One Earth

CellPress
OPEN ACCESS

Perspective

A framework to identify barriers and levers to increase the levels of protection of marine protected areas

Marieke Schultz,[1,*] Victor Brun,[1] Molly Wingate,[1] Philippe Cury,[2] Françoise Gaill,[3,4] Marie-Alexandrine Sicre,[5] and Joachim Claudet[1]

[1]National Center for Scientific Research, PSL Université Paris, CRIOBE, CNRS-EPHE-UPVD, Maison de l'Océan, 195 rue Saint-Jacques, 75005 Paris, France
[2]IRD, UMR MARBEC (Université de Montpellier/CNRS/IRD/IFREMER), Sète, France
[3]National Center for Scientific Research, Institute of Ecology and Environment (INEE-CNRS), 3 rue Michel Ange, 75016 Paris, France
[4]Ocean and Climate Platform, Maison des Océans, 195 rue Saint-Jacques, 75005 Paris, France
[5]LOCEAN, Sorbonne Université, CNRS/IRD/MNHN, 4 place Jussieu, Case 100, 75252 Paris Cedex 05, France
*Correspondence: marieke.schultz@imbrsea.eu
https://doi.org/10.1016/j.oneear.2022.08.007

SUMMARY

Marine protected areas (MPAs) are a key conservation tool to meet the objectives of ocean protection policies. Many MPAs fail to be effective because of too weak levels of protection, and some governments aim to increase the coverage of fully and highly protected areas within their waters. However, governments face numerous barriers in translating their commitments into effective conservation measures. Here, we propose a three-step framework to identify the barriers faced when designating and implementing specific levels of protection and to design an action plan to lever these barriers. Using France as a case study, we found that differing stakeholders' perceptions and impaired interaction between stakeholders and decision makers hamper the transition from ambitions to action. We suggest a two-tiered action plan to address these barriers, acting at both deep and shallow leverage points. Enhancing participation and holding decision makers accountable for their commitments while mobilizing financial capital and simplifying governance will facilitate the implementation of effective conservation measures with adequate levels of protection.

INTRODUCTION

Marine protected areas (MPAs) are defined geographical spaces that are recognized, dedicated, and managed to achieve the long-term conservation of nature.[1] Their effectiveness in protecting biodiversity and ensuring ecosystem services provision is well demonstrated.[2–5] Since 1982, governments have used MPA coverage to set international objectives for the protection of the ocean.[6–8] The 196 Parties of the Convention on Biological Diversity (CBD, 2010) committed to protecting 10% of their coastal and marine waters with MPAs by 2020.[6] However, as of August 2022, only 8.13% of the global ocean is covered by MPAs,[9] meaning that the CBD Aichi 11 target to protect 10% of the ocean by 2020 has not been reached.[10]

The conservation community argues that both policy commitments on MPA implementation and their effective establishment should be improved. With the increasing rate of biodiversity and ecosystem function loss through overfishing, sea-use change, species invasion, pollution, and climate change,[11] the scientific community has called for an upgrade of marine conservation.[12–14] Some scientists argue for the need to cover a larger portion (20%–50%) of the ocean with MPAs.[15–17] Others, demonstrating that most of the documented benefits of MPA stem from MPAs with no extractive activities,[3,18–22] highlight the need to distinguish between different levels of protection of MPAs, based on the restrictions they impose.[22,23] The highest levels of protection (i.e., fully and highly protected areas, which strictly restrict extractive activities within MPA boundaries), should be implemented more widely to sustain marine biodiversity and ensure ecosystem services provision.[10] For instance, maximum fisheries benefits occur when at least one-third of an MPA is fully protected.[10,24]

This call to upgrade marine conservation was heard by many governments, which have committed to protecting larger portions of the ocean with higher levels of protection. More than 100 countries have voluntarily committed to protecting 30% of the ocean by 2030,[25] and at least 16 have called for this protection to be fully and highly protected MPAs.[26] In its 2030 Biodiversity Strategy, the European Union (EU) stipulates that, out of the 30% of its seas that must be protected, one-third must be under "strict protection."[27] To reach such targets, considerable progress needs to be made. Fully and highly protected areas are lagging behind lower levels of protection, such that only 2.4% of the global ocean is covered by these levels of protection.[28] For example, in the Mediterranean Sea, less than 0.3% of the basin is covered by fully or highly protected areas.[29] In the northeast Atlantic Ocean, less than 0.003% of the OSPAR regional sea convention area is covered by fully or highly protected areas.[30]

When moving from theoretical commitments to actual designation and implementation of protection-level-specific

conservation measures, governments may face several challenges. However, these challenges remain poorly known. The lack of political will or the lack of resources are often pointed out as barriers to implementing restrictive MPAs. Yet, to our knowledge, no published study has demonstrated what are the barriers and levers to designate and effectively implement highly and fully protected MPAs over less protected MPAs. In addition, stakeholders' perception on the type and weight of barriers that hinder the designation and implementation of effective MPAs may differ according to MPA protection levels. If some barriers are common across the types of MPAs, then the levers to remove these barriers can be protection-level specific. The lack of knowledge on the potential barriers to MPA implementation, on how they are perceived by stakeholders, and how to lever them hinders the development of comprehensive action plans to achieve protection-level-specific MPA targets.

Here, using a social-ecological approach informed by studies on sustainable futures[31–35] and transformative changes,[34,36–40] we developed a framework allowing the identification of the key barriers and levers to the implementation of specific levels of marine protection. This framework aims to identify stakeholders' perception of what actions (and their respective leverage points) should be prioritized to ensure the effective designation and implementation of highly and fully protected MPAs. We use France as a case study to illustrate the potential of our framework, but it is applicable at different geographical scales and it can target different groups of stakeholders, which makes it useful for any country engaged with increasing its MPAs level of protection. This framework is solution oriented—it provides keys to achieving MPA targets.

A framework to achieve protection-level-specific targets

We present a framework articulated into three steps. Each step aims to address a challenge faced through the process of translating government commitments into the designation and the implementation of specific levels of marine protection. For convenience, we refer to this process as MPA implementation throughout this perspective. All together, these steps should help to guide the identification of barriers and their relative weights specific to each level of protection, to select suitable levers to overcome these barriers, and to prioritize those levers as part of an action plan.

Step 1: Identification of barriers and levers

The first challenge addressed by our framework is the lack of knowledge of the potential barriers the MPA implementation process may face, and the actions needed to address them (i.e., the levers). To identify these potential barriers and levers, we recommend carrying out a review of the gray and scientific literature. The review can aim to gather a list of the barriers that can be faced and the levers that can be used when implementing conservation measures in general. Then, the lists of levers and barriers can be refined using more context-specific scientific or gray literature (e.g., practical reports from regional MPA implementation), depending on the frame of the study. Interviews with different stakeholders may also be carried out. At this point, the barriers and levers should be considered hypothetical, and their validity for specific levels of protection is assessed in the following step.

Step 2: Assessment of barriers and levers

The second challenge to address is the lack of knowledge of how parties involved in MPA implementation themselves apprehend potential barriers and levers. Our second proposed step consists of collecting stakeholders' perception of the identified barriers and levers. This can be done via direct or online surveys. One or more groups of stakeholders, or MPA experts, should be targeted and specifically contacted to participate in the survey. The number and type of levels of MPA protection one wishes to investigate should be chosen and explicitly defined in the survey. We recommend using the levels of protection defined in the new MPA guide[10] because they are clearly defined and the associated social-ecological benefits are known. Surveys should be semi-structured, with close-ended and open-ended questions, and include three elements: (1) an evaluation of the intensity of each proposed barrier for each level of protection of interest, (2) a selection of the levers that can help overcome the barriers independently of the level of protection, and (3) the possibility for the respondents to add additional barriers and/or levers. Ideally, multiple stakeholder groups at different geographical scales (e.g., regional and national) should be surveyed. The results of the different groups could then be analyzed to identify potential synergies across groups and scales that could constitute levers for MPA implementation.

Step 3: Definition of an action plan

The third challenge addressed is the development of an operational action plan to implement targeted marine protection levels. This last step is designed to define pathways toward successful implementation while accounting for the specific barriers and levers to achievement. The first two elements of the survey (i.e., the rating of the intensity of the barriers and the matching of the levers with the barriers) can be analyzed quantitatively. This analysis helps to determine whether the barriers differ according to the level of protection considered. The predominant barriers for each protection level should be identified. This analysis also allows for the determination of the scope of action for each lever (i.e., what barriers each lever can be used for and whether some levers can address more barriers or stronger barriers than others). Barriers and levers may also be grouped according to the component of the social-ecological system they act upon (e.g., the "resources" or the "users"). The third element of the survey (i.e., the provision of additional barriers and levers through an open-ended question) can be analyzed qualitatively. The analysis should sort out whether the new contributions are providing new barriers or levers and which component of the social-ecological system they act upon. The aim of those analyses is to prioritize the barriers that should be levered first to trigger positive feedback loops on other barriers. The identification of such pathways should then be translated into an action plan that clearly states the priority actions needed for implementing the marine protection levels of interest.

Illustration of the framework: France as a case study

To show the potential of this framework, we trialed it by focusing on the case study of French MPA experts. France, the second largest exclusive economic zone, including its overseas territories, has its own MPA coverage objectives. It aims to place 30% of its waters within an MPA, including one-third in strong protection.[23,41] The timeline to achieve this has been postponed

multiple times. At the 2020 International Union for Conservation of Nature (IUCN) world conservation congress, French President Emmanuel Macron also established a specific target for the French Mediterranean: 5% of its waters shall be strongly protected by 2027. With its 631 designated MPAs, France has already reached its 30% coverage target, but France faces challenges in operationalizing its protection-level-specific target because fewer than 1.6% of global French waters and 0.1% of French Mediterranean waters are fully or highly protected.[18,28] France thus appears to be a good case study for understanding the barriers to strong protection implementation over moderate protection and for identifying the pathways to overcoming these barriers.

We used our framework to identify the barriers and levers to the implementation and effective management of MPAs for two categories of levels of MPA protection: moderate and strong protection. We define an effective management, *sensu* Hockings,[42] as one that sets objectives and that ensures appropriate design, processes, and actions to deliver on these objectives. We defined strong protection as non-extraction areas or areas where only light extractive activities are allowed and moderate protection as areas where protection measures exist but where the majority of extractive activities are allowed. These definitions correspond, respectively, to the highest protection levels (full and high protection) and lowest protection levels (moderate and poor) defined in the MPA guide.[10]

While our framework can be applied to many different stakeholder groups, we chose to focus here on MPAs experts: people working on or within MPAs and hence directly linked with their implementation and management. Given their high hierarchical position within their organization, these experts have an overall view of the topic that allows them to make assessments that are not based on single personal experiences. In the following, we present and discuss our results for French MPAs.

Potential barriers and levers

On the basis of a literature review of scientific and gray literature, we compiled a list of 12 barriers and a list of 11 levers applicable to the French context (Table 1). The barriers are sorted into three groups according to the characteristics of the social-ecological system they refer to.[36,43]

- Barriers linked to the stakeholders' system of values and their objectives and perceptions that underlie the decision making within the system, herein named "intent barriers"
- Barriers linked to the way MPAs are implemented and function through their governance regime and institutions, herein named "governance barriers"
- Barriers linked to the resources available and necessary to the implementation and functioning of an MPA, herein named "resource barriers"

Experts' assessment

Of the 239 MPA experts we reached out to, 53 took part in the survey. A total of 81% of the respondents were working in associations, academia, or government. Most of the experts from fishing, tourism, and shipping sectors did not respond (Figures S1–S3; Table S1). The influence of the sector of activity of the respondents on the answers was not supported statistically ($F(5) = 2.32$, $p = 0.06$), indicating that the score assigned to the barriers by an expert cannot be predicted looking solely at his or her sector of activity. However, descriptive analysis revealed diverging answers between certain sectors of activities. For example, 50% of experts from the government did not consider "knowledge" as a barrier (i.e., they stated that the barrier is non-existent; 0 score), while 89% of the researchers assessed "knowledge" as being a barrier (i.e., they stated that the barrier is weak, medium, or strong [scores 1, 2, or 3, respectively]). For the barrier "common standard," none of the experts working in an association opted for the 0 score, whereas 38% of the MPA managers did (see section below for the full list of barriers).

With that in mind, the results presented below should be regarded as based mainly on the perspective of MPA experts in academia, associations, and government.

The mean level of agreement of the respondents across all of the barrier's questions was 52% (SD = 7.81). For the barriers "knowledge," "common standards," and "monitoring," the level of agreement fell below 50%: 43%, 42%, and 37%, respectively. The level of agreement was positively correlated with the intensity of the barrier assessed ($R = 0.72$, $p < 0.001$) (i.e., the respondents tend to agree more on barriers with high intensity than on barriers with lower intensities) (see Figure S3).

Overall, the intensity of the barriers across protection levels did not differ significantly ($F(11) = 1.3$, $p = 0.22$). The level of protection alone did not have a significant effect on the intensity scores ($F(1) = 2.83$, $p = 0.09$). This indicates that barriers were not necessarily more intense in strong protection than in moderate. However, importantly, the intensities of the barriers were statistically different from one another ($p < 0.01$). This is true for both moderate protection ($p < 0.01$) and strong protection ($p < 0.01$). This means that some barriers represented more important obstacles than others and that this relative intensity of the barriers was not the same according to the level of protection considered (Figure 1, left).

The most intense barriers in strong protection were the "different and potentially conflicting perceptions of MPA benefits" ("perception") and the "lack of prioritization of the conservation measures by the decision makers" ("policy"). In contrast, the "lack of scientific knowledge" was assessed as the least intense barrier for both strong and moderate protection (Figure 1, left). These results are consistent with the increasing recognition that a major barrier to conservation implementation and success is not the lack of knowledge in the natural sciences,[72] but rather, the human behavior and support toward conservation measures.[56,73–76] The results on the groups of barriers further illustrate this finding and differentiates between the dominant barriers faced in strong and moderate protection. In strong protection, the "intent" barriers significantly prevailed over "resources" barriers and "governance" barriers ($p < 0.05$). In addition, "intent" barriers were significantly more intense in strong protection than in moderate protection ($p < 0.05$), while "governance" and "resources" barriers were equally and less intense, respectively, in strong protection compared with moderate protection (Figure 1, right).

Ives and Kendal[77] showed that the value systems of stakeholders shape their perceptions of conservation measures. This is consistent with our results showing that the "intent"

Table 1. List of the potential barriers and levers to MPA implementation and effectiveness

Barriers and levers	Definitions
Governance barriers	
Administration	complexity and length of administrative procedures for the creation of MPAs, their development, obtaining funding, etc.[44–46]
Common standards	lack of common standards on the definition of an MPA and the levels of protection[46,47]
Delimitation	lack of clarity in geographic delineation and overlapping regulatory frameworks[45,48]
Regulatory framework	difficulty for managers to make the regulatory framework evolve due to a lack of decision-making or legal prerogatives[46]
Resource barriers	
Information	lack of information to the public or local stakeholders on the role and objectives of MPAs[45,49,50]
Capital	lack of financial or human capital[45,51]
Knowledge	lack of scientific knowledge in natural sciences and/or human and social sciences[45,52,53]
Monitoring	MPAs are not adequately monitored on a long-term basis[54]
Intent barriers	
Participation	not all stakeholders are involved in management and/or do not have the same influence in decision making[44,51,53,55]
Perception	different and potentially conflicting views of the socioeconomic and ecological costs and ecological costs and benefits of MPAs[56–59]
Policy	the use of MPAs as a conservation tool is not a political priority[44,46]
Redistribution	existence of "losers" and "winners" after the establishment of MPAs, restricted or expanded activities, lack of compensation measures, etc.[60,61]
Levers	
Adopt binding regulations (regulations)	enact rules that clearly define prohibited activities and the actors involved[44,45,62]
Develop education on the marine environment (education)	training on the ecological and socioeconomic issues of the marine environment, in schools, in universities, and for professionals[33,45,63]
Design MPAs as an investment opportunity (investment)	think of MPAs as capable of generating economic benefits by developing long-term financing strategies[45,52,55,64]
Encourage transfer of skills between professionals (skills transfer)	strengthen the continuous training between the different professions of the sea[45,52,55]
Encourage stakeholder consultation (consultation)	consult with stakeholders to determine the socioeconomic effects of strong protection, for the establishment of strategies, objectives, and regulations[45,55,65]
Further communicate about the role of MPAs (communication)	develop a clear, long-term communication strategy to promote the results of the researchers' work and raise awareness of the benefits of MPAs[45,49,65–67]
Increase and sustain the MPA budget (budget)	increase and sustain the MPA budget[68,69]
Merge overlapping areas and regulatory frameworks (merge)	unify overlapping tools in the same territory (e.g., within the same MPA or coherent sector)[45]
Promote collaboration between groups of stakeholders (collaboration)	encourage actors to work toward the implementation of common objectives[45,55,65]
Promote participatory research (participatory research)	include non-scientists in MPA research processes (e.g., encourage collaboration between researchers and users in data collection)[45,70,71]
Standardize management and monitoring indicators (standardization)	use scientifically robust and standardized protocols and standardize monitoring systems[45]

For each barrier and lever, a succinct definition is presented, as well as references from which they are derived. Barriers are grouped in three categories according to the component of the social-ecological system to which they refer (governance, resources, and intent; see experimental procedures).

barrier group and the "perception" specific barrier both demonstrate the same behavior, being considered, relative to other barriers, as more intense in strong protection than in moderate protection. Perceptions of conservation management and outcomes determine stakeholders' support for the implementation of conservation measures.[78] In turn, stakeholders' support is key to implementing conservation measures and ensuring the success of MPAs through time.[56,79] Thus, these results, consistent with previous studies, highlight the potential challenges France may face in translating its commitments to implement strong protection into a reality.

The additional barriers suggested by 12 experts (out of 53) in an open-ended question further defined where the barriers occurred in the process to translate a national strategy into implementation. The experts mostly mentioned barriers that intervene upstream of the decision to establish strong protection measures (Table 2). The barriers occurred at places where stakeholders (i.e., people who can be affected by MPAs) and the

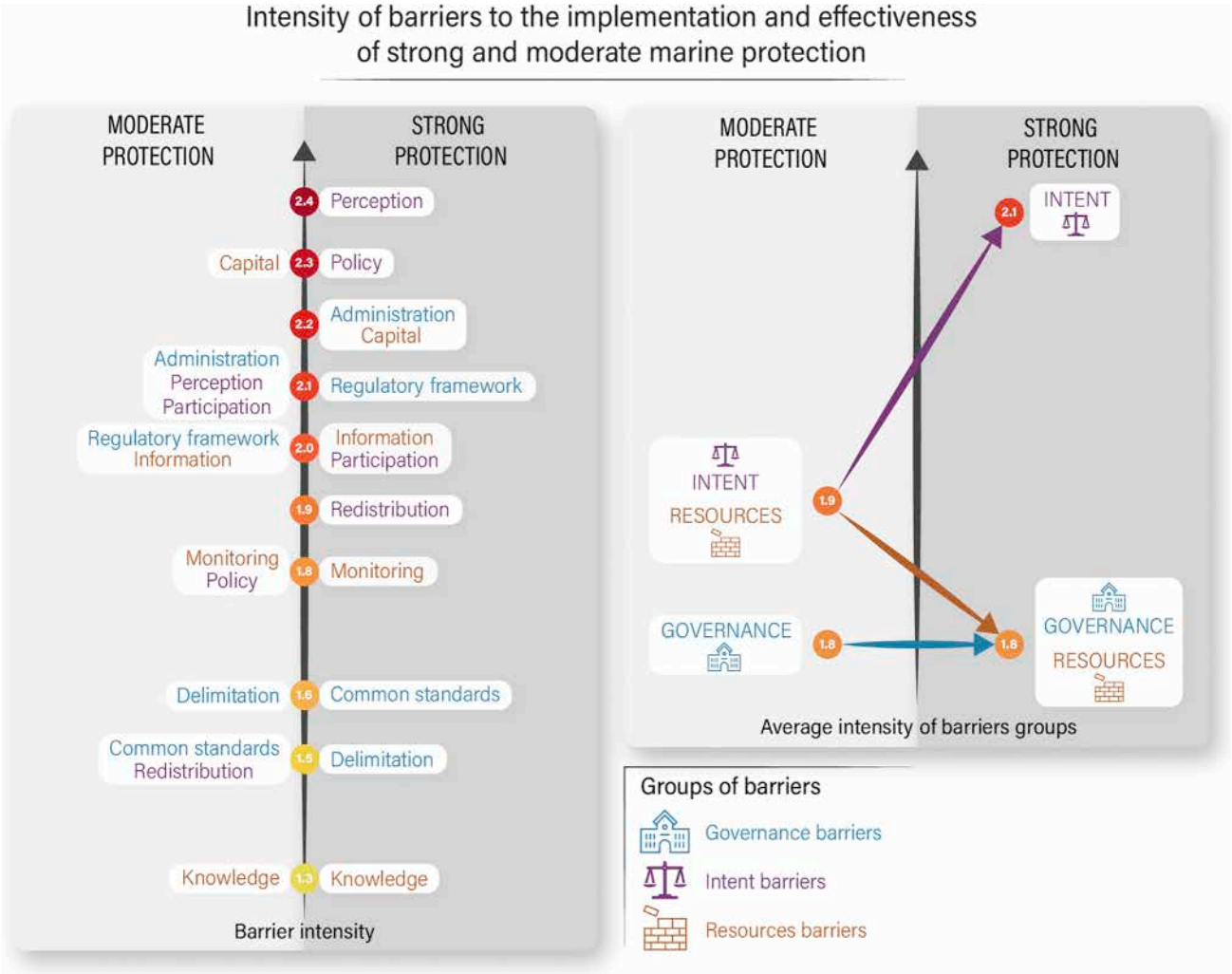


Figure 1. Intensity of barriers to marine protected area (MPA) designation and effective implementation per protection level according to French MPA experts

(Left) Ranking of the barriers according to their assessed intensity by MPA experts for moderate and strong protection. The arrow displays the barriers' intensity (mean of the Likert scores, ranging from 0 to 3, assigned to each barrier by the respondents) in strong and moderate protection. Barriers are defined in Table 1. (Right) Ranking of the barriers' group according to their intensity for moderate and strong protection. The arrows display the intensity of the groups, which corresponds to the mean of the Likert scores assigned to the barriers belonging to each group in strong and moderate protection. Intent barrier intensity is significantly higher in strong protection than in moderate protection ($F(1) = 2.68$, $p = 0.46$). In strong protection, intent barrier intensity is significantly higher than governance and resources intensity ($F(3) = 2.68$, $p < 0.001$). In moderate protection, there are no statistical differences between the groups of barriers ($F(2) = 0.57$, $p = 0.57$).

decision makers (i.e., people who decide on national strategies and are responsible for implementation actions) are involved or should be involved—for example, during participation and stakeholders' engagement processes (Table 2).

With the open-ended question, experts mentioned the "fear of the ministry of defense to see their activity hindered by MPAs" (as MPAs can restrict military exercises), the "important lobbying of the fishing industry against strong protection blocking the decision-making process," and the "gap between the short-term considerations of elected decision makers and the long-term conservation objectives" (Table 2). These results illustrate how the different considerations of stakeholders and decision makers impede the translation of French national strategy into effective decisions to implement conservation measures. The implementation of French MPAs often spans large periods of time (over 16 years for the Iroise MPA[44]), which can encompass local elections and change of state government. In France, the implementation of MPA is led by the central government, mandating a committee, here referred to as decision makers, to orchestrate the consultation of local stakeholders and politicians for the definition of the MPA and its management plan. Facing opposition and conflict between actors, it is common that local politicians and decision makers, bound by the short-term considerations of the electoral system they work in, do not take a stand for strong protection.[44] During the implementation of the Gironde Estuary and Pertuis Sea MPA, the fear of not being re-elected drove the local politicians to position themselves against the implementation, in support of certain groups of stakeholders who

Table 2. Summary of the barriers identified by the respondents in the open-ended question

Expert activity	Cited barrier	Related barrier	Where it occurs	Target
Administration	lobbying of the economic actors of the sea blocking decision-making process or downwarding initial ambitions	participation	upstream decision making	interaction between stakeholders and decision makers
Administration	the Ministry of the Armies' fear of the impediment of strategical defense activities	perception	upstream decision making	stakeholders
Association or NGO	poor listening to the actors in the field	participation	upstream decision making	interaction between stakeholders and decision makers
Association or NGO	lack of knowledge of local and national elected politicians on biodiversity issues	knowledge	upstream decision making	decision makers
Administration	low solicitation of European funds	capital	downstream decision making	decision makers
Association or NGO	short-term political mandates impede decision making for long-term goals	administration	–	governance framework
Association or NGO	complexity of quantitative politics rather than qualitative	administration	–	governance framework
MPA manager	imposed job caps despite the available budget or the potential of these jobs to raise additional funding	administration	–	governance framework
Administration	integrate national objectives into the activities of regional decision makers (French prefects) by means of instructions from the state and by taking into account the work done to implement these objectives in their evaluation	policy	upstream decision making	decision makers

For each answer, we indicate where it occurs in the decision-making process, what component of the social-ecological system is targeted, and to which previously identified barriers or levers it refers.

were more powerful than others.[80] Similarly, for the implementation of the Iroise MPA[48] and the Moorea MPA network,[81] local politicians used their position against the MPAs, as proposed by the government bodies, to gain votes from reluctant stakeholders. Furthermore, decision makers mandated by the government are also influenced by this electoral system: the Gironde Estuary and Pertuis Sea MPA was suspended for 3 years when the government changed in 2012.[80] Consistent with our results, these examples highlight how influenceable local and central government representatives can be.

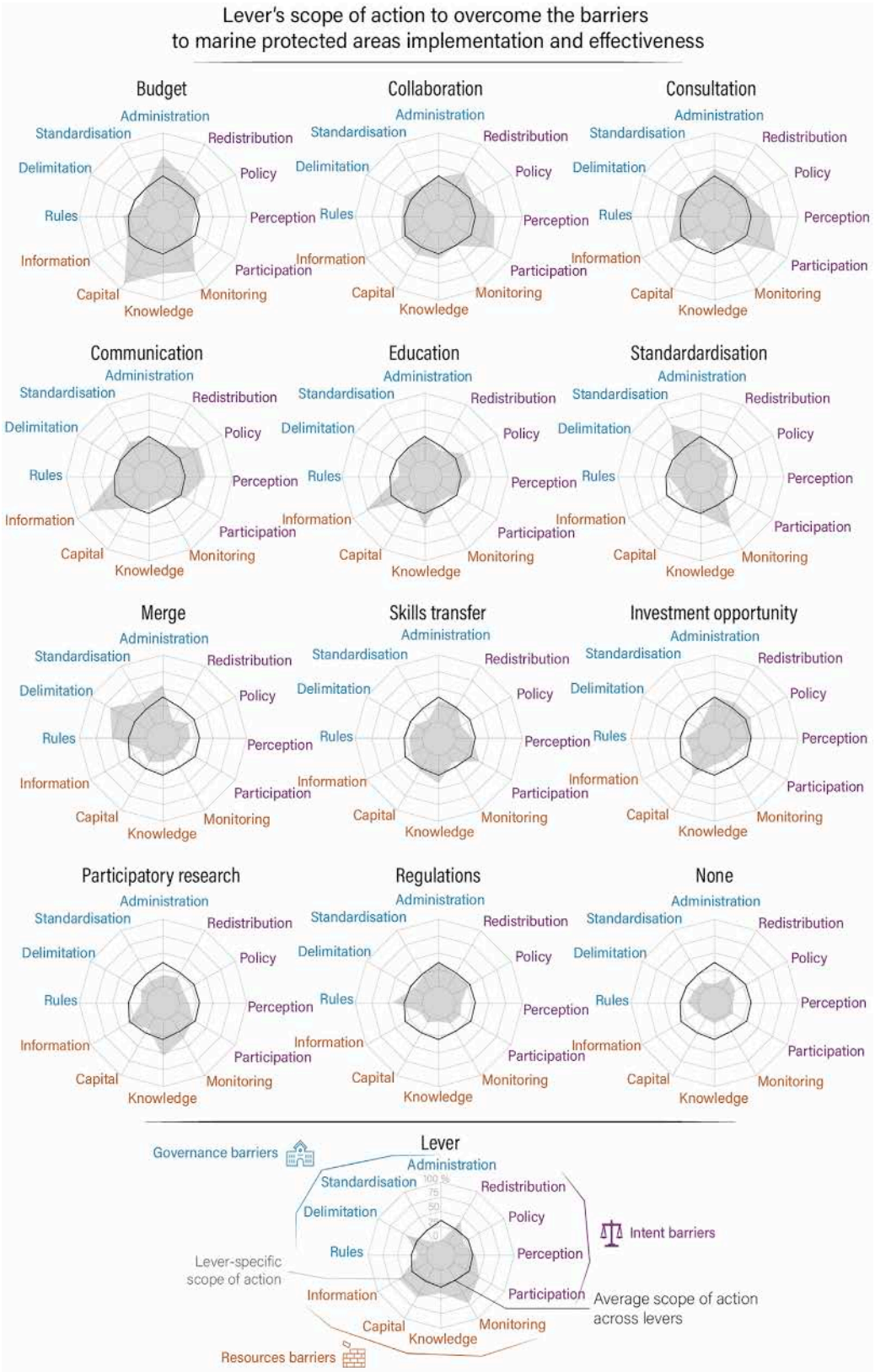
Moderate protection, however, encounters "resources," "intent," and "governance" barriers with no significant predominant intensity ($p > 0.05$) (Figure 1, right). As moderate protection is already widely implemented in France,[18] these barriers most probably occur downstream of the decision to implement measures and relate to the way this implementation is being done.

Based on the proposed 11 levers detected through the literature review (Table 2), we requested that the MPA experts link the levers to the barriers that they felt could contribute to overcoming them. Spider diagrams were used to examine the levers in relation to each barrier (Figure 2).

For each barrier, the majority of the experts (>80%) selected at least one lever that could contribute to address it. For all of the barriers, except "redistribution," at least one lever was selected by more than 50% of the respondents. For the "redistribution" barrier, 49% of the respondents selected the lever "promote collaboration between groups of stakeholders" (Figure 2). This indicates that the tools to lever barriers to conservation implementation were well identified by the experts. Here, we show how to enact them to lever barriers to strong protection implementation.

Meadows[38] and Abson et al.[36] ranked the social-ecological system's characteristics to their potential to trigger systemic change when targeted by actions. They distinguished the "shallow leverage points," where intervention is easy to implement but triggers little change throughout the overall system, from "deep leverage points," where change is more difficult to implement but may trigger an overall shift of the system. Relating this theory to our barrier groups, we determined that "intent" was the deepest system's characteristics (i.e., they have the largest scope and highest potential to trigger change), followed by "governance," while "resources" system's characteristics were the shallowest (i.e., they represent more specific or sectoral leverage points).

Dominant barriers to strong protection, intent barriers, are linked to characteristics of the social-ecological system described as deep leverage points by Abson et al.[36] They relate to the system of values of the stakeholders. Manfredo et al.[82,83] showed that these values cannot be changed by straightforward measures. They are deeply rooted in stakeholders' culture and other underlying mechanisms. Jentoft et al.[84] suggested that, further than perception, it is the images that are deeper "representations of what people believe, what they perceive could happen, and what they think should be," which stakeholders have of MPAs that can constitute a barrier to their implementation. These images stem from people's experiences—from what they have heard through different media and peers—and they guide people's reactions and support for MPAs. The



(legend on next page)

Table 3. Summary of the levers identified by the respondents in the open-ended question

Expert activity	Cited lever	Related lever	Where it occurs	Target
Administration	initiate dialogue at very early stage to find acceptable compromises and common ground	consultation	upstream decision making	interaction between stakeholders and decision makers
Administration	work on how to convince economic stakeholders about the long-term benefits they could foster from marine protection	communication	upstream decision making	stakeholders
Association or NGO	reference MPA by using international impact-based classification system to monitor international commitment achievement	standardize	upstream decision making	decision makers
Association or NGO	from the outset, set up a concerted, multi-stakeholder dynamic	consultation	upstream decision making	interaction between stakeholders and decision makers
Association or NGO	change generations of decision makers and ways of thinking	perception	upstream decision making	decision makers
Association or NGO	establish a more equitable weighting between representatives of economic sectors and those of environmental and social issues within national and regional governance bodies	consultation	upstream decision making	interaction between stakeholders and decision makers
Association or NGO	follow the MPA development roadmap to respect the initial commitments in the long term	monitoring	upstream and downstream decision making	decision makers

For each lever, we indicate where it occurs in the decision-making process, what component of the social-ecological system is targeted, and to which previously identified barriers or levers it refers.

multiplicity and potential incompatibility of these images can represent a barrier to MPA implementation and effective management.

In the survey, some of the answers provided by the experts—"poor listening of the actors in the field" and "unequal weight of the stakeholders in the participation process"—suggested that action should be taken at the level of the interaction between stakeholders and decision makers (Table 2). Levers identified by the experts for intent barriers are "encourage stakeholder's consultation," "further communicate on the role of MPAs," and "promote collaboration between groups of stakeholders" (Figure 2). These results are consistent with Jentoft et al.,[84] suggesting that to lever barriers linked to the multiplicity of deeply rooted images, communication between stakeholders and decision makers should be improved through interactive processes. During the implementation process of the Gironde Estuary and Pertuis Sea MPA, stakeholders from different backgrounds found the chance to get to know one another and exchange about their activities. This was perceived as a successful part of the consultation and probably contributed to the more peaceful exchanges throughout the MPA implementation process.[80] However, during the implementation of Moorea's MPA network, few stakeholders participated in the consultation. Tensions between the different stakeholders and decision makers increased throughout the MPA design and implementation process, leading to downward revision of the objectives, going from planned fully protected MPAs to moderately protected MPAs.[81] Understanding better the different MPA images, where they come from, and what they convey will help resolve potential conflicts around French MPA implementation and management and hence enhance the decision-making process.

Moreover, experts pointed out in the open-ended question that "short-term political mandates hinder decision making for long-term goals" and suggested to "integrate national objectives in regional decision makers evaluation," to "follow the MPA development roadmap to fulfill the initial commitments in the long term," and to "reference MPA using international impact-based classification systems to monitor international commitment achievement" (Table 3). These answers suggest a need for trustworthy and transparent institutions. In addition, Jentoft et al.[84] showed that perceived MPA images depend on the people conveying them. This strengthens the need for reliable institutions and decision makers who carry MPA images supporting their implementation in France.

Acting on shallower leverage points, which are linked to governance and resources, was found to have the potential to trigger

Figure 2. Scope of action of the levers to overcome the barriers to MPA implementation and management effectiveness according to French MPA experts

Each chart shows, in gray, the frequency (in percentage) at which the lever (title of each spider plot) was chosen for each barrier (around the spider plots) by the experts. The black line shows the average frequency of selection of each barrier over all levers (i.e., the line is the same over all of the spider plots). The further to the extremity the gray polygon is, the more experts selected the lever to address the corresponding barrier. When the gray polygon exceeds the black line, it indicates that the lever is more often selected to address the barrier considered than on average any other lever for that same barrier. The wider the gray polygon area, the larger the scope of action of the lever over different barriers. The graphs are ordered by average selection frequency of the lever over all of the barriers. See Table 1 for definitions of the barriers and levers.

positive feedback loops fostering strong protection implementation.

Although not predominantly for strong protection, governance and resource barriers were cited by some respondents in the open-ended questions (Table 2). These barriers impede decision making ("complexity of quantitative policies rather than qualitative" and "lack of knowledge of local and national elected politicians on biodiversity issues"). They also alter the implementation of the measures once the decision has been made ("low solicitation of European funds" and "imposed job caps in spite of the available budget"). The lack of financial and human capital was assessed as the third most important barrier to strong protection (Figure 1, left), and "increasing the MPA budget" was assessed as the lever with the widest scope of action (Figure 2). Because they affect both the decision making and the actual establishment, levering these barriers has the potential to bring about change at the scope of the entire system. Resources can be used as tools to directly change deeper components of the system through direct incentive for stakeholder's change of behavior and change of social norms.[85] Indirectly, resources can trigger profound change in the system through positive feedback loops. Human and financial capital influence MPA effectiveness,[86] and a positive perception of ecological effectiveness is correlated with social support for strong protection. We suggest that strong stakeholder support for protection and conservation policies would have the power to change policy priorities, which would result in allocating more resources to French strongly protected MPA implementation.

Similarly, a simplified governance framework and good management can lever perception barriers, foster support, ease decision making, and ensure conservation success. Levers chosen to address governance barriers such as "merge overlapping areas and regulatory frameworks" (Figure 2) and "offer administration frameworks that are more flexible, allowing more societal responsibility" (Table 3) suggest that simplifying the governance framework would facilitate stakeholder's engagement, hence assisting in decision making and implementing strongly protected MPAs. Thus, resources and governance can be strong leverages in triggering the transformation of the entire system.

On the basis of experts' answers and recommendations from the literature,[68,87] we propose key actions to use resources and governance as levers to efficiently engage changes in France.

Action plan

Based on our results from French MPA experts and the literature on the best practices for MPA implementation and management,[88] we propose a two-tiered action plan to minimize barriers to the implementation of strong protection levels in French MPAs (Figure 3).

First, we propose actions at deep leverage points—for example, targeting stakeholders' and decision makers' systems of value, their objectives, and the image they have of MPAs. French MPAs are intrinsically linked to central government power.[48] Although the initial intent to implement an MPA can result from a local initiative, it is the Ministry of the Sea that orchestrates the consultation process through a state committee. Local stakeholders are designated and invited at the convenience of the committee to choose the design and management plan of the MPA. Eventually, the final decision regarding the MPA designation and management plan lies with the Ministry of the Sea.[80,81] On the basis of our results and on previous research, highlighting the importance of participatory process in decision making[89–91] and the failures due to poor participation framing,[92–94] we propose an enhanced participatory process beyond simple consultation. For stakeholders with different perspectives and decision makers to come to a decision on implementing strong protection, a fair and transparent participation process should be established. Stakeholders should be engaged at the very beginning of the design of goals and measures for the implementation of national commitments and throughout the decision-making process. The role of stakeholders in the participatory process and their influence on the output of the decision should be made clear to avoid frustration and misunderstanding (Figure 3).

Furthermore, on the basis of the MPA experts' answers to the survey, we advise acting at the level of decision makers. We suggest that local politicians and national decision makers' achievement toward the implementation of national and international commitments should be evaluated with the use of international and scientifically supported indicators. These indicators should be publicly shared and understood (Figure 3).

Second, we suggest actions at shallower leverage points—for example, targeting governance systems and resources allocated to the implementation of strong protection downstream of the decision process. As suggested by Sala et al.,[52] we propose using financial resources as a way to change social perspectives on conservation directly through incentives and indirectly through compensations of the short-term loss. In addition, we advise reforming the governance framework to make it more accessible to stakeholders (Figure 3).

Scope and conclusions

Our case study on French MPAs, with the assessments of French experts working in research, government, and associations, demonstrates the potential of our framework to address challenges faced to operationalize protection-level-specific targets into effective conservation measures. Going through the three steps of our framework, we revealed key barriers to the implementation of MPAs in France, and we designed an action plan to achieve 10% coverage of fully and highly protected MPAs in France by using the most effective levers.

Moving beyond moderate protection already in place in France and in many places around the world[4] will require levering barriers undermining the process to translate international and national conservation strategies into concrete measures. The application of our framework to the case of France highlights the need for dual action both at the level of deep-seated barriers and at the level of more superficial barriers of governance and resources to see the implementation of strong marine protection emerge. Implementing fair, transparent, and equitable collaborative actions will facilitate the integration of stakeholders' images of an MPA and facilitate the interactions between stakeholders and decision makers. In conjunction with these measures, actions targeting resources and governance have the potential to lever barriers at different levels in the system through positive feedback loops.

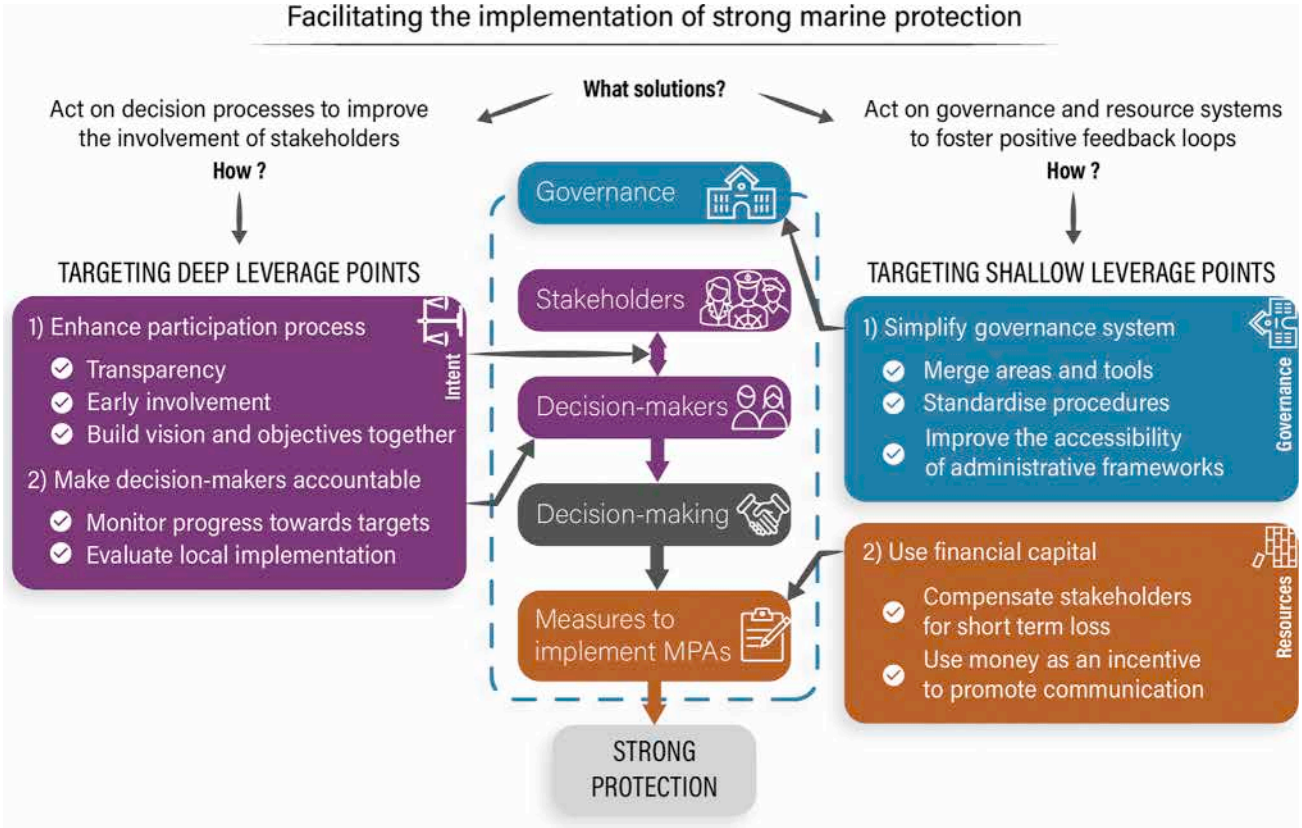


Figure 3. Proposed two-tiered action plan to remove barriers to implementation of MPAs of strong protection on the basis of French MPA experts' assessment

First, we propose actions at deep leverage points that target stakeholders' and decision makers' systems of value, objectives, and perceptions upstream of decision making. Second, we suggest actions at shallower leverage points that target governance systems and resources allocated to the implementation of strong protection downstream of the decision process.

This framework could be applied in future studies surveying multiple groups of stakeholders at multiple geographical scales—for example, targeting different specific MPAs and surveying local and governmental stakeholders. This could help to further determine the barriers to strong protection implementation by investigating stakeholders' dynamics at different levels of the decision-making process.

This perspective builds on scientific work to achieve conservation implementation through a social-ecological approach. Our perspective goes further in proposing a framework to tackle the challenges faced when operationalizing protection-level-specific targets. This "per-level-of-protection"-specific approach is key to achieving conservation targets that acknowledge the need of higher levels of protection. Thus, our proposed framework should be of interest to all countries engaged in increasing the levels of protection of their waters by designating new fully and highly protected MPAs or strengthening their existing MPAs to full and high protection.

EXPERIMENTAL PROCEDURES

Resource availability

Lead contact

Further information and requests should be directed to the lead contact, Marieke Schultz (marieke.schultz@imbrsea.eu).

Materials availability

This study did not generate any new materials.

Data and code availability

With respect to the EU General Data Protection Regulation, answers of the survey cannot be publicly shared; thus, the dataset resulting from the survey cannot be published with this article. No new code was used in this study.

Identification of barriers and levers

To complete the first step of our framework, we reviewed the scientific and gray literature. We extracted the barriers and levers identified in the Assessment of the National Strategy for the Implementation and Management of MPAs between 2012 and 2020 carried out by the consulting firm ACTéon[45] at the request of the French Office for Biodiversity, a French government agency. We analyzed barriers and levers identified by scientists and non-governmental organizations (NGOs) in the broader context of conservation implementation and effectiveness, both terrestrial and marine. We retained barriers and levers that were applicable to the French context, which is a wealthy democracy in which a national conservation strategy has already been developed. We compiled two lists, one for the barriers and one for the levers, and we provided a definition for each item.

Assessment of the barriers and levers

In the second step of our framework, we collected French MPA experts' perceptions through an online survey that we designed. The survey was sent to a pool of n = 239 experts (researchers, MPA managers, government and local authority administrators, administrators in associations and NGOs, professionals of the fishing and tourism industry, and private consultants in MPA management). In the survey, the respondents mentioned their sector of activity (see Notes S1–S3 for further details on the survey procedure).

The survey provided the aim of the study and the definition associated with the levels of protection considered. Strong protection was defined as non-extraction areas or areas where only light extractive activities are allowed. Moderate protection was defined as areas where protection measures exist, but where the majority of extractive activities are allowed. These definitions correspond, respectively, to highest protection levels—full and high protection—and lowest protection levels—moderate and poor—defined in the MPA guide.[10]

The survey breaks down in three parts. First, the experts assessed the intensity of the proposed barriers, in strong protection and in moderate protection, by using a four-point Likert scale (the barrier is non-existent, 0; weak, 1; medium, 2; or strong, 3). Second, the experts were asked, for each of the 12 barriers, to select among the 11 identified levers the one(s) that could help address it. They had the option to choose "none of these levers can address this barrier." Third, the experts could mention additional barriers and/or levers in an open-ended question.

Definition of an action plan

In the third step of our framework, we analyzed the results of the survey to design an action plan for the implementation of strong MPA protection in France.

Quantitative analyses were carried out for the first two parts of the survey as follows. Likert scores assessing barrier intensity were treated as a continuous variable.[95] The influence of the variables—respondents, barriers, and protection level—on the scores assigned to the barriers were assessed through ANOVA. Variability linked to inter-individual respondents' effect was accounted for by carrying out repeated-measures ANOVA. The level of agreement among the respondents on the barriers' intensity was assessed using the consensus measure proposed by Tastle and Wierman.[96] Barriers were then grouped using a factorial analysis according to the social-ecological system's characteristics theorized by Ostrom,[43] Abson et al.,[36] and Meadows[38] to define the groups. Ostrom[43] theorized a general model of a social-ecological system with four core subsystems: resource units, resource system, governance systems, and users. Meadows[38] identified 12 leverage points, places within a system on where to act to transform the system, and hierarchized them according to their capacity to trigger change within a system when targeted by an action. Abson et al.[36] classified these leverage points into four categories based on the characteristics of the system to which they refer: parameters, feedback, design, and intent. We adapted these categories to classify our barriers into four groups.

The scope of action for each lever was assessed by calculating the mean frequency of selection of a leverage for a barrier. Open-ended questions were analyzed thematically following an inductive approach to sort out the answers according to whether they are providing barriers or levers. Then, we determined where in the social-ecological system these barriers and levers were occurring, whether they relate to previously identified levers and barriers, and in which manner.

Using these analyses and scientific literature, we designed an action plan to clearly indicate which levers should be actioned in priority to ensure the implementation of strongly protected French MPAs.

SUPPLEMENTAL INFORMATION

Supplemental information can be found online at https://doi.org/10.1016/j.oneear.2022.08.007.

ACKNOWLEDGMENTS

We thank Future Earth for gathering the scientific committee that validated this work, with particular regards to Clément Brousse, who planned the meetings and orchestrated the dissemination of the survey. We also thank two anonymous reviewers who gave useful feedback on an earlier version of this manuscript. This work received funding from Fondation de France (MultiNet) and BiodivERsA (METRODIVER).

AUTHOR CONTRIBUTION

Conceptualization, J.C.; methodology, M.S., V.B., M.W., and J.C.; validation, P.C., M.-A.S., F.G., and J.C.; formal analysis, M.S.; data curation, M.S.; writing – original draft, M.S. and J.C.; writing – review & editing, M.S., V.B., P.C., F.G., M.-A.S., and J.C.; visualization, M.S., V.B., and J.C.; supervision, J.C.; funding acquisition, J.C.

DECLARATION OF INTERESTS

The authors declare no competing interests.

REFERENCES

1. IUCN; WCPA (2018). Applying IUCN's global conservation standards to marine protected areas (MPA): Delivering effective conservation action through MPAs, to secure ocean health & sustainable development. https://www.dfo-mpo.gc.ca/oceans/documents/conservation/advisorypanel-comiteconseil/submissions-soumises/Woodley-Applying-MPA-Global-Standards-v120218-NK-v2.pdf.
2. Reimer, J.M., Devillers, R., and Claudet, J. (2020). Benefits and gaps in area-based management tools for the ocean Sustainable Development Goal. Nat. Sustain. *4*, 349–357. https://doi.org/10.1038/s41893-020-00659-2.
3. Sala, E., and Giakoumi, S. (2018). No-take marine reserves are the most effective protected areas in the ocean. ICES J. Mar. Sci. *75*, 1166–1168. https://doi.org/10.1093/icesjms/fsx059.
4. Sala, E., Lubchenco, J., Grorud-Colvert, K., Novelli, C., Roberts, C., and Sumaila, U.R. (2018). Assessing real progress towards effective ocean protection. Mar. Policy *91*, 11–13. https://doi.org/10.1016/j.marpol.2018.02.004.
5. Sala, E., Mayorga, J., Bradley, D., Cabral, R.B., Atwood, T.B., Auber, A., Cheung, W., Costello, C., Ferretti, F., Friedlander, A.M., et al. (2021). Protecting the global ocean for biodiversity, food and climate. Nature *592*, 397–402. https://doi.org/10.1038/s41586-021-03371-z.
6. Convention on Biological Diversity (2010). Decisions adopted by the conference of the parties to the convention on biological diversity at its tenth meeting. In Tenth meeting of the Conference of the Parties to the Convention on Biological Diversity, *21*, pp. 82–353. https://www.cbd.int/decisions/cop/?m=cop-10.
7. McNeely, J.A., and Miller, K.R. (1983). IUCN, national parks, and protected areas: priorities for action. Environ. Conserv. *10*, 13–21. https://doi.org/10.1017/S0376892900011826.
8. United Nations Department of Economic and Social Affairs (2015). Transforming our world: the 2030 agenda for sustainable development. https://sdgs.un.org/2030agenda.
9. Protected Planet (2022). World database on protected areas. https://www.protectedplanet.net/en/thematic-areas/wdpa?tab=WDPA.
10. Grorud-Colvert, K., Sullivan-Stack, J., Roberts, C., Constant, V., Horta E Costa, B., Pike, E.P., Kingston, N., Laffoley, D., Sala, E., Claudet, J., et al. (2021). The MPA guide: a framework to achieve global goals for the ocean. Science *373*. https://doi.org/10.1126/science.abf0861.
11. (2019). Summary for policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services, S. Díaz, J. Settele, E.S. Brondízio, H.T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K.A. Brauman, and S.H.M. Butchart, et al., eds. (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). https://zenodo.org/record/3553579#.YfmYTerMI2w.
12. Bennett, N.J., Teh, L., Ota, Y., Christie, P., Ayers, A., Day, J.C., Franks, P., Gill, D., Gruby, R.L., Kittinger, J.N., et al. (2017). An appeal for a code of conduct for marine conservation. Mar. Policy *81*, 411–418. https://doi.org/10.1016/j.marpol.2017.03.035.
13. Edgar, G.J., Stuart-smith, R.D., Willis, T.J., Kininmonth, S., Baker, S.C., Banks, S., Barrett, N.S., Becerro, M.A., Bernard, A.T.F., Berkhout, J., et al. (2014). Global conservation outcomes depend on marine protected areas with five key features. Nature *506*, 216–220. https://doi.org/10.1038/nature13022.
14. Laffoley, D., Baxter, J.M., Amon, D.J., Claudet, J., Downs, C.A., Earle, S.A., Gjerde, K.M., Hall-Spencer, J.M., Koldewey, H.J., Levin, L.A., et al. (2022). The forgotten ocean: why COP26 must call for vastly greater ambition and urgency to address ocean change. Aquat. Conserv. *32*, 217–228. https://doi.org/10.1002/aqc.3751.
15. Bohnsack, J., Causey, B., Crosby, M., Griffis, R., Hixon, M., Hourigan, T., Maragos, J., Simons, A., and Tilmant, J. (2000). A rationale for minimum 20-30% no-take protection. In Proceedings of the Ninth International Coral Reef Symposium, *2*, pp. 615–620.
16. Dinerstein, E., Olson, D., Joshi, A., Vynne, C., Burgess, N.D., Wikramanayake, E., Hahn, N., Palminteri, S., Hedao, P., Noss, R., et al. (2017). An ecoregion-based approach to protecting half the terrestrial realm. Bioscience *67*, 534–545. https://doi.org/10.1093/biosci/bix014.
17. O'Leary, B.C., Winther-Janson, M., Bainbridge, J.M., Aitken, J., Hawkins, J.P., and Roberts, C.M. (2016). Effective coverage targets for ocean protection. Conserv. Lett. *9*, 398–404. https://doi.org/10.1111/conl.12247.

18. Claudet, J., Loiseau, C., and Pebayle, A. (2021). Critical gaps in the protection of the second largest exclusive economic zone in the world. Mar. Policy *124*, 104379. https://doi.org/10.1016/j.marpol.2020.104379.

19. Costello, M.J., and Ballantine, B. (2015). Biodiversity conservation should focus on no-take Marine Reserves: 94% of Marine Protected Areas allow fishing. Trends Ecol. Evol. *30*, 507–509. https://doi.org/10.1016/j.tree.2015.06.011.

20. Friedlander, A.M., Donovan, M.K., Koike, H., Murakawa, P., and Goodell, W. (2019). Characteristics of effective marine protected areas in Hawai'i. Aquat. Conserv. *29*, 103–117. https://doi.org/10.1002/aqc.304.

21. Turnbull, J.W., Johnston, E.L., and Clark, G.F. (2021). Evaluating the social and ecological effectiveness of partially protected marine areas. Conserv. Biol. *35*, 921–932. https://doi.org/10.1111/cobi.13677.

22. Zupan, M., Fragkopoulou, E., Claudet, J., Erzini, K., Horta e Costa, B., and Gonçalves, E.J. (2018). Marine partially protected areas: drivers of ecological effectiveness. Front. Ecol. Environ. *16*, 381–387. https://doi.org/10.1002/fee.1934.

23. Claudet, J. (2019). Apply strict levels of marine protection. Nature *570*, 36. https://doi.org/10.1038/d41586-019-01750-1.

24. Gaines, S.D., White, C., Carr, M.H., and Palumbi, S.R. (2010). Designing marine reserve networks for both conservation and fisheries management. Proc. Natl. Acad. Sci. USA *107*, 18286–18293. https://doi.org/10.1073/pnas.0906473107.

25. High Ambition Coalition for Nation and People (2021). https://www.hacfornatureandpeople.org/home.

26. Blue Leaders 30x30 (2020). https://www.theblueleaders.org/.

27. European Commission (2020). Fishing opportunities in the Baltic Sea for 2021: improving long-term sustainability of stocks. https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1522.

28. Marine Conservation Institute (2022). Marine protection atlas. https://mpatlas.org/.

29. Claudet, J., Loiseau, C., Sostres, M., and Zupan, M. (2020). Underprotected marine protected areas in a global biodiversity hotspot. One Earth *2*, 380–384. https://doi.org/10.1016/j.oneear.2020.03.008.

30. Roessger, J., Claudet, J., and Horta e Costa, B. (2022). Turning the tide on protection illusions: the underprotected MPAs of the 'OSPAR Regional Sea Convention. Mar. Policy *142*, 105109. https://doi.org/10.1016/j.marpol.2022.105109.

31. Magness, D.R., Hoang, L., Belote, R.T., Brennan, J., Carr, W., Stuart Chapin, F., Clifford, K., Morrison, W., Morton, J.M., and Sofaer, H.R. (2022). Management foundations for navigating ecological transformation by resisting, accepting, or directing social–ecological change. Bioscience *72*, 30–44. https://doi.org/10.1093/biosci/biab083.

32. Naito, R., Zhao, J., and Chan, K.M.A. (2022). An integrative framework for transformative social change: a case in global wildlife trade. Sustain. Sci. *17*, 171–189. https://doi.org/10.1007/s11625-021-01081-z.

33. Uehara, T., Hidaka, T., Matsuda, O., Sakurai, R., Yanagi, T., and Yoshioka, T. (2019). Satoumi: re-connecting people to nature for sustainable use and conservation of coastal zones. People Nat. *1*, 435–441. https://doi.org/10.5751/ES-10006-230226.

34. Andrachuk, M., Armitage, D., Hoang, H.D., and Le, N.V. (2018). Building blocks for social-ecological transformations: identifying and building on governance successes for small-scale fisheries. Ecol. Soc. *23*, 26. https://doi.org/10.5751/ES-10006-230226.

35. Berkes, F., and Folke, C. (1998). Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience (Cambridge University Press).

36. Abson, D.J., Fischer, J., Leventon, J., Newig, J., Schomerus, T., Vilsmaier, U., von Wehrden, H., Abernethy, P., Ives, C.D., Jager, N.W., and Lang, D.J. (2017). Leverage points for sustainability transformation. Ambio *46*, 30–39. https://doi.org/10.1007/s13280-016-0800-y.

37. Barnes, M.L., Wang, P., Cinner, J.E., Graham, N.A.J., Guerrero, A.M., Jasny, L., Lau, J., Sutcliffe, S.R., and Zamborain-Mason, J. (2020). Social determinants of adaptive and transformative responses to climate change. Nat. Clim. Chang. *10*, 823–828. https://doi.org/10.1038/s41558-020-0871-4.

38. Meadows, D. (1999). Leverage Points: Places to Intervene in a System (Sustainability Institute). http://www.donellameadows.org/wp-content/userfiles/Leverage_Points.pdf.

39. Moberg, E., Allison, E.H., Harl, H.K., Arbow, T., Almaraz, M., Dixon, J., Scarborough, C., Skinner, T., Rasmussen, L.V., Salter, A., et al. (2021). Combined innovations in public policy, the private sector and culture can drive sustainability transitions in food systems. Nat. Food *2*, 282–290. https://doi.org/10.1038/s43016-021-00261-5.

40. Villasante, S., Gianelli, I., Castrejón, M., Nahuelhual, L., Ortega, L., Sumaila, U.R., and Defeo, O. (2022). Social-ecological shifts, traps and collapses in small-scale fisheries: envisioning a way forward to transformative changes. Mar. Policy *136*, 104933. https://doi.org/10.1016/j.marpol.2021.104933.

41. Ministère de la Transition Écologique (2021). Stratégie nationale pour les aires protégées. https://www.ecologie.gouv.fr/sites/default/files/DP_Biotope_Ministere_strat-aires-protegees_210111_5_GSA.pdf.

42. Hockings, M., Stolton, S., Leverington, F., Dudley, N., and Courrau, J. (2006). Evaluating Effectiveness: A Framework for Assessing Management Effectiveness of Protected Areas (IUCN). https://www.iucn.org/content/evaluating-effectiveness-a-framework-assessing-management-protected-areas-2nd-edition.

43. Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. Science *325*, 419–422. https://doi.org/10.1126/science.1172133.

44. Boncœur, J., Noël, J.-F., Sabourin, A., and Tsang King, J. (2007). La gouvernance des aires marines protégées: Le projet de parc marin en iroise, un exemple de processus participatif? Mondes en Développement *138*, 77–92. https://doi.org/10.3917/med.138.0077.

45. ACTéon (2020). Le bilan de la stratégie nationale de création et de gestion des aires marines protégées 2012-2020 (Agence Française pour la Biodiversité). https://professionnels.ofb.fr/fr/doc/bilan-strategie-nationale-creation-gestion-aires-marines-protegees-2012-2020.

46. Féral, F. (2012). L'evolution de l'administration française des aires marines protégées. In Revue Juridique de l'Environnement, *37*, pp. 123–135. https://www.persee.fr/doc/rjenv_0397-0299_2012_hos_37_1_5766.

47. Horta e Costa, B., Claudet, J., Franco, G., Erzini, K., Caro, A., and Gonçalves, E.J. (2016). A regulation-based classification system for marine protected areas (MPAs). Mar. Policy *72*, 192–198. https://doi.org/10.1016/j.marpol.2016.06.021.

48. Lelong, S. (2010). La mise en place d'aires marines protégées et leurs incidences conflictuelles dans le monde de la pêche. L'exemple du Parc Naturel Marin d'Iroise (France). edyte *10*, 149–162. https://www.persee.fr/doc/edyte_1762-4304_2010_num_10_1_1123.

49. Cosquer, A., Hughes, M., Le Corre, N., Saint-Pierre, A., Peuziat, I., Michot, T., and Bernard, N. (2019). Recreation user knowledge, support and engagement in French MPAs: are there reverse side-effects of the French soft regulation and management approach? Mar. Policy *104*, 108–117. https://doi.org/10.1016/j.marpol.2019.02.044.

50. Roberts, K.E., Hill, O., and Cook, C.N. (2020). Evaluating perceptions of marine protection in Australia: does policy match public expectation? Mar. Policy *112*, 103766. https://doi.org/10.1016/j.marpol.2019.103766.

51. Collier, C.E. (2020). Enabling conditions for community-based comanagement of marine protected areas in the United States. Mar. Policy *122*, 104244. https://doi.org/10.1016/j.marpol.2020.104244.

52. Sala, E., Costello, C., Dougherty, D., Heal, G., Kelleher, K., Murray, J.H., Rosenberg, A.A., and Sumaila, R. (2013). A general business model for marine reserves. PLoS One *8*, e58799. https://doi.org/10.1371/journal.pone.0058799.

53. Aubanel, A., Salvat, B., and Feral, F. (2013). Analyse du rôle des scientifiques et de la place des connaissances scientifiques dans l'élaboration et la mise en oeuvre du Plan de Gestion de l'Espace Maritime (PGEM) de Moorea et de sa gouvernance.

54. Mascia, M.B. (2003). The human dimension of coral reef marine protected areas: Recent social science research and its policy implications. Conserv. Biol. *17*, 630–632. https://doi.org/10.1046/j.1523-1739.2003.01454.x.

55. Gorris, P. (2019). Mind the gap between aspiration and practice in co-managing marine protected areas: a case study from Negros Occidental, Philippines. Mar. Policy *105*, 12–19. https://doi.org/10.1016/j.marpol.2019.03.006.

56. Bennett, N.J., and Dearden, P. (2014). Why local people do not support conservation: community perceptions of marine protected area livelihood impacts, governance and management in Thailand. Mar. Policy *44*, 107–116. https://doi.org/10.1016/j.marpol.2013.08.017.

57. Agardy, T., di Sciara, G.N., and Christie, P. (2011). Mind the gap: Addressing the shortcomings of marine protected areas through large scale marine spatial planning. Mar. Policy *35*, 226–232. https://doi.org/10.1016/j.marpol.2010.10.006.

58. Levin, P.S., Gray, S.A., Möllmann, C., and Stier, A.C. (2020). Perception and conflict in conservation: The Rashomon effect. Bioscience *71*, 64–72. https://doi.org/10.1093/biosci/biaa117.

59. Zafra-Calvo, N., and Geldmann, J. (2020). Protected areas to deliver biodiversity need management effectiveness and equity. Glob. Ecol. Conserv. *22*, e01026. https://doi.org/10.1016/j.gecco.2020.e01026.

60. Sanchirico, J., Cochran, K., and Emerson, P. (2002). Marine protected areas: Economic and social implications (Resources for the Future). https://www.cbd.int/doc/case-studies/inc/cs-inc-rf-04-en.pdf.

61. Pita, C., Horta e Costa, B., Franco, G., Coelho, R., Sousa, I., Gonçalves, E.J., Gonçalves, J.M., and Erzini, K. (2020). Fisher's perceptions about a marine protected area over time. Aquac. Fish. *5*, 273–281. https://doi.org/10.1016/j.aaf.2020.01.005.

62. Cadoret, A. (2021). Conflicts and acceptability of visitation management measures for a marine protected area: the case of Porquerolles, Port-Cros National Park. Ocean Coast Manag. *204*, 105547. https://doi.org/10.1016/j.ocecoaman.2021.105547.

63. Claudet, J., Bopp, L., Cheung, W.W., Devillers, R., Escobar-Briones, E., Haugan, P., Heymans, J.J., Masson-Delmotte, V., Matz-Lück, N., Miloslavich, P., et al. (2020). A roadmap for using the UN decade of ocean science for sustainable development in support of science, policy, and action. One Earth *2*, 34–42. https://doi.org/10.1016/j.oneear.2019.10.012.

64. Pascal, N., Brathwaite, A., Bladon, A., Claudet, J., and Clua, E. (2021). Impact investment in marine conservation. Ecosyst. Serv. *48*, 101248. https://doi.org/10.1016/j.ecoser.2021.101248.

65. Arlinghaus, R. (2006). Understanding recreational angling participation in Germany: Preparing for demographic change. Hum. Dimens. Wildl. *11*, 229–240.

66. Schmidt, R., Le Corre, N., Hughes, M., and Peuziat, I. (2020). The view from the inside: Institutional dimensions of public communication of two coastal and marine protected area networks in France. Coast. Manage. *48*, 210–231. https://doi.org/10.1080/08920753.2020.1754088.

67. Thiault, L., Curnock, M.I., Gurney, G.G., Heron, S.F., Marshall, N.A., Bohensky, E., Nakamura, N., Pert, P.L., and Claudet, J. (2020). Convergence of stakeholders' environmental threat perceptions following mass coral bleaching of the Great Barrier Reef. Conserv. Biol. *35*, 598–609. https://doi.org/10.1111/cobi.13591.

68. Seeds, B. (2020). Financing mechanisms: a guide for Mediterranean marine protected areas. https://blueseeds.org/en/guide-financing-mechanisms/.

69. Thiele, T., Alleng, G., Biermann, A., Corwin, E., Crooks, S., Fieldhouse, P., Herr, D., Matthews, N., Roth, N., Shrivastava, A., et al. (2020). Towards sustainable blue infrastructure finance: The need, opportunity and means to integrate nature-based solutions into coastal resilience planning and investments (IUCN). https://bluenaturalcapital.org/wp2018/wp-content/uploads/2020/03/BIF-Towards-sustainable-blue-infrastructure-finance.pdf.

70. Levin, N., Tulloch, A.I.T., Gordon, A., Mazor, T., Bunnefeld, N., and Kark, S. (2013). Incorporating socioeconomic and political drivers of international collaboration into marine conservation planning. Bioscience *63*, 547–563. https://doi.org/10.1525/bio.2013.63.7.8.

71. Mason, E.T., Kellum, A.N., Chiu, J.A., Waltz, G.T., Murray, S., Wendt, D.E., Starr, R.M., and Semmens, B.X. (2020). Long-term participation in collaborative fisheries research improves angler opinions on marine protected areas. PeerJ *8*. e10146–26. https://doi.org/10.1525/bio.2013.63.7.8.

72. Balmford, A., and Cowling, R.M. (2006). Fusion or failure? The future of conservation biology. Conserv. Biol. *20*, 692–695. https://conbio.onlinelibrary.wiley.com/doi/full/10.1111/j.1523-1739.2006.00434.x.

73. Ehrlich, P.R., and Kennedy, D. (2005). Millenium assessment of human behavior. Science *309*, 562–563. https://doi.org/10.1126/science.1113028.

74. Fabinyi, M. (2008). Dive tourism, fishing and marine protected areas in the Calamianes Islands, Philippines. Mar. Policy *32*, 898–904. https://doi.org/10.1016/j.marpol.2008.01.004.

75. Opdam, P., Nassauer, J.I., Wang, Z., Albert, C., Bentrup, G., Castella, J.C., McAlpine, C., Liu, J., Sheppard, S., and Swaffield, S. (2013). Science for action at the local landscape scale. Landsc. Ecol. *28*, 1439–1445.

76. Schultz, P.W. (2011). Conservation means behavior. Conserv. Biol. *25*, 1080–1083. https://doi.org/10.1111/j.1523-1739.2011.01766.x.

77. Ives, C.D., and Kendal, D. (2014). The role of social values in the management of ecological systems. J. Environ. Manage. *144*, 67–72. https://doi.org/10.1016/j.jenvman.2014.05.013.

78. Bennett, N.J., Di Franco, A., Calò, A., Nethery, E., Niccolini, F., Milazzo, M., and Guidetti, P. (2019). Local support for conservation is associated with perceptions of good governance, social impacts, and ecological effectiveness. Conserv. Lett. *12*, 1–10.

79. Walton, A., Marina, G., and Di Carlo, G. (2013). Stakeholder engagement. Participatory approaches for the planning and development of marine protected areas (World Wide Fund for Nature and National Marine Sanctuary Program). http://awsassets.panda.org/downloads/stakeholder_engagement.pdf.

80. Duquette, R. (2017). Les aires marines protégées au Québec et en France – quelle influence ont les élus locaux lors du processus de mise en place?. https://semaphore.uqar.ca/id/eprint/1311/.

81. Walker, B.L.E. (2001). Mapping Moorea's lagoons: conflicts over marine protected areas in French Polynesia. In Inaugural Pacific Regional Meeting of the International Association for the Study of Common Property. http://gif.berkeley.edu/moorea/articles/Walker2001.pdf.

82. Manfredo, M.J., Bruskotter, J.T., Teel, T.L., Fulton, D., Schwartz, S.H., Arlinghaus, R., Oishi, S., Uskul, A.K., Redford, K., Kitayama, S., and Sullivan, L. (2017). Why social values cannot be changed for the sake of conservation. Conserv. Biol. *31*, 772–780. https://pubmed.ncbi.nlm.nih.gov/27757996/.

83. Manfredo, M.J., Teel, T.L., Berl, R.E.W., Bruskotter, J.T., and Kitayama, S. (2020). Social value shift in favour of biodiversity conservation in the United States. Nat. Sustain. *4*, 323–330. https://doi.org/10.1038/s41893-020-00655-6.

84. Jentoft, S., Pascual-Fernandez, J.J., de la Cruz Modino, R., Gonzalez-Ramallal, M., and Chuenpagdee, R. (2012). What stakeholders think about marine protected areas: case studies from Spain. Hum. Ecol. *40*, 185–197. https://doi.org/10.1007/s10745-012-9459-6.

85. Lubchenco, J., Cerny-Chipman, E.B., Reimer, J.N., and Levin, S.A. (2016). The right incentives enable ocean sustainability successes and provide hope for the future. Proc. Natl. Acad. Sci. USA *113*, 14507–14514. https://doi.org/10.1073/pnas.1604982113.

86. Gill, D.A., Mascia, M.B., Ahmadia, G.N., Glew, L., Lester, S.E., Barnes, M., Craigie, I., Darling, E.S., Free, C.M., Geldmann, J., et al. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. Nature *543*, 665–669. https://doi.org/10.1038/nature21708.

87. Huwyler, F., Käppeli, J., Sefrafimova, K., Swanson, E., and Tobin, J. (2014). Conservation Finance: Moving beyond Donor Funding toward an Investor-Driven Approach. https://www.cbd.int/financial/privatesector/g-private-wwf.pdf.

88. Ehler, C., and Douvere, F. (2009). Marine spatial planning: a step-by-step approach toward ecosystem-based management. https://tethys.pnnl.gov/publications/marine-spatial-planning-step-step-approach-toward-ecosystem-based-management.

89. Brown, K., Adger, W., Tompkins, E., Bacon, P., Shim, D., and Young, K. (2001). Trade-off analysis for marine protected area management 1. Decision making for multiple use resources. Ecol. Econ. *37*, 417–434. https://doi.org/10.1016/S0921-8009(00)00293-7.

90. Di Franco, A., Hogg, K.E., Calò, A., Bennett, N.J., Sévin-Allouet, M.A., Esparza Alaminos, O., Lang, M., Koutsoubas, D., Prvan, M., Santarossa, L., et al. (2020). Improving marine protected area governance through collaboration and co-production. J. Environ. Manage. *269*, 110757. https://doi.org/10.1016/j.jenvman.2020.110757.

91. Sayce, K., Shuman, C., Connor, D., Reisewitz, A., Pope, E., Miller-Henson, M., Poncelet, E., Monié, D., and Owens, B. (2013). Beyond traditional stakeholder engagement: public participation roles in California's statewide marine protected area planning process. Ocean Coast Manag. *74*, 57–66.

92. Baker-Médard, M. (2016). Gendering marine conservation: the politics of marine protected areas and fisheries access. Soc. Nat. Resour. *30*, 723–737. https://doi.org/10.1080/08941920.2016.1257078.

93. Semitiel-García, M., and Noguera-Méndez, P. (2019). Fishers' participation in small-scale fisheries. A structural analysis of the Cabo de Palos-Islas Hormigas MPA, Spain. Mar. Policy *101*, 257–267. https://doi.org/10.1016/j.marpol.2018.04.009.

94. Voyer, M., Gladstone, W., and Goodall, H. (2012). Methods of social assessment in marine protected area planning: is public participation enough? Mar. Policy *36*, 432–439. https://doi.org/10.1016/j.marpol.2011.08.002.

95. Boone, H., and Boone, D. (2012). Analyzing likert data. J. Ext. *50*. https://archives.joe.org/joe/2012april/pdf/JOE_v50_2tt2.pdf.

96. Tastle, W.J., and Wierman, M.J. (2007). Consensus and dissention: a measure of ordinal dispersion. Int. J. Approx. Reason. *45*, 531–545. https://doi.org/10.1016/j.ijar.2006.06.024.