PROTECTING THE OCEAN, MITIGATING CLIMATE CHANGE?

STATE OF THE EVIDENCE AND POLICY RECOMMENDATIONS

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The health and management of terrestrial carbon sinks have historically received most of the international attention –in research, advocacy, and policy developments–, while the role of policy interventions aimed at the ocean and its coastal habitats in regulating the global climate system has been less developed in climate negotiations before UNFCCC COP21, in Paris[1]. In recent years, the works of State- and NGO-led coalitions, the Intergovernmental Panel on Climate Change (IPCC) Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC), and the Ocean and Climate Change Dialogue held under the UNFCCC Subsidiary Body for Scientific and Technological Advice (SBSTA) in December 2020, have all contributed to turning the tide. The ocean is gradually becoming established as an important element of climate action, and the contribution of healthy marine ecosystems to climate change mitigation is receiving greater attention.

While marine protected areas (MPAs) are increasingly being advocated as ocean-based climate solutions[2], the mechanisms through which MPAs can protect carbon pools and enhance carbon sequestration, as well as the magnitude of these effects still need to be better understood and quantified. These clarifications are necessary for MPAs to be integrated as actionable mitigation measures in national and international climate policies[3]. With this purpose, this brief summarizes the findings of a comprehensive literature review[4] focusing on the effects of MPAs on the carbon sequestration capacity of different marine carbon pools. ➡

KEY MESSAGES

- The review found that MPAs can have a significant positive effect on the carbon stored in seagrass, mangroves, and sediments. For fish carbon, only the MPAs with full and high levels of protection were found to have a significant positive effect on carbon stored in living biomass. The results found for tidal marshes were positive, but not statistically significant. No study has assessed the contribution of MPAs to carbon storage in the biomass of macroalgae.

- “Blue carbon” ecosystems (mangroves, seagrass meadows, and tidal marshes) have been the most studied[3]. They are the most efficient at storing carbon per surface unit, but their geographical extent is rather limited. Marine sediments, on the other hand, store less carbon per surface unit, but have enormous global extent and carbon sequestration potential. More research on sediments, and new or updated IPCC guidelines for including sediments and other marine carbon pools into national greenhouse gas accounting, would help making MPAs more actionable in climate change mitigation and including them into Nationally Determined Contributions (NDCs).

- MPAs are gradually being included in updated NDCs, mostly in the adaptation chapters. They should be considered when appropriate in mitigation chapters, when sufficient data is gathered to prove additionality, and in a complementary fashion alongside other economy-wide emissions reduction. Countries should also report on the associated national policy reforms (e.g., in fisheries) and the recognition and respect of rights, and especially those of Indigenous Peoples and Local Communities (IPLCs), that are necessary for the equitable and effective implementation of MPAs.

1 WHERE IS CARBON SEQUESTERED IN MARINE ECOSYSTEMS?

Marine ecosystems are comprised of several carbon pools which have received contrasting levels of scientific attention. The IPCC has already acknowledged and quantified the mitigation value of three types of coastal ecosystems and has produced guidelines to include them in national GHG inventories[3]. These ecosystems, usually referred to as "blue carbon ecosystems", are mangroves, seagrass meadows, and tidal marshes. Blue carbon ecosystems store an important amount of carbon per surface unit but are being lost at an alarming rate[5,6,7]. Mangroves are still subject to high rates of deforestation and degradation linked to aquaculture and infrastructure development[5]. Seagrass meadows are strongly impacted by dredging and water quality degradation[8], and tidal marshes are threatened by land reclamation and coastal erosion[7].

Other carbon pools such as marine sediments, fish, and macroalgae, have received less attention although they cover much larger cover areas[8,9], which could make them relevant carbon sequestration solutions depending on the timescale considered. These carbon pools are also currently under threat from different human activities (e.g., bottom trawling, overfishing)[8,10]. For these six carbon pools (carbon contained in mangroves, seagrass meadows, tidal marshes, marine sediments, fish, and macroalgae; see Figure 1), it is necessary to better understand (relative to global emissions) how conservation and restoration measures can help avoid the release of stored carbon resulting from their destruction or degradation, as well as help increase their carbon sequestration.

It should be noted that fish and macroalgae have the particularity that they do not store carbon in their biomass for long time periods (>100 years), which is a necessary criterion for carbon to be considered sequestered[11]. Carbon stored in fish and macroalgae biomass (as reported in Figure 1 and Table 1) is only sequestered after being exported to external carbon pools such as deep-sea sediments[9]. This exportation step also means that carbon sequestered by fish and macroalgae cannot be considered additionally to the carbon sequestered in marine sediments. Currently, the exact proportion of carbon from fish and macroalgae biomass which is exported remains to be quantified. These specificities represent significant limitations to the inclusion of fish and macroalgae to carbon sequestration solutions.

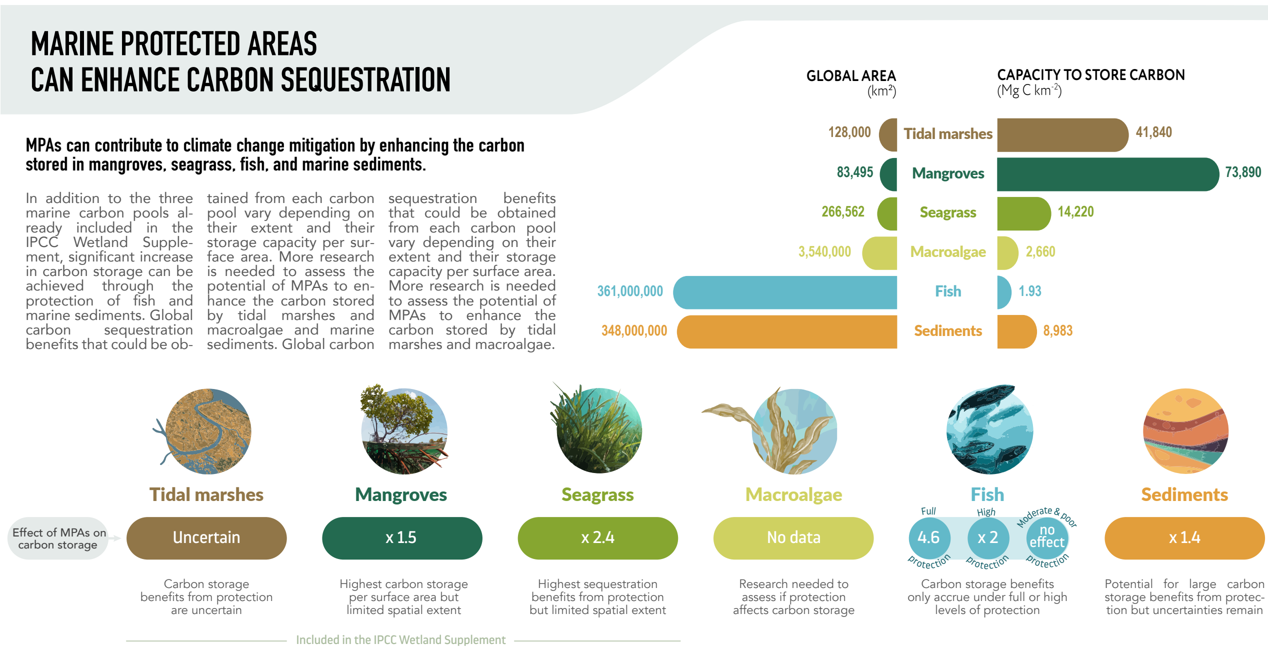

Figure 1. The effect of MPAs on the storage capacity of marine carbon pools contained in mangroves, seagrass meadows, tidal marshes, marine sediments, fish, and macroalgae.

Table 1. Evaluating MPAs as actionable conservation measures for climate change mitigation. Adapted from Lovelock & Duarte (2019)[12] and The Blue Carbon Initiative (2021)[13]. Green shading indicates compliance of the carbon pool to the stated criteria, yellow shading indicates uncertain or partial compliance, red shading indicates no compliance and grey shading indicates knowledge gaps. In situ sequestration refers to whether carbon is sequestered for long periods of time (> 100 years) at the same place where it was produced.

CARBON POOL	ABILITY OF MPAs TO ENHANCE STOCKS/ REDUCE EMISSIONS	AMOUNT OF STORED CARBON WHICH ENDS UP SEQUESTRATED	IN SITU SEQUESTRATION	CARBON STORAGE PER HECTARE (Mg C/ha ± SD)	TOTAL CARBON STORAGE (Gt C)	CLIMATE MITIGATION POTENTIAL THROUGH MPAs
Mangroves	Yes	Majority	Yes	738 ± 417	6	High
Tidal marshes	Uncertain	Majority	Yes	418 ± 284	5	Intermediate
Seagrass	Yes	Majority	Yes	142 ± 182	150	High
Sediments	Yes (shallow)	Majority	Yes	89 ± 144	3000	High
Fish	Yes	Unknown	No	0.0193	0.7	Intermediate
Macroalgae	Unknown	Unknown	No	3.33 ± 3.51	1	Unknown

2 MPAs CAN HAVE A STRONG POSITIVE EFFECT ON SEVERAL MARINE CARBON POOLS

Since MPAs are effective management tools to reduce human pressures on marine ecosystems, they could have the potential to protect and restore marine carbon pools[14]. So far, no synthesis has assessed the ability of MPAs to contribute to carbon sequestration across the world's marine ecosystems. The study summarized here aims at filling this gap by systematically reviewing published literature in order to assess the effect of MPAs on the six carbon pools mentioned above. As studies directly assessing MPA effects on carbon sequestration were found to be very scarce, the research also included studies comparing healthy ecosystems (that for instance benefited from restoration interventions) with degraded and exploited ecosystems.

The review found that MPAs can have a significant positive effect on the carbon stored in seagrass, mangroves, and sediments. For fish carbon, interestingly, only MPAs with full and high levels of protection were found to have a significant positive effect on carbon stored in living fish biomass, which may indicate an increase in the size of the fish carbon pool. These correspond to protection levels with fishing allowed or for which only a limited number of low-impact sustainable fishing methods are allowed[15]. Protection was not found to significantly increase the carbon stored in tidal marshes, yet this could be due to the limited number of studies available, and calls for further research. Currently, no study has assessed the contribution of MPAs to carbon storage through macroalgae biomass (see Figure 1 and Table 1 for more details).

Comparing the size of marine carbon pools with that of terrestrial ecosystems highlights their global significance for climate change mitigation. Indeed, although the extent of coastal vegetated ecosystems is about 100 times smaller than that of terrestrial forests, they store as much or more carbon per hectare as terrestrial forests[16]. It has been estimated that their degradation is responsible for the emission of 0.15-1.02 Pg of CO_2 yearly, which represents 3-19% of emissions from deforestation globally[16]. On the other hand, marine sediments extend throughout incredibly larger areas, making them the largest carbon stock of any type of sediment or soil in the world[8].Protecting marine sediments, especially those undisturbed sediments under threat, could potentially provide substantial carbon sequestration benefits where additionality can be proven, mitigation measured quantitatively, and the timeline for the release of carbon into the atmosphere known[17]. Ensuring sediment carbon is not disturbed may imply regulating the activities that have an impact on their storage capacity, such as bottom trawling or deep-sea mining[18,19,20].

3 MAKING MPAs MORE ACTIONABLE IN CLIMATE CHANGE MITIGATION

The study synthesized here shows that MPAs have the potential to contribute to carbon sequestration, either by enhancing carbon stocks of previously exploited ecosystems or by avoiding future emissions from healthy ecosystems[4]. When considering a series of criteria that are important to assess whether a given measure is "actionable" for climate mitigation (see Table 1), it appears that MPAs could be most easily integrated within climate mitigation measures when applied to the protection of mangrove and seagrass, which are the two carbon pools for which significant enhancement from protection was found and that are already acknowledged by the IPCC.

Furthermore, protecting marine carbon pools for carbon sequestration will also provide additional climate change mitigation and adaptation benefits through synergies resulting from conservation. For example, the protection of blue carbon ecosystems can also enhance coastal protection[21,22] a critical ecosystem service for coastal populations to adapt to sea-level rise. Similarly, the protection of fish stock can generate greater food security through the spill-over of larvae and fish to nearby fishing grounds[23,24].

Given the important knowledge gaps that remain, the United Nations Decade of Ocean Science for Sustainable Development should be seen as an opportunity to increase global knowledge on how ocean protection contributes to climate change mitigation and to develop capacity at the national level to better include ocean protection in climate action. The UN Decade on Ecosystem Restoration could also provide impetus to strengthen action for marine ecosystem protection and develop knowledge on its climate benefits. Some key research topics that should be addressed in the near future include:

- A better understanding of the variation of carbon stored in sediments according to depth, sediment type, oceanographic conditions and latitude, and the proportion of carbon from sediments which ends up released in the atmosphere when disturbed.
- A direct quantification of the effect of MPAs on carbon sequestered in mangroves, seagrass and tidal marshes.
- Foundational research work which would allow to formulate baseline estimations of the proportion of fish and macroalgae biomass which ends up effectively sequestered.

Filling these knowledge gaps would be especially important so that the IPCC could better take these carbon pools into account, notably to update its guidelines with new methodologies, particularly for sediments, which would be relevant to assist Parties in including new marine carbon pools (in addition to the already recognized blue carbon ecosystems) in their national GHG accounting.

4 ACTION POINTS FOR UNFCCC COP26 AND BEYOND

Achieving the goals of the Paris Agreement of limiting global warming to well below 2°C and aiming for 1.5°C (Article 2) will require a drastic increase of ambition and action, both on the urgent reductions in GHG emissions that we need and on protecting as many carbon sinks as possible. The results presented above show that there is strong evidence that coastal MPAs can play a significant role in protecting carbon pools of "blue carbon" ecosystems and thereby providing mitigation benefits under full and high levels of protection. There is also mounting evidence that marine sediments can provide mitigation benefits under full and high levels of protection (i.e. when no trawling, mining or high-impact fishing activities are allowed). However, a substantial body of research must be conducted to include sediment carbon in mitigation calculations. These results have several implications for ocean-climate action, at and beyond UNFCCC COP26. As several marine carbon pools, and sediments in particular, extend beyond national jurisdictions, their protection should also be considered in synergy with other governance arenas (see below).

Further including MPAs with blue carbon habitats as a mitigation measure in national climate strategies. Compared to the first round of Nationally Determined Contributions (NDCs)[25], the ocean has been included in more submissions on the road to COP26[26]. Out of 91 countries[27], 4 have included MPAs in their first NDCs, while 27 have included MPAs in their updated NDCs. Overall, 24 countries have added measures to design and implement MPAs as part of their adaptation strategies in their updated NDCs, relative to first NDCs.

MPAs are still mostly included in adaptation chapters of NDCs, but their role in mitigation, or the mitigation co-benefits they provide even when they are included as adaptation measures, is being recognized by an increasing number of countries (see for example the revised NDCs of Chile, Seychelles, and the United Kingdom). The results presented in this policy brief suggest that MPAs should be considered by more countries and as part of the mitigation chapter of their NDC alongside other economy-wide emissions reduction activities.

Addressing climate change and biodiversity loss both require important structural transformations in economic sectors at the domestic level. The results presented here suggest that several activities known to harm marine biodiversity (e.g., overfishing or destructive fishing techniques) also destroy important marine carbon pools, such as sediments and fish[18–20,28]. In addition to the establishment of MPAs, these results provide even further arguments for urgently reforming extractive sectors that are unsustainably impacting marine ecosystems. How countries intend to engage in such reforms should also be part of their commitments and be undertaken and reported on in a transparent manner.

This is also true for other dimensions pertaining to MPA implementation. There is at last growing recognition of the central role of rights-based approaches to implement measures that truly benefit people and the planet. The major contribution of Indigenous Peoples and Local Communities (IPLCs) to biodiversity conservation and climate action is documented[29], but their role and rights in the development and implementation of MPAs have received little attention when compared to land-based approaches[30]. It is all the more important that countries committing to increasing the surface of their MPAs pay special attention to how they recognize the rights of IPLCs in their commitments and also report on how they have progressed in this regard.

Strengthening the Ocean-Climate nexus at the UNFCCC, and in synergy with other governance arenas. The results presented here suggest that conservation measures for the ocean can significantly contribute to climate mitigation. Building upon the work done in recent years to better connect ocean and climate action, we suggest that the COP26 decision should consider the conclusions of the 2020 Ocean and Climate Change Dialogue and establish a recurring dialogue at the SBSTA[31], which could enable a regular uptake of advances in knowledge on the effect of MPAs on marine carbon pools.

All the above will be crucial not only to address climate change but also to implement global biodiversity goals currently being negotiated within the Convention on Biological Diversity (CBD). Stronger synergies and coherence are still being needed overall between the UNFCCC and the CBD and their national implementation[32], and this also concerns the ocean and MPAs in particular. Discussions on global area-based conservation targets should more comprehensively considering their benefits for climate mitigation, for both terrestrial and marine ecosystems. These benefits are increasingly recognized by science[29], and were recently included in motion 101 (WCC 2020 Resolution 125) adopted at the IUCN World Conservation Congress in Marseille, which calls for recognizing the need to protect, conserve and restore at least half of the planet and to support a minimum of 30% by 2030[33]. Given the global significance of marine carbon pools, and especially the global extent of marine sediments, negotiations under the United Nations Convention on the Law of the Sea on biodiversity beyond national jurisdiction should also acknowledge their connections with climate action. ■

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