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MARINE AND COASTAL ECOSYSTEM RESTORATION

Introduction

Marine and coastal ecosystems - including mangroves, seagrasses, saltmarshes and coral reefs -provide essential ecosystem services, including biodiversity support, carbon sequestration, coastal protection and food provision. However, these ecosystems are undergoing rapid degradation due to cumulative pressures such as coastal development, pollution, overfishing, habitat modification, and climate change.

In this context, restoration has become a central component of the Kunming–Montreal Global Biodiversity Framework (KMGBF), particularly under Target 2 **[1]**. While scientific evidence increasingly highlights successful restoration outcomes, including examples of long-term recovery and large-scale implementation, outcomes remain highly variable, context-dependent and subject to ecological, governance and social constraints.

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Key Messages

This brief examines the feasibility and design of marine restoration commitments and highlights that:

- Removing pressures - including pollution, destructive fishing practices, coastal habitat destruction and climate-related stressors - is a prerequisite for success
- Because marine ecosystems are highly connected, restoration outcomes often depend on governance frameworks capable of addressing pressures across ecological and jurisdictional boundaries
- Marine restoration requires ecological, social, governance and economic interventions, including habitat restoration, regulation, financing mechanisms and community participation
- Restoration, social equity and protection must be implemented together to ensure successful uptake of the measures and avoid restored ecosystems being degraded again
- Combining interventions across the restoration continuum - from reducing pressures and enabling natural regeneration to direct ecological interventions - is generally more effective than isolated actions

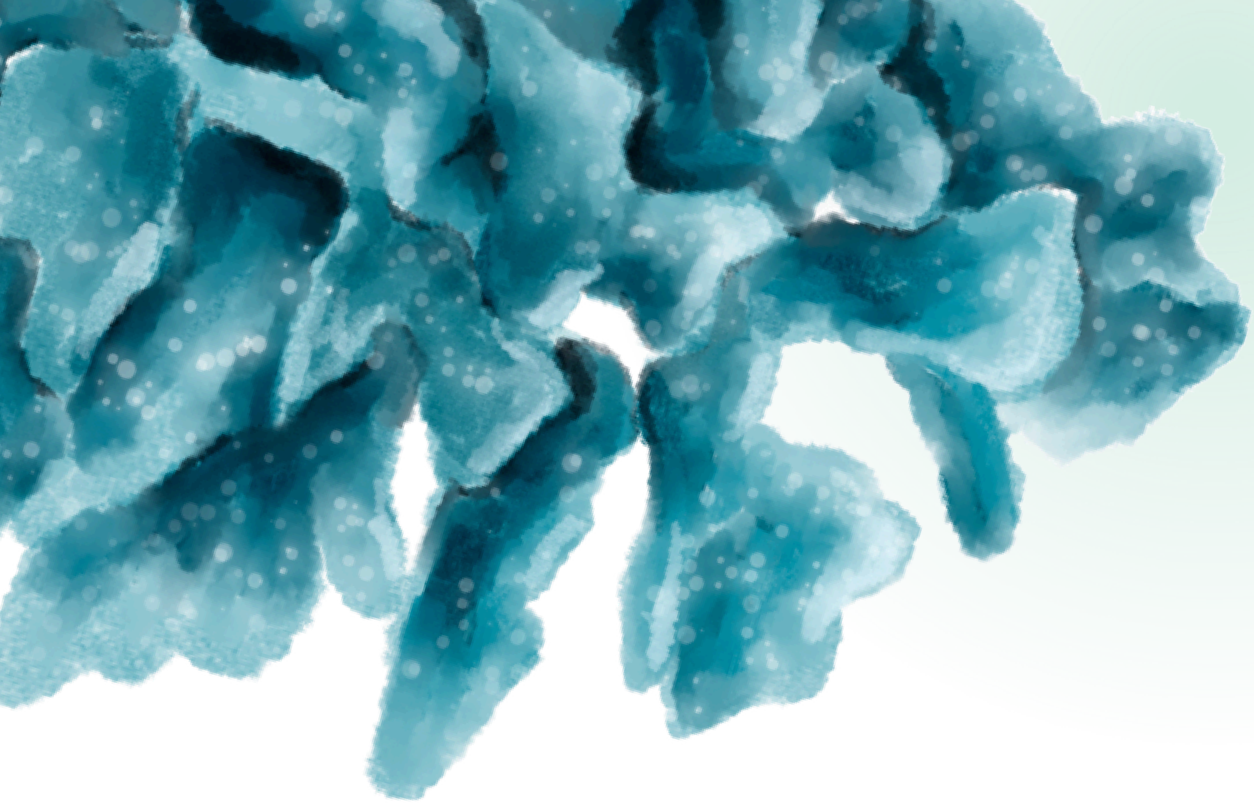
1. Technical background and key insights

Ecological and operational complexity

Marine restoration presents specific challenges compared to terrestrial systems due to:

- Hydrodynamic conditions (e.g. currents, wave action and sediment transport), which can strongly influence restoration outcomes
- High ecological connectivity across marine systems, which can create mismatches between ecological processes and governance boundaries
- Multiple interacting pressures often act simultaneously, including overfishing, pollution, coastal development and climate change
- Limited availability of donor material (seeds, shoots, larvae) for some habitats
- Logistical challenges related to access and restoration cost

[1] Ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, coastal and marine ecosystems are under effective restoration, in order to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity.



Restoration outcomes vary significantly across ecosystems and contexts. Earlier assessments highlighted high failure rates where pressures remained unaddressed and methodologies were being tested. More recent studies identify "bright spots" where restoration has persisted over decades, scaled across large areas and generated ecological and socio-economic benefits.

Success increasingly depends on informed site selection, pressure reduction, appropriate monitoring and long-term management.

Historical baselines remain important to understand ecosystem potential and avoid normalising degraded states that provide fewer ecological and societal benefits. However, restoration does not necessarily imply a return to past conditions. In many cases, historical conditions are uncertain or no longer achievable, particularly under climate change. Instead, restoration aims to place ecosystems on a trajectory toward improved ecological functioning, guided by historical baselines, reference conditions and realistic ecological objectives.

Importance of scale, thresholds and time

Restoration success is strongly influenced by:

- the scale of intervention
- the suitability of restoration techniques and restored species to local ecological conditions;
- the existence of minimum ecological conditions required for recovery (e.g. sufficient water quality, habitat connectivity, or population density for ecosystems to become self-sustaining)
- the time needed for recovery

Evidence shows that large-scale interventions significantly increase survival and stability, while small-scale interventions often fail to trigger broader ecosystem recovery processes. Restoration is not linear: when critical ecological conditions are not met, restoration efforts may systematically fail.

In slow-growing marine systems—such as maerl beds and deep-sea ecosystems—recovery may take many decades. Even in faster-growing systems such as seagrass meadows, the recovery of key ecosystem functions, including carbon storage, may take years to materialise.

Restoration interventions across a continuum of actions

Marine restoration interventions range from reducing pressures that prevent natural recovery to direct ecological interventions, and these approaches are often combined in practice.

This continuum may include:

- reducing pollution or destructive fishing practices
- supporting natural regeneration through habitat protection
- direct interventions such as coral propagation, seagrass planting or oyster reef restoration

Scientific evidence shows that direct interventions often fail when degradation drivers remain unaddressed, while pressure reduction alone may be insufficient in highly degraded ecosystems. Combining interventions across this continuum often delivers stronger long-term outcomes.

Restoration, protection and governance

Restoration and protection are interdependent.
Effective restoration requires:

- reduction of ongoing pressures
- enforcement of protection measures (e.g. marine protected areas)
- alignment between governance, policy and financing mechanisms
- Regional and international collaboration frameworks
- coordination across sectors
- meaningful participation of coastal communities and local stakeholders

Without these conditions, restored ecosystems are unlikely to persist.

Many marine protected areas remain insufficiently enforced or ineffective in reducing pressures. Governance fragmentation across sectors and jurisdictions continues to limit restoration effectiveness.

Feasibility constraints and knowledge gaps

Despite growing experience, major uncertainties remain regarding:

- high implementation costs (particularly in offshore and deep-sea environments)
- limited evidence of success at large scales
- insufficient ecological baseline data
- limited long-term monitoring
- Limited funding for mapping and monitoring
- limited long-term political commitment and institutional continuity

These uncertainties may lead to unrealistic targets or ineffective resource allocation.

Deep-sea ecosystems face particularly high uncertainty due to limited ecological knowledge, extremely slow recovery rates and major operational constraints. In many cases, reducing pressures and protecting suitable, connected areas may be more feasible than direct ecological interventions, although recovery may still take decades.

Co-benefits and cross-sectoral relevance

Marine restoration contributes to multiple objectives:

- climate mitigation and adaptation
- disaster risk reduction
- food security and livelihoods
- marine ecosystem resilience

It therefore sits at the intersection of biodiversity, climate and development agendas.

2. Case studies: illustrative restoration pathways

The following case studies illustrate three complementary restoration pathways: policy integration, ecological intervention, and governance transformation.

System-level integration: Blue Carbon Initiative

Coastal ecosystems such as mangroves, salt marshes, and seagrasses are among the most efficient natural carbon sinks, yet they continue to decline rapidly due to coastal development and land-use change. The Blue Carbon Initiative has emerged as a response to this challenge by embedding ecosystem restoration within climate policy and finance frameworks. It operates by developing methodologies to quantify carbon sequestration (MRV systems), which allows these ecosystems to be integrated into national greenhouse gas inventories and climate strategies. This approach is relevant for blue carbon ecosystems such as mangroves, salt marshes and seagrasses, but is less applicable to marine ecosystems that are not primary producers such as coral reefs, shellfish reefs or deep-sea habitats, where restoration benefits are less directly linked to carbon sequestration and may require different policy and financing approaches.

In several countries, this has enabled:

- the inclusion of coastal restoration in **Nationally Determined Contributions (NDCs)**
- the mobilisation of **climate finance mechanisms**, including carbon markets
- The development of **national restoration programmes** linked to climate mitigation

This demonstrates how restoration can scale when embedded in policy and financing systems. **Negotiation relevance:** highlights the importance of monitoring frameworks and financing mechanisms, while raising questions about balancing carbon objectives with biodiversity outcomes.

Active restoration: Coral Vita

Coral reefs are among the most rapidly declining ecosystems globally, primarily due to ocean warming, acidification and local stressors.
Coral Vita represents a model of technologically driven active restoration, based on land-based coral aquaculture. Corals are grown in controlled environments where growth conditions are optimised, allowing them to develop up to 50 times faster than in natural settings. Selected coral strains are then transplanted back onto degraded reefs.

This model has demonstrated:

- the possibility of accelerating ecological processes
- the development of private-sector restoration models, including partnerships with tourism and coastal stakeholders
- increased short-term survival rates in targeted sites

However, restoration in this case remains costly, site-specific and vulnerable to climate and ocean acidification impacts.

Negotiation relevance:
This case illustrates both the potential and limits of technological solutions. Active restoration can support local recovery, but cannot substitute for broader climate mitigation and pressure removal efforts.

Governance-based restoration: Fish Forever

In many coastal regions, ecosystem degradation is primarily driven by overfishing and weak governance rather than habitat destruction alone. Fish Forever addresses this by focusing on institutional and behavioural change through the implementation of community-based fisheries management systems.

It combines:

- clearly defined fishing rights (managed access areas)
- the establishment of no-take zones
- local governance structures involving fishing communities

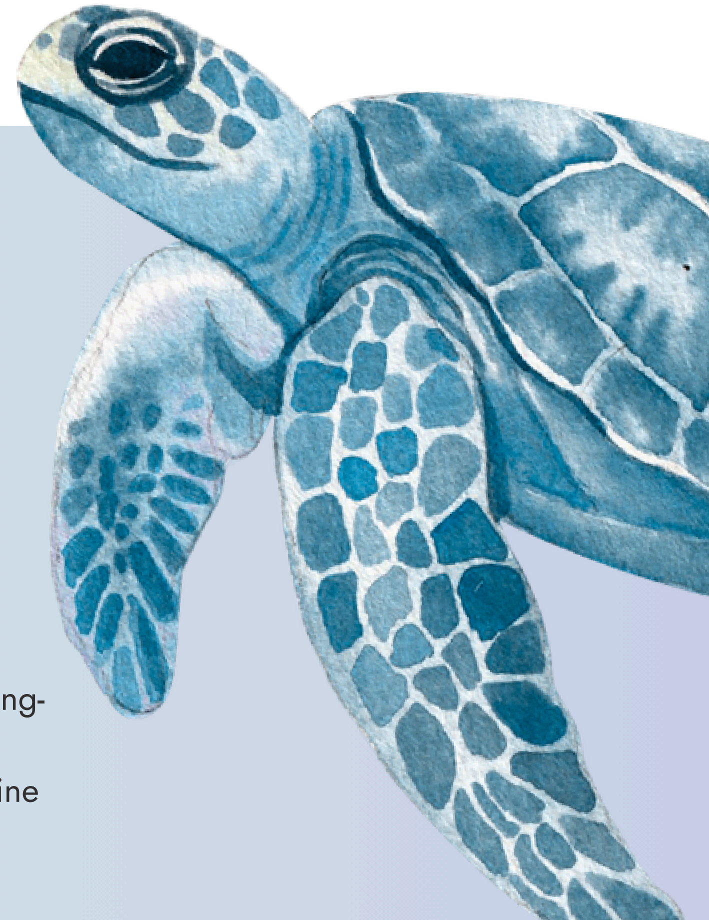
In several countries (including Brazil, the Philippines, Indonesia, Mozambique, and Belize), this approach has led to:

- documented increases in fish biomass in several locally managed marine areas
- increased and more stable incomes for local communities
- improved compliance and enforcement

Rather than restoring ecosystems through direct ecological intervention, this model enables **natural regeneration by reducing pressures and restructuring incentives**. Its effectiveness, however, depends on:

- long-term governance support and enforcement capacity
- social acceptance and community engagement
- resilience to external pressures (e.g. industrial fishing, market demand)

Negotiation relevance: restoration can be achieved through **governance reform**, and highlights the importance of **rights-based and incentive-based approaches** in delivering durable outcomes.



Conclusion

Marine restoration is a key component of global biodiversity policy, but its success depends on aligning ecological interventions, governance systems and financing frameworks.

Scientific evidence shows that restoration outcomes are conditional, context-dependent and often uncertain.

Achieving Target 2 will require realistic expectations, long-term investment and transformative changes in governance, incentives and societal approaches to marine ecosystems.

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