ecosystems and prioritize the allocation of space for their restoration and conservation accordingly, in such a way that supports carbon storage and prevents significant emissions if such ecosystems were to be degraded or destroyed[98]. Another mitigation pathway pertains to renewable energy production. As recognized by the UN Global Compact, climate-smart MSP can significantly support the potential for renewable energy production in the ocean[8] (e.g., wind, currents, waves) thus contributing to decreasing sources of greenhouse gases. However, to be sustainable in the long-term and avoid unintended environmental losses, such an approach implies a comprehensive assessment of environmental impacts[99]. Additional mitigation pathways relate to MSP acting as a catalyst, and supporting space allocation to other emerging 'green' industries, such as blue ports, climate-smart aquaculture, or green shipping lanes[100–102] — see further examples in the World Bank's document on climate-informed MSP[6].

As for climate adaptation (the process of adjustment to actual or expected climate effects, to moderate harm or exploit beneficial opportunities[55]) there are also numerous pathways[4]. Nature-based approaches stand out once again, as blue carbon ecosystems play a fundamental role in climate adaptation by being ecosystem engineers, supporting marine biodiversity, enhancing productivity, and increasing ecological resilience[103,104]. Allocating space to protect them (together with other important species and habitats) through MPAs or 'other effective conservation measures' (OECMs) can minimize climate impacts[20,104–107]. At the same time, prioritizing the protection of 'climate refugia' (i.e., areas naturally less prone to be modified by climate change) can also support ecological resilience[108,109]. An additional pathway for climate adaptation through MSP relates to decreasing other local human stressors (non-climatic)[32] and increasing social-ecological resilience by anticipating (and planning to avoid) new use-use and use-environment spatial conflicts[2]. By taking a 'systems view' to the area being managed (see component 2), MSP can also ensure that adaptation actions targeting one sector are not maladaptive to others (leading, for example, to increased vulnerability to climate change, inequitable outcomes, or diminished welfare[55]). Finally, as mentioned in the context of social knowledge, equity, and change (see component 3), the involvement of local stakeholders and communities in MSP processes, particularly in scenario-building exercises (see component 5), provides the opportunity to enhance societal adaptation and resilience to the social impacts of climate change[110,111]. While not always spatially-explicit, important adaptation actions in this context are linked to community-based adaptation, increasing social adaptive capacity, improving risk reduction policies, implementing conflict reduction and resolution measures, and relocating and diversifying economic activities[110].

MSP and climate-related policies

Implementing global ocean sustainability goals requires effective coordination among different policy arenas, and climate-smart MSP must contribute to that integration (*component 9*; Fig. 1). Until recently, there has been a lack of mutual recognition between, and integration of, MSP policies and climate policies[3]. For example, the need to address climate change is not sufficiently imprinted in national and regional MSP policies such as the European MSP Directive (the major MSP policy document in the European Union)[112]. In the latter, while it is stressed that plans are to contribute to climate resilience and consider climate-related long-term changes, no procedural steps are identified. Conversely, MSP (and broader ocean governance) is largely absent from climate strategies and policies. In effect, despite the recognized potential of the ocean to address climate change, only a minority of countries discussed ocean actions as climate solutions in their first round of Nationally Determined Contributions (NDCs)[113,114] (national climate goals under the Paris Agreement). This misalignment between policies makes it more difficult to ensure that climate change is properly integrated as a relevant factor in MSP processes. Yet, new opportunities emerge as the link between MSP and NDCs gains recognition[6,8]. The World Bank identified that MSP can support the implementation and strengthening of NDC commitments[6], for example, by identifying spatial opportunities for ocean-based climate solutions (see component 8) and how to implement NDCs in blue sectors such as ocean energy, fisheries, aquaculture, shipping, and conservation. It further pinpointed that entities responsible for MSP can identify appropriate governance and regulatory frameworks and institutions dealing with climate change, and actively support their inclusion in MSP processes[6]. At the same time, the UN Global Compact identified the important role of MSP as a holistic framework for unlocking the potential for ocean-based climate mitigation and adaptation actions, reconciling different policy priorities (e.g., sustainable food production, energy security, biodiversity), and achieving the objectives of the Paris Agreement[8]. Mutual recognition between climate and MSP frameworks must be continuously pursued to support the development of climate-smart ocean plans.

Building common narratives through co-development

New narratives on the importance of both ocean health (see component 1) and integrating climate knowledge (see component 2) must be built together with policymakers, the private sector, civil society, and other rightsholders and MSP stakeholders (*component 10*; Fig. 1). Scientists, conservationists, and marine planners need to highlight approaches that are working to show why 'conservation ready'[21], ecosystem-based, climate-smart MSP benefits everyone, and takes us towards a sustainable and equitable blue economy[115]. There has been a shift in how (some) people think about ecosystem services and contributions from nature to people, aligned with the idea that we care for nature not because we profit from it, but because we depend on it for material, social and cultural needs and values[116–118]. However, these changes in perceptions cannot be superimposed on individuals; they must be developed 'with' MSP stakeholders and rightsholders (from local communities to the business community, to legislators). Advocacy alone is insufficient. Scientists, conservationists, and planners need to focus on co-developing and co-creating visions, knowledge, capacities, and solutions. In this context, they must carefully manage expectations and provide simple and clear messages to decision-makers and the public, avoid imposing ideas from the top down, and focus on sharing and participating in a discussion with local communities and key actors of an MSP initiative. Breaking the barriers between ocean sectors (and actors), and focusing on building a common narrative for the ocean, conservation, and climate change is crucial. Optimism and continuous engagement are also important, as are positive and compelling narratives of the benefits (because it is very easy to become disillusioned and to focus on negative narratives)[119]. Climate adaptation and mitigation can deliver a productive future for everyone, and we need to share this message. We cannot afford to give up and be hopeless about ensuring a healthy and productive ocean for generations to come.

Final considerations: Looking to the future

Developing 'traditional' marine spatial plans is already complex[16] and developing climate-smart MSP will be additionally challenging. MSP must be flexible, adaptive, and integrative; it must consider connections, incorporate diverse knowledge types, and ensure equitable decisions. It must prioritize ocean health and build common narratives with decision-makers, rightsholders, and stakeholders. And it must do this complex task effectively, and in an engaging and empowering way. One of the biggest challenges facing climate-smart MSP, however, is persistent uncertainty, although humans have long since learned to navigate complex systems and uncertainty (e.g., in the business arena). So, while climate-smart MSP is complex, we believe it is doable and, above all, necessary. Climate-smart MSP can contribute to ocean sustainability, anticipating future changes in marine social-ecological systems, ameliorating negative consequences for societies, lessening anthropogenic impacts on ecosystems, and promoting the equitable flow of benefits.

New opportunities and challenges will arise with the implementation of the new High Seas treaty (the Agreement under the UN Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction — BBNJ)[120]. The latter recognizes the importance of "developing, implementing, monitoring, managing and enforcing area-based management tools" to conserve, and sustainably use the High Seas. As MSP is an area-based management tool[121], the idea of MSP in the High Seas[122] will certainly regain new attention. Making sure that such new initiatives are climate-smart is an opportunity that we cannot afford to miss.

The ten key components of climate-smart MSP proposed here provide guidance on how to move towards a sustainable ocean for all[123]. Ultimately, they might lead to the creation of 'codes of conduct' to be followed within specific MSP initiatives. At the very least, they offer a basis for the further development of indicators to continuously measure the 'climate-smartness' (Box 1) of present and future MSP initiatives.

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Author contributions

C.F.S. conceptualised and developed the first draft of the manuscript. All authors commented on initial drafts and contributed to the final version of the manuscript. J.M.R. created Fig. 1.

Competing interests

The authors declare no competing interests.

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