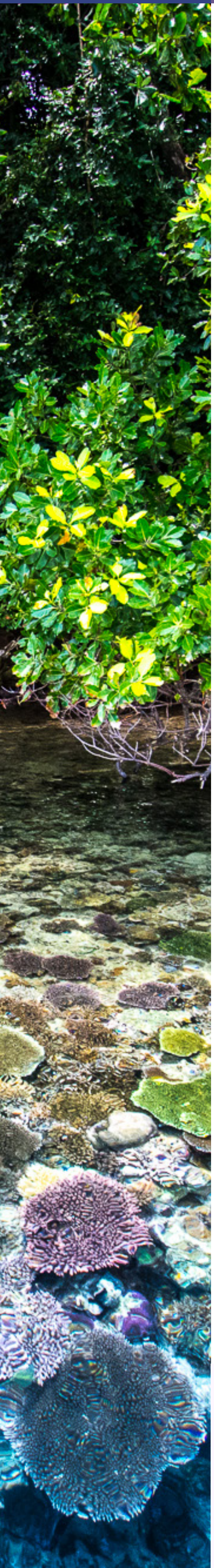

EXECUTIVE SUMMARY & KEY MESSAGES

Opportunities for coral reefs at the ocean-climate policy nexus

A Vibrant Oceans Initiative Whitepaper | NOVEMBER 2021

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- Coral reefs are exceptionally biodiverse and provide ecosystem services for millions.
- However, coral reefs are highly vulnerable to climate change and other threats.
- Strategic management can help enable coral reefs to play their key role in climate adaptation.
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- Hundreds of policy instruments address coral reefs, and other coastal ecosystems.
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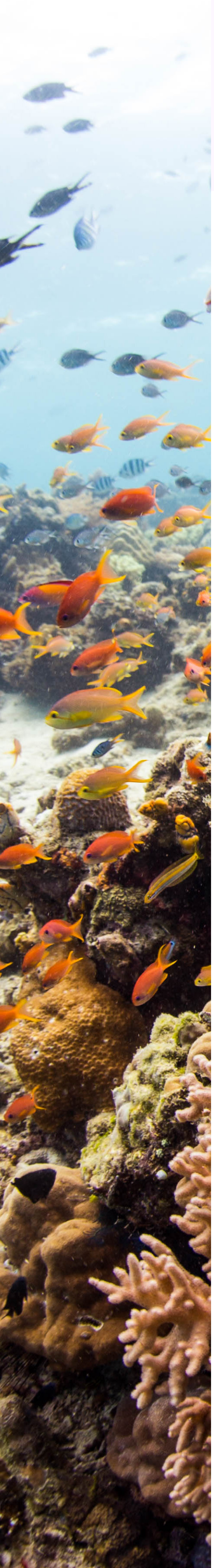

OPPORTUNITIES FOR CORAL REEFS AT THE OCEAN-CLIMATE POLICY NEXUS

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Abstract

Ocean ecosystems play a key role in maintaining the integrity of our biosphere, but vary widely with respect to their biodiversity attributes, their relationship with the atmosphere and climate change processes, and the ecosystem services that they provide to humans. Coral reefs and ecologically associated coastal ecosystems, such as intertidal mangrove forests and seagrass meadows, are complex systems that are often managed together but are also subject to different governance frameworks. The implementation of the UN Framework Convention on Climate Change's Paris Agreement and development of global biodiversity goals and targets under the Convention on Biological Diversity offer examples of these governance challenges, but they also offer significant opportunities to maximize biodiversity outcomes while building on increasing support support for nature-based solutions to climate change mitigation and adaptation. This whitepaper summarizes the scientific and policy consensus at the ocean-climate nexus, specifically with respect to the role of coral reefs and closely associated tropical coastal ecosystems in climate change processes, and explicitly identifies gaps within key intergovernmental climate and biodiversity policy frameworks that must be addressed to maximize their potential as nature-based solutions during a key decade of conservation action. It concludes with recommendations for national governments and other stakeholders.

Introduction

Biodiversity and the natural systems underpinning the Earth's ecological integrity and human wellbeing are threatened by anthropogenic activities, including land- and sea-use change, direct exploitation of living organisms, climate change, pollution, and invasive non-na tive species (IPBES 2019). However, the complexity and uneven distribution of biodiversity and the drivers of biodiversity loss, as well as geopolitical and development contexts (e.g., changing patterns of population growth and consumption), make it challenging to adopt and implement global policy instruments that address these drivers comprehensively and efficiently.

Despite these challenges, however, it is clear that the biodiversity crisis, and the inextricably linked climate change crisis, cannot be solved without holistic, comprehensive approaches (Pörtner et al. 2021). Coral reefs are exceptionally important ecosystems for biodiversity and for people, particularly in their capacity to provide food security and mitigate the impacts of severe weather events, and therefore deserve significant attention. There is a need to recognize how different ecosystems will contribute different solutions to the climate and biodiversity crises, while also recognizing that they are affected by common direct and indirect drivers of biodiversity loss.

Previous reports – notably "Rebuilding Coral Reefs: A Decadal Grand Challenge" (Knowlton et al. 2021) – have comprehensively addressed the urgent need to draw down greenhouse gas emissions and limit global warming to 1.5 degrees Celsius to improve the outlook for coral reef ecosystems. However, there is a need for a full range of solutions through a complex web of interlinked policy instruments and other governance mechanisms. While excellent guides already exist to support ocean-based climate action (e.g. Northrup et al. 2020); this whitepaper brings some experts and practitioners together to explore whether and how coral reefs fit into existing intergovernmental climate policy processes, and what opportunities exist to better address these critical ecosystems across both climate and biodiversity regimes.

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The Scientific Consensus

Coral reefs are distinct ecosystems within broader ecological networks.

This whitepaper focuses primarily, but not exclusively, on 'photic coral reefs,' or functional ecosystem type M1.3 in the IUCN ecosystem typology (Polidoro 2020). These ecosystems are characterized by biogenic reef structures formed by the calcification of dissolved carbonate in seawater by hermatypic (scleractinian) coral species, or inorganic precipitation, and are typically found in warm, shallow, and relatively nutrient-poor intertropical waters (typically within latitudes of 30°N and 30°S). The precise geomorphology, or physical structure, of coral reefs varies widely depending on hydrological and geological conditions, and the various attributes of these ecosystems, such as species composition, structural connectivity and complexity, and functionality is highly dependent on biogeographic context and exogenous conditions.

Tropical, coastal photic coral reefs are ecologically connected to other coastal ecosystems within the marine and transitional realm, such as intertidal mangrove forests (MFT1.2) and seagrass meadows (M1.1) that serve as nurseries for juvenile species that will eventually move into the reef ecosystem (Olds et al. 2013; Nagelkerken 2010). More broadly, the movement of organic matter and nutrients within and between these ecosystems is critical for their respective productivity. They also share key threats, such as coastal development and land- and sea-use change. Therefore, while ecologically distinct through the lens of certain typologies, these ecosystems have often been understood and managed as coherent and interlinked coastal systems that must remain collectively intact to ensure the persistence of biodiversity and ecosystem services.

Coral reefs are exceptionally biodiverse and provide ecosystem services for millions.

Photic coral reefs are widely recognized for their exceptional biodiversity, representing more than 25% of marine biodiversity globally (Fisher et al. 2015). Due in part to their extraordinary biological diversity, coral reefs also provide a wide variety of ecosystem services that contribute to the wellbeing of people (Eddy et al. 2021; Knowlton et al. 2021; Woodhead et al. 2019). Contributions range from provisioning services, such as supporting fisheries that provide food and economic security for hundreds millions of people worldwide and underpinning new pharmaceutical innovations; to regulating services, such as the dissipation of wave energy and related reduction in damages from severe weather events; to cultural services, particularly for Indigenous Peoples and local, coastal communities that have lived alongside coral reefs for millennia (Nash et al. 2020; UN Environment, ISU, ICRI and Trucost 2018).

Some of these ecosystem services are particularly important in an era of increasing impacts from climate change, which is widely understood to contribute to more frequent and severe weather events and associated natural hazards. Coral reefs can provide robust protection against waves and storm surges (Ferrario et al. 2014), and some studies estimate hundreds of billions of US dollars in savings in averted damage from severe weather events along coral coastlines (Beck et al. 2018). However, increased frequency and severity of these events is degrading these natural defenses (Storlazzi et al. 2021), compounding other threats such as sewage pollution and overfishing. Furthermore, these are conservative measurements of their construction to humanity based on available datasets – entire countries and societies are built on coral reef atolls, some of which face existential threats from climate change-associated sea level rise.

However, coral reefs are highly vulnerable to climate change and other threats.

The integrity of coral reef ecosystems, including their biodiversity and the services they provide, is highly dependent on biotic and abiotic attributes that are impacted by climate change (see Knowlton et al. 2021). The Intergovernmental Panel on Climate Change (IPCC), the international scientific authority on climate change and its impacts, concluded in 2018 with medium to very high confidence that almost all warm-water coral reefs are projected to suffer significant losses of area and local extinctions, even if warming is limited to 1.5 degrees; the species composition and diversity of remaining reef communities is projected to differ from present-day reefs; anticipated changes in species composition will threaten the ecosystem services provided by reefs to society including *inter alia* food provision, coastal protection, and tourism; and climate adaptation limits are being reached for vulnerable communities in coral reef environments in the case of high emissions scenarios, with some low-lying coral atoll island nations potentially becoming uninhabitable.

Strategic management can help enable coral reefs to play their key role in climate adaptation.

A summary for policymakers from the IPCC's Sixth Assessment Report (AR6) is clear that "global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO2 and other greenhouse gas emissions occur in the coming decades" (IPCC 2021). Recalling the findings of the IPCC in its special report on the oceans and cryosphere, projected global warming of 1.5 or 2 degrees Celsius is certain to transform coral reef ecosystems and degrade some of their functionality as biodiversity hotspots and critical coastal defenses. The IPCC findings have coincided with, and reinforced, calls for more attention to global and local plans for adapting to the projected impacts of climate change.

Climate adaptation, defined by the IPCC (2018) as "the process of adjustment to actual or expected climate and its effects" is therefore increasingly important as the impacts of climate change are recognized as "locked in" due to historical emissions and the lag time between reduced emissions and reduced concentrations of greenhouse gases such as carbon dioxide in the Earth's atmosphere. Adaptation has separate applications for human and natural systems and can be further refined into 'incremental' adaptation, which seeks to maintain the essence and integrity of an ecosystem, or 'transformational adaptation,' which results in fundamental changes to an ecosystem's attributes.

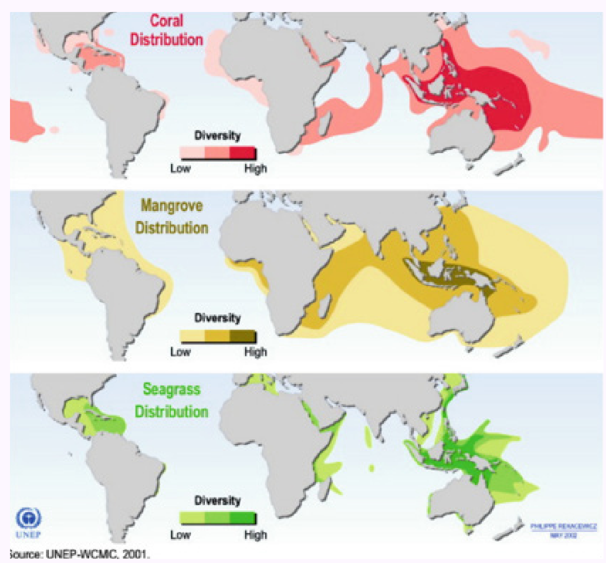
Separately, the IPCC and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) found that the climate and biodiversity crises are inextricably linked, through both common drivers and solutions, and they will require an integrated approach (Pörtner et al. 2021). As one example, high integrity coral reef ecosystems provide key services that help mitigate the projected impacts of climate change on human systems, such as extreme weather events (Roberts et al. 2017), and contribute to adaptation in human systems in other ways, such as providing alternate sources of nutrition and/or economic activity following disruption to terrestrial ecosystems (Mangubhai 2016).

However, to preserve this functionality, it is critical to maintain the essence and integrity through incremental adaptation interventions in coral reef ecosystems, including particularly through targeted protection and management of coral reef refugia and their associated ecosystems (Beyer et al. 2018; Obura et al. 2021; Hoegh-Guldberg et al. 2020). Piecemeal ecosystem restoration efforts have historically had high rates of failure because they did not effectively consider and address local socio-ecological context and pursue holistic land- and sea-scape scale approaches (Claudet et al. 2021; Hein et al. 2019). However, more holistic approaches, including those that draw on the increasing availability of spatially explicit data, may be able to enhance restoration efforts and align it with localized threat reduction (Donovan et al. 2021; Hicks et al. 2021).

Connectivity between coral reefs and 'blue carbon' ecosystems supports overall functionality.

The ability of ecosystems to sequester and store more atmospheric carbon than they release, a functionality referred to as being a "carbon sink," is widely recognized as a critical regulating service that mitigates the impacts of climate change. The global ocean, overall, is a major carbon sink and absorbs approximately 25-30% of anthropogenic carbon emissions (Bopp et al. 2017; Sabine 2004). However, the ocean is vast and complex; it can be divided into many functional ecosystem types that play different roles in the carbon cycle.

Certain marine ecosystems, and particularly coastal ecosystems that are ecologically interlinked with coral reefs, including intertidal mangrove forest, seagrass meadow, and tidal/salt marsh ecosystems are widely understood to be carbon sinks or "blue carbon" ecosystems (UNEP 2020; Herr et al. 2015; Howard et al. 2014; McLeod et al. 2011; Fourgurean et al. 2012; UNEP 2020; Donato et al. 2011; Chmura 2003). Their ability to sequester and store carbon rival those of intact forest and peatland ecosystems found in terrestrial biomes (Hoegh-Guldberg et al. 2019; Laffoley & Grimsditch (eds). 2009). There has historically been some debate as to whether coral reefs are also blue carbon ecosystems (Mallon 2018; Allemand 2017; Ware et al. 1992; Kinsey and Hopley 1991); however, the current scientific consensus is that coral reefs as discrete ecosystems actually function as a net source (albeit small) of atmospheric carbon dioxide (Laffoley & Grimsditch (eds). 2009; Tambutté et al. 2011).



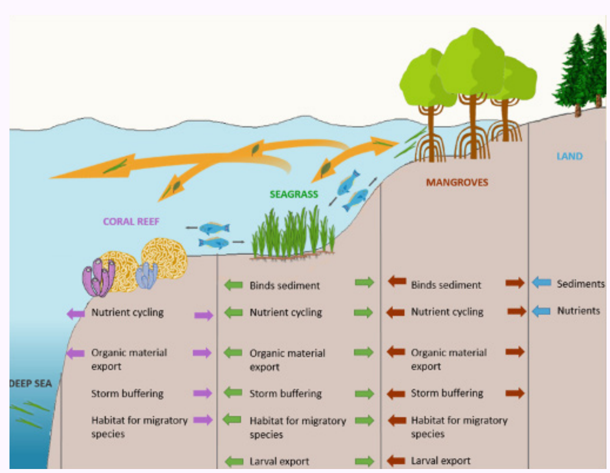


Figure 1. Interrelationships between coastal ecosystems (Earp et al. 2018)

As discussed above, high functional connectivity between coral reefs and adjacent or associated ecosystems result in increased productivity and biomass (Mumby et al. 2004), and contribute other benefits in both "directions," such as seagrasses mitigating effects of localized pollution or sedimentation (Lamb et al. 2017 Saunders et al. 2013), and coral reefs reducing wave impact on mangroves and seagrasses, etc. (see Figure 1, below; Earp et al. 2018). There is evidence to suggest that the ecological connections between blue carbon ecosystems and coral reefs can make blue carbon ecosystems more resilient and effective in sequestering and storing carbon. For example, Guerra-Vargas et al. (2019) found more organic carbon in seagrass sediments in seagrass beds sheltered behind barrier reefs compared to unsheltered beds. However, this is an area of ongoing scientific research, and there remains outstanding questions for scientific exploration such as additional research is needed at the nexus of coastal ecosystems to determine their relative contributions (Macreadie et al. 2019).

The International Policy Consensus

Hundreds of policy instruments address coral reefs, and other coastal ecosystems.
A UN Environment Programme and International Coral Reef Initiative (ICRI) analysis (2019) identified more than 230 binding and non-binding multilateral agreements (at the global or regional scale) that directly or indirectly support coral reef conservation and sustainable management, including, for example, their protection through area-based conservation measures. Commitments in these agreements to address coral reef conservation tend to be broad in nature, covering all drivers of coral reef degradation and decline in some way, but lack strength (i.e., commitments requiring action, contained in legally binding agreement) and robust review mechanisms. Furthermore, they often focus on planning and process-oriented interventions that States can make to address drivers of coral reef degradation and loss (as opposed to measuring progress against achieving certain outcomes with respect to coral reef ecosystem composition, structure, or function), but are implemented through siloed or fragmented approaches that undermine overall success. Many of them address both coral reefs and associated blue carbon ecosystems. In sum, States have committed through multilateral agreements to address most anthropogenic drivers of change in coral reef ecosystems, even if these commitments have often been relatively 'weak' in nature and lacking monitoring or accountability mechanisms.

Some studies of policy instruments and interventions or management approaches specifically for blue carbon ecosystems have been undertaken, including for mangroves (Slobodian & Badoz (eds.) 2019) and seagrasses (Griffiths et al. 2020). In these analyses the connections between coastal ecosystems, including blue carbon ecosystems and coral reefs, are mentioned but the issue is less frequently explored from a governance perspective.

Coral reefs do receive political attention as important, threatened ecosystems.
As indicated by the large number of highly diverse international policies supporting coral reef conservation and management, coral reefs do receive increasing attention from policymakers around the world at different jurisdictional scales. At the international or global scale, the UN Environment Assembly, representing UN Member States, adopted Resolution 2/12 (2016) and 4/13 (2019). More than 40 governments, serving as custodians of more than 75% of the world's coral reefs by area, have voluntarily joined ICRI, representing a national commitment to preserving coral reefs and associated ecosystems. Many coral reef countries and champions have signed onto additional statements, such as the Coral Reef Life Declaration, or made other high-level statements through the G7, G20, High Level Panel on a Sustainable Ocean Economy, and highlighting the importance of coral reefs in the context of sustainable development.

While a global "coral reef" target (Aichi Target 10) was agreed by almost all governments under the Convention on Biological Diversity (CBD) in 2010, the target's lack of clarity and delayed adoption of appropriate coral reef indicators undermined its actionability. However, this has also led to visible efforts to secure a new target or set of targets in the CBD post-2020 global biodiversity framework (GBF) that address coral reef conservation and management (ICRI 2021). This interest from political leaders is further reflected by the adoption of IUCN Resolution 105 with unanimous support from voting government members of IUCN, which calls on all IUCN members to support global coral reef targets, monitoring programs, and financial mechanisms in the coming decade.

Policymakers are also interested in 'nature-based solutions' to climate change and other threats.
Alongside wide recognition of the urgent threats to coral reefs and other ecosystems, there is also increasing recognition

of the potential for natural ecosystems to be part of the solution to those same threats. "Nature-based solutions" (NbS) is a term with increasing political visibility that is intended to capture the various contributions that ecosystem conservation, restoration and sustainable management can provide for human wellbeing while also delivering biodiversity-, climate-, and nature-positive outcomes (Claudet 2021; Seddon et al. 2021). The term has appeared in high-level statements and political declarations - such as the Leaders' Pledge for Nature and the G7 Nature Compact – and practical implications of the term have been discussed in policy relevant fora such as the UNFCCC Standing Committee on Finance (UNFCCC 2021).

The term's prominence is relatively new, and it remains insufficiently defined and integrated across multilateral environmental agreements, which has provided both political and practical challenges. Some research on NbS has focused on the potential contribution of terrestrial ecosystems to climate change mitigation through conservation and management of terrestrial carbon sinks (e.g., Griscomm et al. 2017), but there have also been attempts to quantify or map the potential contributions of nature-based solutions to climate change adaptation (Chausson et al. 2020). However, these exercises do not always comprehensively evaluate the contribution that marine ecosystems make to both mitigation of and adaptation to climate change, despite being explicitly included in the definition and guidance developed by the IUCN (IUCN 2020). Furthermore, overarching concerns remain about the origins and implications of the term for perpetuating inequities in conservation and greenwashing the actions and roles of different actors (Friends of the Earth 2021).

Existing instruments and efforts have not been able to reverse global coral reef declines.
Despite this high-level attention to coral reefs, the science is clear that coral reefs continue to decline at the global scale. A landmark report from the Global Coral Reef Monitoring Network (GCRMN) compiling coral reef datasets from around the world found that between 2009 and 2018, there was a progressive loss of about 14 percent of live hard coral cover from the world's coral reefs -- about 11,700 square kilometers -- primarily due to recurring, large-scale bleaching events (see Figure 2, below; GCRMN 2020). This analysis of thousands of coral reefs can be practically expressed in terms of its impacts on human systems – for example, Eddy et al. (2021) projects that declines in live coral cover, as noted by the GCRMN report, will result in a 50% decline in the valuable ecosystem services provided by reefs (described above).

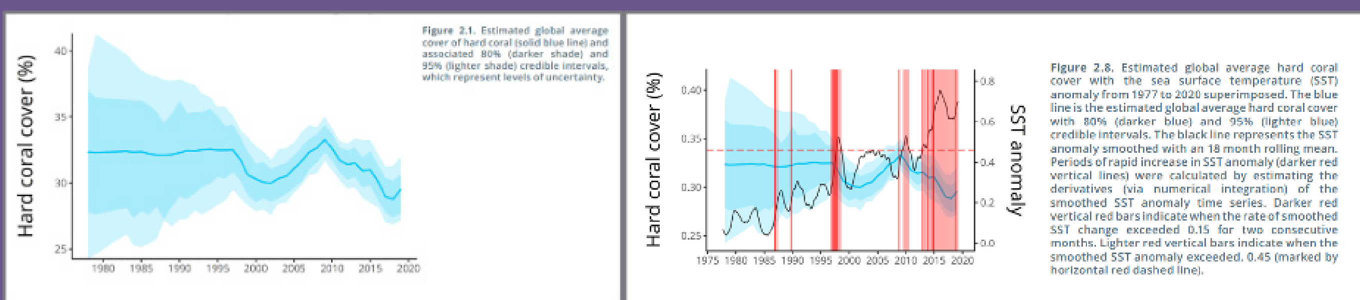


Figure 2. Declines of hard coral cover and correlation with sea surface temperature anomalies (GCRMN 2020)

This is not entirely unexpected – ongoing analyses of progress against existing global coral reef targets reached similar conclusions. For example, the 5th Global Biodiversity Outlook (GBO-5) found that only 5% of Party governments submitting national reports were on track to achieve national targets of comparable scope and ambition to Aichi Target 10 (SCBD 2020). Complementary analyses on trends in live coral cover, frequency of coral bleaching events, etc. suggested that the status of these ecosystems continues to degrade generally (with some regional variation), and that climate change and ocean acidification poses an increasingly dire threat to coral reefs (Eddy et al. 2021; Timmers et al. 2021; Hughes et al. 2018). Whether this failure is a result of poor target design, unclear monitoring frameworks, or insufficient support for implementation, or all three, remains subject to discussion (Butchart et al. 2016).

Key Opportunities at the Ocean-Climate Policy Nexus

There is increasing attention to ocean ecosystems in international climate policy.
Although the ocean has always been recognized under the UN Framework Convention on Climate Change (UNFCCC) and the Paris Agreement in both preambular and operative text (see Box 1), it is only recently that the important role of ocean ecosystems in climate change was formally recognized within an official UNFCCC COP decision, the Chile Madrid Time for Action (Decision 1/CP.25, paragraphs 30-31). This Decision led to the first-ever UNFCCC dialogue on strengthening ocean climate action in the context of the UNFCCC and across other UN fora (see Box 1). This progress is a result of a large number of individual and collective efforts focusing on the opportunities at the ocean-climate nexus, including, but not limited to, partnerships such as the Because the Ocean initiative and the Ocean and Climate Platform.

Box 1: The Ocean under UNFCCC and the Paris Agreement

The UNFCCC and the Paris Agreement

The ocean has been recognized in the preamble (”Aware of the role and importance in terrestrial and marine ecosystems of sinks and reservoirs of greenhouse gases”) and operative paragraphs of the 1992 UN Framework Convention on Climate Change (UNFCCC):

> [Article 4, Paragraph 1] “All Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall:
>
> > ...
> >
> > (d) Promote sustainable management, and promote and cooperate in the conservation and enhancement, as appropriate, of sinks and reservoirs of all 11 greenhouse gases not controlled by the Montreal Protocol, including biomass, forests and oceans as well as other terrestrial, coastal and marine ecosystems;”

The 2015 Paris Agreement also mentions oceans in a preambular paragraph (“Noting the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity”), but also contains an operative paragraph referring to the marine sinks and reservoirs in the UNFCCC:

> [Article 5, Paragraph 1] “Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4, paragraph 1 (d), of the Convention…”

The Paris Agreement also establishes two long-term goals, one for climate mitigation (Article 2 refers to the 1.5 and 2 degree limits and Article 4 deals with climate neutrality) and one for climate adaptation (Article 7, which is less quantitative and refers to “enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change”).

These long-term goals help structure “global stocktake” processes, which draw on nearer-term commitments and communications provided in line with the Agreement:

- [Article 4, Paragraph 2] “Each Party shall prepare, communicate and maintain successive nationally determined contributions that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions.”
- [Article 7, paragraph 9] “Each Party shall, as appropriate, engage in adaptation planning processes and the implementation of actions...”
- [Article 7, paragraph 10] “Each Party should, as appropriate, submit and update periodically an adaptation communication…”
- [Article 7, paragraph 11] “The adaptation communication referred to in paragraph 10 of this Article shall be, as appropriate, submitted and updated periodically, as a component of or in conjunction with other communications or documents, including a national adaptation plan, a nationally determined contribution as referred to in Article 4, paragraph 2, and/or a national communication.”

Ultimately, the most legally binding and specific language pertains to the formulation and submission, as well as revision, of NDCs that can contain both mitigation and, optionally, adaptation-related information. However, there is great complexity in exactly how the NDC, its adaptation related components, and other adaptation related processes can and should interact (Fransen et al. 2019).

UNFCCC SBSTA and the Ocean-Climate Dialogue

The first formal recognition of the ocean-climate nexus in a COP decision was in 1/CP.25, adopted in December 2019, which directed UNFCCC SBSTA to “convene at its fifty-second session...a dialogue on the ocean and climate change to consider how to strengthen mitigation and adaptation action in this context.” As a result of schedule disruptions from the COVID-19 pandemic, a call for written inputs was launched and the SBSTA Chair produced an Information Note for a virtual Ocean-Climate Dialogue in December 2020. A synthesis report and informal summary of the SBSTA Chair represent key outcomes charting a way forward for ocean issues.

The Nairobi Work Programme

Launched at UNFCCC COP11 (2005), the Nairobi Work Programme on impacts, vulnerability, and adaptation to climate change (NWP) serves as a "knowledge-to-action hub for adaptation and resilience." At the direction of SBSTA, the NWP has set up a priority area on oceans, coastal areas and ecosystems, which includes consideration of coral reefs and mangroves. The 13th NWP Focal Point Forum, convened at COP25 in December 2019 and supported by the NWP Expert Group on Oceans and a scoping paper, provided a platform to discuss ocean issues, and these discussions in turn informed the Ocean-Climate Dialogue (see above) and ongoing discussions at SBSTA-52.

The Warsaw International Mechanism on Loss and Damage (WIM)
As two of the formally 'constituted bodies' under the Paris Agreement and UNFCCC respectively, the Warsaw International Mechanism on Loss and Damage (WIM) Executive Committee (ExComm) worked with the UNFCCC Technology Executive Committee to develop a prepare a policy brief for SBSTA-52 on available technologies (hardware, software, and orgware) to assess and reduce risks, and recover/rehabilitate from impacts of climate change in coastal zones, including e.g. coral bleaching.

The Financial Mechanisms
Article 11 of the UNFCCC establishes the broad mandate for a 'financial mechanism,' which has historically been operationalized by the Global Environment Facility (GEF) and, more recently, by the Green Climate Fund (GCF). The GEF and GCF have separate governance structures, and focal points, but are in theory directed by guidance agreed to by consensus via the UNFCCC COP (Article 11 paragraph 1).

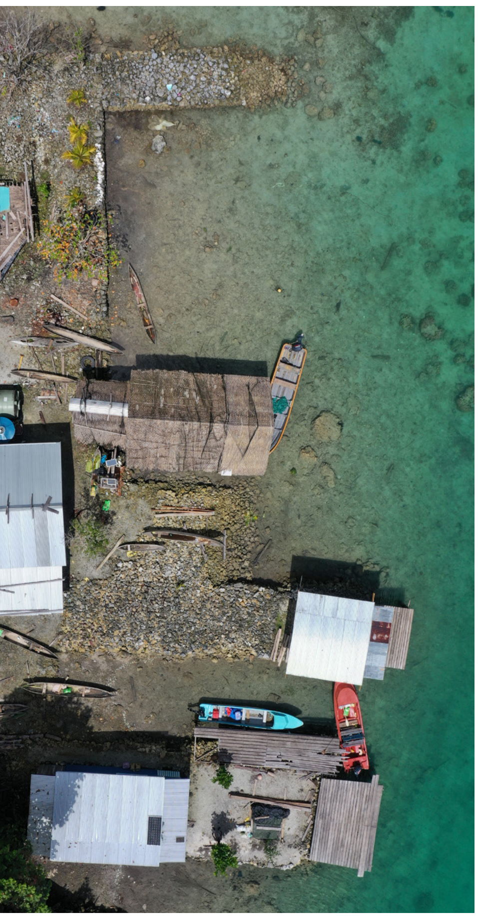
However, continued attention by the UNFCCC will rely on sustained political support, including through a formal decision text at COP26 and subsequent COPs. Civil society has recommended that Parties take advantage of upcoming COP decisions to: highlight the urgency of mitigating climate impacts on ocean ecosystems; call for greater integration of ocean-climate activities across UNFCCC subsidiary bodies and working groups; request enhanced guidance for Parties to develop and implement national commitments and plans involving ocean ecosystems, including at the mitigation-adaptation nexus in coastal ecosystems; and drive stronger engagement with other relevant multilateral processes on biodiversity and development ("Considerations for the Ocean-Climate Dialogue" 2020). Party governments to the UNFCCC/Paris Agreement have also expressed support for maintaining momentum on ocean-climate issues, including steps in line with these recommendations such as a recurring Ocean-Climate Dialogue, through formal decision text at COP26 (UNFCCC 2021).

Whether or not this progress on ocean issues continues at the multilateral level under the UNFCCC, there has been concurrent and significantly related progress at the national level. A 2017 analysis of over 160 intended national climate commitments (NDCs) found that more than 70% include some reference to ocean or coastal zones, representing nearly three-quarters of the global human population at the time (Gallo et al. 2017). As part of these references to ocean ecosystems, over one third mentioned the contribution of ocean-related mitigation measures, primarily through blue carbon ecosystems or other interventions in shipping or renewable energy. 28 NDCs mention coral reefs, usually as part of adaptation components, and 14 countries, primarily Small Island Developing States, addressed ocean acidification as a pressure on coral reefs. A more specific analysis on blue carbon ecosystems in 2016 found that 28 countries' NDCs include a reference to coastal wetlands in terms of mitigation, while 59 countries are including coastal ecosystems and the coastal zone in their adaptation strategies (Martin et al. 2016).

Governments increasingly recognize the urgency of climate change adaptation.
Longstanding calls from Parties and Observers for greater attention to, and investment in, climate change adaptation has led to progress in recent years, particularly in light of scientific evidence reflected in IPCC AR6. Although there is no binding legal obligation for Parties to include adaptation commitments in their NDCs (see Box 1), the UNFCCC Secretariat's synthesis report of the 164 NDCs submitted by July 2021 notes that most governments included some adaptation related content (largely focused on the development of National Adaptation Plans). The Secretariat also notes and that there is increased attention to: ecosystems and communities most vulnerable to climate change impacts such as sea level rise and extreme weather events; adaptation targets and indicators; and mitigation and adaptation co-benefits; and the need to enhance adaptation-relevant research (UNFCCC 2021). Parties also expressed the need for enhancing "adaptation-relevant research, data, information and monitoring, and ensuring that adaptation efforts are informed by science." The UNFCCC Secretariat also noted that some Parties included a focus on restoring and conserving coral reefs, as well as seagrass and mangroves.

The Nature-based Solutions Policy Platform found that around 30% of NDCs contain detailed adaptation plans, with a far higher percentage (primarily developing countries) containing some form of adaptation commitments, plans, or other references (Oxford University 2021). While the most recent OECD report on climate finance from developed to developing countries suggests an increase in climate adaptation funding from 2016-2019, with a sharp increase in 2019 (OECD 2021), evaluation of adaptation-related outcomes remains scarce. Furthermore, these financial flows tend to be concentrated in certain geographic regions or other categories and may reflect political concerns or other practical realities. There are opportunities through the UNFCCC Standing Committee on Finance to review and discuss these financial flows and their imbalances in the context of broader climate finance. However, there remains a need for broader scrutiny of implementation of existing climate adaptation plans and commitments.

Updating national plans can maximize outcomes for coastal mitigation, adaptation, and biodiversity.
Articles 4 and 7 of the Paris Agreement contain obligations for Party governments, including to update NDCs on a regular basis and update national adaptation communications and plans as appropriate (see Box 1). Although challenges remain, including precise accounting methodologies for coastal carbon sinks and equity issues for coastal rights holders, a variety of organizations and partnerships have produced guidance or recommendations on how to maximize the opportunities and processes of the UNFCCC ambition cycle, across NDCs, NAPs, and other tools, for blue carbon and other coastal ecosystems (e.g. Northrop 2020; Ocean and Climate 2019; Beasley et al. 2019; Varda Group 2018; FEBA 2017; Blue Carbon Initiative TBC). There is also guidance from other multilateral fora that touches specifically on adaptation and coastal biodiversity (e.g., CBD and FAO). Steps outlined in these documents, and potentially further refined to focus on key adaptation practices and approaches, can also be incorporated into UNFCCC global 'stocktake' processes that measure progress and commitments against the global mitigation and adaptation goals (Schindler Murray, Romero, and Herr 2021).



The long-term, iterative, political, and technical process of updating national commitments in the form of NDCs, as well as optional communications on adaptation and other reporting mechanisms, can offer significant, cyclical opportunities to continually improve and/or incorporate plans for coral reefs and coastal ecosystems. More specifically, greater inclusion of adaptation components in NDCs may be able to increase visibility for coral reefs, link them explicitly to blue carbon mitigation efforts, and help secure external funding. This can also help institutionalize adaptation plans across government agencies and non-governmental partners, including on transparency frameworks and subsequent reporting (GIZ 2017). By integrating adaptation planning processes with the higher-profile process of updating and implementing mitigation-related commitments under NDCs, there is also an opportunity to maximize synergies with other sectoral efforts and multilateral frameworks (GIZ 2020; Fransen et al. 2019).

Other policy frameworks for biodiversity, etc. can reinforce and complement climate policies.
The IPCC and IPBES found that the climate and biodiversity crises are inextricably linked, through both common drivers and solutions, and will require an integrated approach (Pörtner et al. 2021). This was also acknowledged by UNFCCC Parties into official COP Decision text in 1/CP.25. This will be operationalized into different ways, but this coherence must accommodate the statutory requirements and policy processes that Parties to the UNFCCC and biodiversity-related conventions such as the CBD must engage with. Such coherence can streamline the implementation and reporting burden for Parties, particularly for developing countries.

Further identification of synergies between the intergovernmental climate and biodiversity regimes will take place at multiple scales, and can include formal cooperation between the Conventions' technical bodies on monitoring frameworks, associated implementation and review mechanisms, and global assessments that underpin 'stocktaking' and 'ratcheting' processes for informing and enhancing national contributions (Climate Action Network 2021; Barber et al. 2020). Given the precise mandates and legal nature of these agreements, ensuring that separate but complementary fora must have long-term goals, near-term targets, and associated monitoring frameworks that complement one another and address all necessary actions to conserve coastal ecosystems. This speaks to the critical nature of adopting goals, targets and indicators under the CBD's post-2020 GBF and updating relevant national planning documents. This conceptually extends to the UN's 2030 Sustainable Development Goals, which have relevant (if disjointed) goals, targets and indicators (Nash et al. 2020) and other multilateral frameworks.

Key Challenges at the Ocean-Climate Policy Nexus

Oceans, and coral reefs, are not uniformly reflected in national climate commitments.
The inclusion of coral reefs and other coastal ecosystems in national climate commitments and plans is not universal or consistent. Gallo et al. (2017) found that, at the time, many key countries with large exclusive economic zones or major

ocean-based economies did not mention the ocean within their NDCs. This study found that some of the strongest factors influencing whether oceans were included in NDCs was whether membership in certain political blocs that pay significant attention to the ocean (e.g., Alliance of Small Island States) and whether significant portions of the population are in low-lying areas (i.e., perceived human vulnerability to sea-level rise and severe weather events) -- not as much geographic factors such as coastline length, or even factors such as domestic fisheries landings that entail significant climate-dependent economic impacts.

A brief analysis of the current (October 2021) UNFCCC interim NDC registry and the latest adaptation communications suggests that of the top 25 coral countries, only four countries specifically mention coral reefs within their NDC, with many using far broader terms such as coastal ecosystems or resources, or focusing primarily on opportunities for mangroves or other associated ecosystems. Additionally, most of top 25 coral reef countries have not submitted an adaptation communication or national adaptation plan to the UNFCCC Secretariat. While this does not mean that adaptation planning is not ongoing, or that coral reef adaptation is not addressed by, for example, a country's NBSAP, it speaks to possible gaps that might indicate a lack of coherence across policy frameworks for key coastal ecosystems.

Finally, some coral reefs are found on the high seas and will therefore be dependent on intergovernmental negotiations around management of areas (and biodiversity) beyond national jurisdiction on the high seas (Wagner et al. 2020).

Adaptation in coastal ecosystems requires integrated guidance and local approaches.
As discussed above, the projected impacts of climate change demand significant attention from governments and other stakeholders on adaptation planning and action, which has historically received less attention given the urgency of mitigation efforts and less stringent legal requirements under the Paris Agreement. However, the guidance cited above, as well as forthcoming guidance developed in line with Decision 9/CMA.1 – outlining the elements for Parties' Adaptation Communications, inviting financial support for their development, and requesting supplementary technical guidance to be drafted by June 2022 for consideration by Parties – may lead to increased attention from Parties on climate adaptation in the coming years.

Ultimately, however, governments and stakeholders will need to develop and implement strategies at a domestic and sub-national systems level, addressing direct and indirect drivers while optimizing outcomes for climate change mitigation, adaptation, and biodiversity. The protection, management and conservation of coastal ecosystem networks to deliver mitigation and adaptation outcomes is one widely agreed approach (Roberts et al. 2017), but other solutions will be required to secure climate resilient fisheries with lowered fuel consumption, reduced impacts of shipping on biodiversity and climate, etc. These strategies will need to be tailored to local context, including different forms of governance and the local stressors on coral reef ecosystem integrity; however, it will still be essential to identify and maximize synergies between the UNFCCC and the forthcoming post-2020 global biodiversity framework and improve guidance that serves Parties to both.

Ultimately, continued political and practical shortfalls may undermine global progress.
At present (October 2021), there is significant concern regarding the political barriers to successful outcomes at UNFCCC COP26, as well as CBD CoP15. These barriers include significant disagreements on highly detailed policy issues such as rules for international carbon markets and circumstantial issues such as access for delegates during the ongoing COVID-19 global pandemic. However, underlying these and cutting across different debates, including those detailed above and others at the ocean-climate nexus, are fundamental disagreements about whether developed and developing countries are being held accountable to their pledges under the Conventions and associated frameworks.

Related to this, there remains a significant "biodiversity finance gap" and shortfalls in meeting climate finance pledges (Deutz et al. 2020; Oxfam 2020). There are also concerns that key governments are not matching their historic or current role in climate change or biodiversity loss with commensurate commitments and action. While these debates extend far beyond coral reefs and associated coral reef ecosystems, there are direct implications for the level of ambition on coral reef conservation and restoration, and the ambition of domestic commitments or plans that involve coastal ecosystems. These overarching political debates form a critical backdrop to intergovernmental, national, and local action, and without resolving them, it is unlikely that any individual successes in coral reef conservation or adaptation will be part of a globally successful effort to protect these ecosystems and people who depend on them.

Recommendations and Next Steps through 2030

This whitepaper recommends the following near-term actions for national governments, as well as their sub-national and civil society partners. These recommendations build on informal summary report of the Ocean-Climate Dialogue from the UNFCCC SBSTA Chair (UNFCCC 2020) and other reports from civil society.

1. Ensure that the outcomes of climate and biodiversity conferences work together for coral reefs.
It is essential that delegates to UNFCCC COP26 (November ‘21) and CBD CoP15 (concluding May ‘22), and those to future UNFCCC and CBD COPs, identify synergies to collaborate and strengthen the outcomes for coral reefs, and associated ecosystems, for nature and people.

Generally, this can be accomplished by: national governments requiring, and the civil society supporting, dialogue and close cooperation between national focal points for climate, biodiversity and other marine issues (e.g. coral reefs, fisheries) leading up to key meetings, which should result in alignment of positions related long-term (2050) goals, nearer-term (2030) targets, and domestic cooperation on NDCs, National Adaptation Plans, NBSAPs, etc. designed to achieve such targets. Such cooperation must also address transparency, monitoring, and accountability frameworks (including indicators and other metrics), and synergistic public investments to implement commitments and measure progress.

More specifically, government delegations should collectively adopt COP decisions calling for formal cooperation between the Conferences of the Parties and the Conventions’ subsidiary bodies (e.g., UNFCCC SBSTA and CBD SBSTTA) and other work streams or initiatives, including relevant international partnerships and technically qualified civil society organizations working to manage coastal ecosystems for climate and biodiversity outcomes. This cooperation should produce, as one output, improved guidance and support for relevant Parties seeking to build coastal nature-based solutions for ecosystem-based adaptation into mutually coherent national biodiversity and climate targets and plans in line with globally adopted targets.

2. Use climate COPs as an opportunity to strengthen adaptation plans for coral reef countries.
Following on the conclusions of IPCC and political priorities expressed by UNFCCC Parties and the incoming CoP Presidency, COP26 (and subsequent COPs) are key opportunities to focus political attention on climate change adaptation. Within the formal negotiations, Parties can consider how any potential revisions to the long-term goal for climate adaptation could benefit a global adaptation agenda, and they should ensure that any global stocktake should incorporate data on trends in the status of coral reefs as a key, climate-sensitive indicator as to our successful efforts on both mitigating the impacts of climate change and ecosystem-based adaptation. Additionally, mobilizing additional multilateral flows for adaptation to reach parity with climate change mitigation will benefit global adaptation efforts (see below).

However, the consensus-based negotiations should not stand in the way of, and could in fact benefit from, increased national ambition on climate adaptation. COP26 and future UNFCCC COPs present an opportunity for countries, particularly coral reef countries that have not already done so, to consider updates to NDCs and national adaptation communications/plans to account for coral reefs and associated coastal ecosystems, as well as for the COP to call for enhanced guidance and increased ambition in this regard (see above). Funding must be mobilized and dedicated specifically to support such planning processes, particularly context-appropriate processes for coral reef countries, as well as greater accountability for implementation and action on the ground.

3. Strategically link mitigation and adaptation outcomes through area-based conservation.
Parties are required to regularly increase their ambition on overall emissions reductions for the near term as part of updated NDCs. As Parties present updated NDCs to the UNFCCC Secretariat around COP26 and enhance them subsequently as part of the ambition cycle, there are key opportunities to consider how the retention of blue-carbon ecosystems, through protection or other management approaches, may contribute to overall emissions reduction targets while delivering co-benefits for coral reef ecosystems. Strategic protection or conservation of blue carbon ecosystems should be planned in tandem with updates to national adaptation plans that seek to maximize contributions of coastal ecosystems for adaptation. While COP26 is an important moment to increase ambition and make overarching commitments, the process of implementing NDCs will provide opportunities to more specifically increase ambition on the protection of blue carbon ecosystems and updating national adaptation plans accordingly.

Furthermore, recognizing the global momentum behind a ‘30x30’ approach to conserving the global ocean for biodiversity and ecosystem services (see below), there is an opportunity to maximize the contributions of coastal protection and conservation measures by linking ecosystems that provide different mitigation and adaptation measures. Areas identified for enhanced protection and monitoring under 30x30 should prioritize coastal ecosystems that link co-benefits for coral reefs, mangroves, and other key habitats to secure their co-benefits for biodiversity and climate.

4. Adopt a global biodiversity framework, with indicators, that provides for coral reef adaptation.
In order to proactively address the urgent threats to coral reef ecosystems that are not under explicitly the remit of the UNFCCC, including coastal development and habitat destruction (e.g. mangrove destruction), overfishing or destructive fishing (including targeting of key species for reef ecosystem integrity such as herbivorous fish), illegal harvest and trade in species (e.g. reef sharks and other top predators), invasive species (e.g. crown-of-thorns starfish), and land- and sea-based pollution (e.g. agricultural runoff and sewage inputs), governments must conclude negotiations on an effective, evidence-based and synergistic post-2020 global biodiversity framework at CBD CoP15. The post-2020 GBF must adopt measurable, time-bound targets and indicators that address all threats to the biodiversity and functionality of coral reefs, including those most urgent stressors where international cooperation and assistance would be most beneficial.

However, part of maximizing the synergies between the climate and biodiversity regimes will be appropriate and careful design of climate change-related targets within the GBF. Climate change presents an existential threat to biodiversity, particularly coral reefs, but coastal ecosystems also present opportunities and solutions. GBF targets must drive greater ambition on protecting ecosystems that sequester and store carbon and ensure that we safeguard those ecosystems like coral reefs, which contribute to ecosystem-based climate adaptation and provide a host of other nature-based solutions.

Finally, there is a global push to go beyond "net zero" impacts on ecosystems and move towards an urgent "nature-positive" future by 2030 (Locke et al. 2021; Bull et al. 2019). While this is most challenging for ecosystems with dire outlooks under current climate projections, coral reef restoration will remain an important area of focus. Restoration-related targets in the GBF, and associated efforts under the UN Decade on Ecosystem Restoration, must explore coral reef-relevant strategies including assisted accretion in suitable habitats, strain selection, etc. without detracting from the simultaneous efforts to bring existing coral reefs through the climate and biodiversity bottlenecks. Only through integrated retention and restoration strategies, as well as holistic measures to protect interlinked blue carbon ecosystems, will we be able to achieve a net-positive outcomes for coastal biodiversity.

5. Create a global 'currency' of coral reef indicators to measure collective progress.
Targets, and plans to achieve them, must include robust and standardized monitoring and reporting frameworks to determine whether steps taken are contributing to the overall goals. Recognizing that governments are tasked with developing and implementing climate, biodiversity, and many other national plans, there is an urgent need to assist both national governments and local coral reef managers by identifying a global set of indicators at the coral reef and climate nexus for coherent and streamlined monitoring and reporting. Such efforts must build on the work of ICRI to identify coral reef indicators for the GBF, but should take place through closer cooperation between the technical subsidiary bodies of the Conventions, technical advisory panels to financial mechanisms, and any associated ad hoc advisory groups. These indicators should also underpin information provided during global stocktake processes, and processes that go beyond review to focus on the accountability of States and other actors to achieve their stated commitments. Core indicators must capture trends in the status of biodiversity and functionality of ecosystems; key pressures on biodiversity; and interventions to secure their function under climate projections.

6. Improve biodiversity outcomes by strengthening capacity and building on traditional knowledge.
To ensure that perspectives and contributions from all stakeholders are appropriately recognized and, where biodiversity-positive, supported, recognized as the only means to lasting impact, it is essential to create global and national commitments, plans and frameworks that explicitly capture the views and contributions of stakeholders at all levels, including women and youth, Indigenous Peoples and local communities, civil society - and encourage their participation in implementation. But it is essential to beyond consultation or reflecting the role of stakeholders, particularly Indigenous Peoples and local communities (IPLCs), in documents – national plans must empower the traditional and current custodians of coral reefs to contribute to overarching goals for coral reefs. This includes direct support, including both financial and technical support, for implementation and monitoring/reporting and appropriate recognition of the contributions from traditional knowledge and customary sustainable use.

Capacity building efforts must also target those countries and geographies where there is significant opportunity presented because of a confluence of coastal ecosystem types and benefits, including the presence of coral reefs, mangroves, and seagrass meadows that deliver a variety of climate and biodiversity co-benefits.

7. Use existing partnerships to increase momentum for, and cooperation on, implementation.
Coherence and collaboration between existing partnerships working to center coral reefs and ocean ecosystems within climate and biodiversity decision-making should be enhanced to drive increased political ambition and urgency for key, synergistic ocean outcomes. For example, the work of ICRI member governments and organizations on the post-2020 GBF can link more explicitly to advocacy for coral reefs and associated ecosystems, which should link clearly to planned investments from financial mechanisms. Rather than creating new platforms or initiatives, enhanced coordination, particularly among government focal points and political leaders at key moments such as climate, biodiversity, and ocean summits, as well as new discrete and time-bound programs of work, can achieve desired outcomes without duplicating administrative structures or travel costs.

8. Fund sustainable, strategic interventions across networks of coastal ecosystems.

Finally, the effective implementation of recommendations above will depend on sufficient financial resources for both policy development and implementation. Recognizing political obligations of developed countries under both the UNFCCC and CBD, it is essential that those countries contribute significantly, through both multilateral financial mechanisms and bilateral assistance, to activities including the updating nationally determined contributions, national adaptation plans, national biodiversity strategies and action plans, and associated monitoring programs. Therefore, governments, through the governing bodies of ocean- and climate-funding mechanisms, and particularly those mechanisms operating at the climate-biodiversity nexus should seek to prioritize investments that enhance coastal resilience through integrated approaches to climate change mitigation and adaptation, including those that identify and support the role of coral reefs as an integral part of these coastal systems and therefore of national plans.

This could be done through, for example, expanding the number of countries helping to capitalize existing financial mechanisms such as the Global Fund for Coral Reefs (GFCR), as is currently being undertaken by the Green Climate Fund (GCF 2021). Targeted outreach and readiness programs for least developed coral reef countries could also help drive greater ambition in key coral geographies by increasing access to and uptake of this finance. There are specific strategies to inform this effort – for example, through strategic text in the guidance to the financial mechanism adopted at UNFCCC and CBD COPs – but ultimately this will be an iterative and context-specific effort.

Conclusion

There are significant near-term and long-term opportunities for coral reefs and associated ecosystems to be prioritized in tandem as part of holistic responses to the climate and biodiversity crises. Existing intergovernmental policy fora at the ocean-climate nexus offer some clear pathways, as well as some opportunities that require additional deliberation and individual and/or collective action. The urgency of coral reef conservation, for biodiversity and people, should inform our efforts to seek every available policy opportunity and examine those that remain unexplored. While UNFCCC COP26 and CBD CoP15 offer significant opportunities, the ongoing and iterative negotiation of global responses to climate and biodiversity crises means that cooperation must be built into existing partnerships and maximized during this coming decade of conservation action.

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