

Challenges and Opportunities in Repairing the Ocean

Carlos M. Duarte

Ibn Sina Distinguished Professor of Marine Science & CEO CORDAP.org



King Abdullah University
of Science and Technology



The Tragedy of the commons

Garrett Hardin, *The Tragedy of the Commons*, Science, 1968

- The ocean was codified as “*terra nullis*” in the Justinian Code, open to the use of all persons and owned by none, just as air.
- Fish and marine life was “*res nullius*”, belonging to its capturer



Nature is inexhaustible

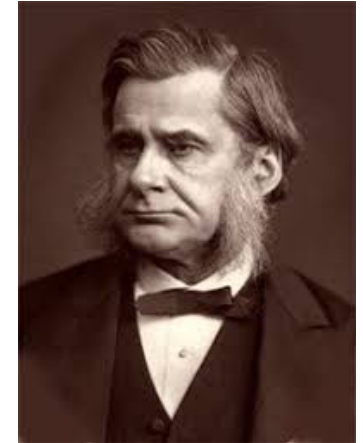


“One is constantly reminded of the infinite lavishness and fertility of Nature-inexhaustible abundance amid what seems enormous waste. And yet when we look into any of her operations that lie within reach of our minds, we learn that no particle of her material is wasted or worn out. It is eternally flowing from use to use, beauty to yet higher beauty; and we soon cease to lament waste and death, and rather rejoice and exult in the imperishable, unspendable wealth of the universe.”

~ JOHN MUIR

all the great sea fisheries are inexhaustible , overfishing or permanent exhaustion is scientifically impossible

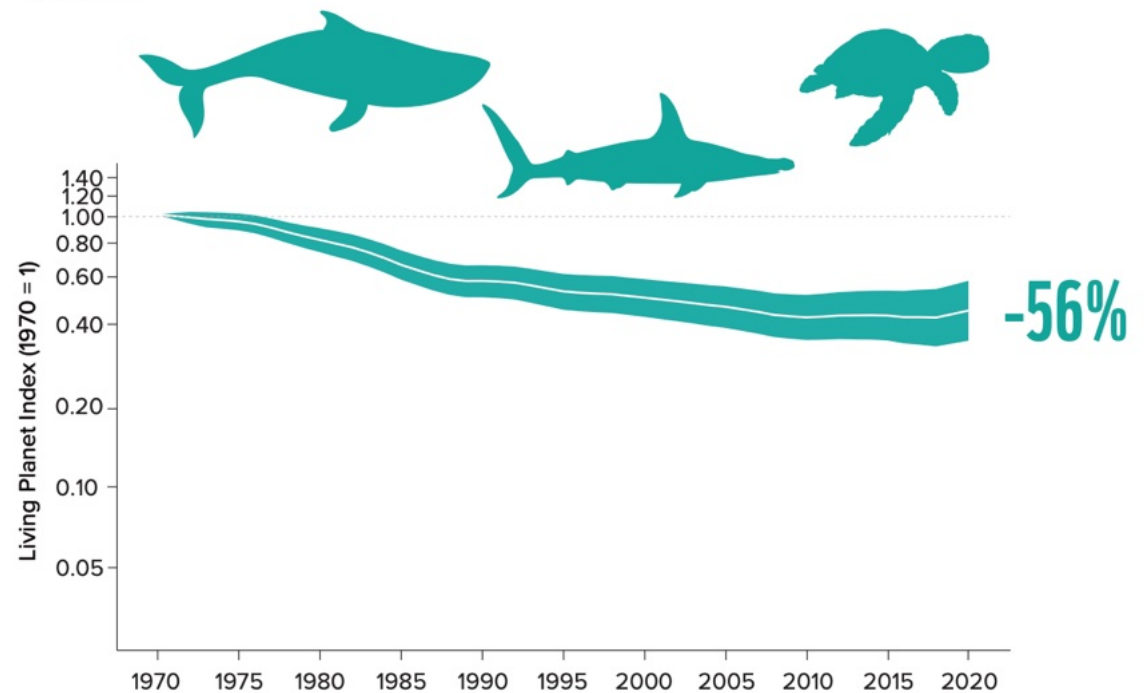
(Thomas Huxley, 1883 inaugural address, International Fisheries Exhibition in London)



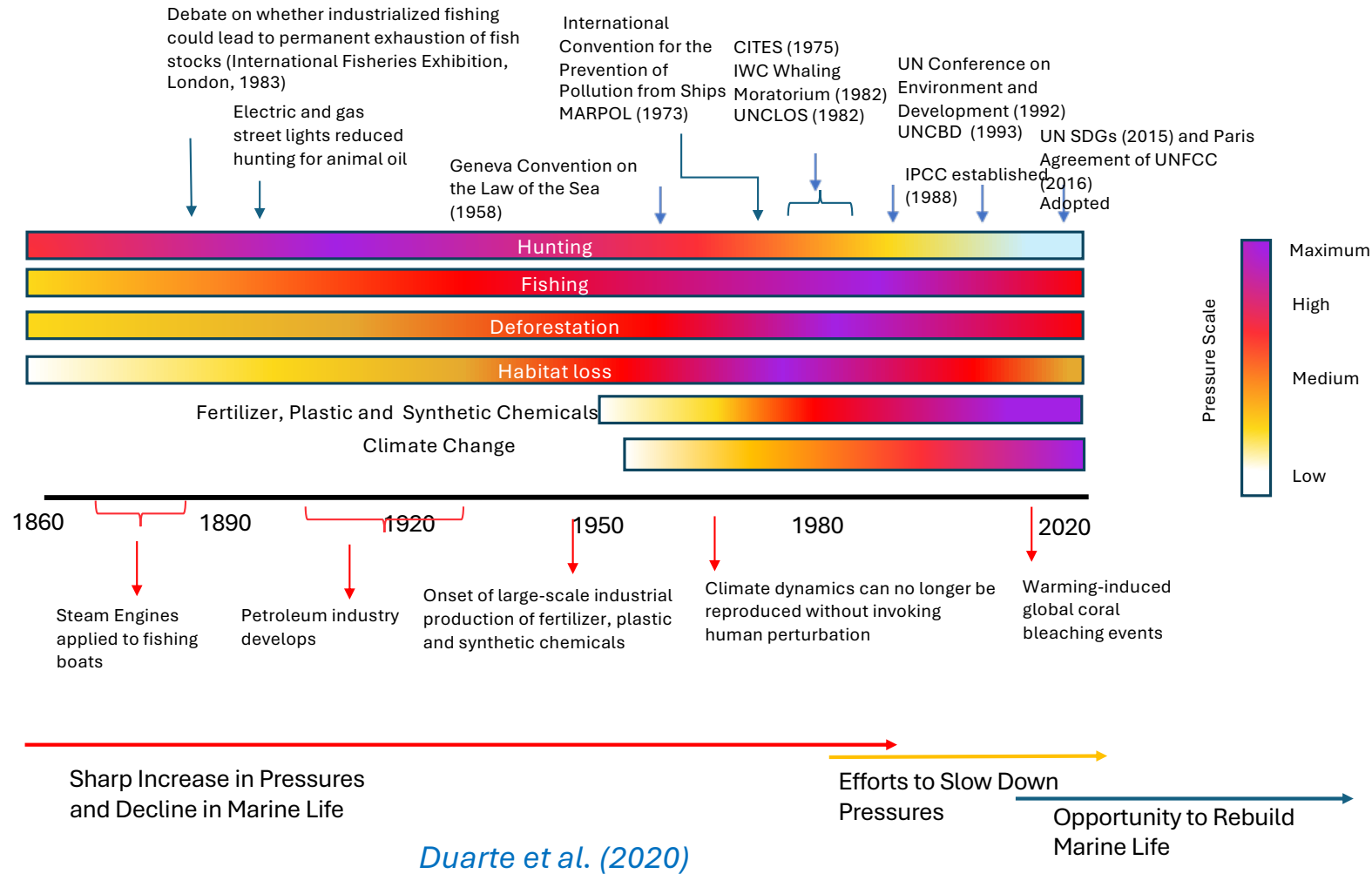


We have lost at least half of the ocean's Blue Natural Capital

Marine



The path of loss (and recovery)



It is possible to substantially rebuild the abundance of life in the ocean within one human generation (30 years)

Six levers to Recovery and one prerequisite

- Protect Species
- Harvest Wisely
- Protect Spaces
- Restore Actively
- Mitigate Climate Change
- Mitigate Pollution

nature

[Explore our content](#) ▾ [Journal information](#) ▾

[nature](#) > [review articles](#) > [article](#)

[Review](#) | [Published: 01 April 2020](#)

Rebuilding marine life

[Carlos M. Duarte](#) , [Susana Agusti](#), [Edward Barbier](#), [Gregory L. Britten](#), [Juan Carlos Castilla](#), [Jean-Pierre Gattuso](#), [Robinson W. Fulweiler](#), [Terry P. Hughes](#), [Nancy Knowlton](#), [Catherine E. Lovelock](#), [Heike K. Lotze](#), [Milica Predragovic](#), [Elvira Poloczanska](#), [Callum Roberts](#) & [Boris Worm](#)

[Nature](#) **580**, 39–51(2020) | [Cite this article](#)

Don't Give up!

Charting the Course to a Healthy Ocean

by **2050**

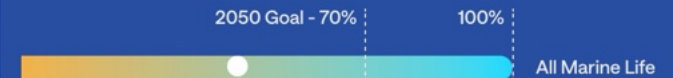
Ocean Central provides a comprehensive view of ocean health and the actions shaping its recovery.



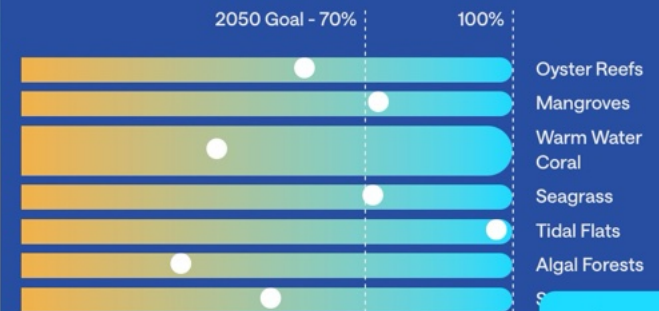
Measuring Progress

By comparing the ocean's living systems to their historical baseline, we reveal the recovery gap and the extraordinary opportunity to restore what once thrived.

Marine Life Abundance



Ecosystem Coverage



Ask AI



Paris Agreement (UNFCCC)

By 2050:

- Contain global warming within 1.5 to 2.0 C of preindustrial values
- Meet a balance between emissions and sinks


Blue Natural Capital




Kunming-Montreal Biodiversity Framework (CBD) – December 2022

By 2030:

- Stop Biodiversity losses
- Protect 30% of land and oceans
- Restore 30% of degraded habitat

Marine Forests: The most intense C sinks in the biosphere:

Long-term C burial in vegetated soils >10 fold higher in marine forests than terrestrial ones

1.02 t C ha⁻¹ year⁻¹ (Grace et al. 1993)



Up to 17 t C ha⁻¹ year⁻¹ (Duarte et al. 2005)



*Seagrass (Posidonia oceanica) meadow,
Spanish Mediterranean (photo Manu Sanfelix)*

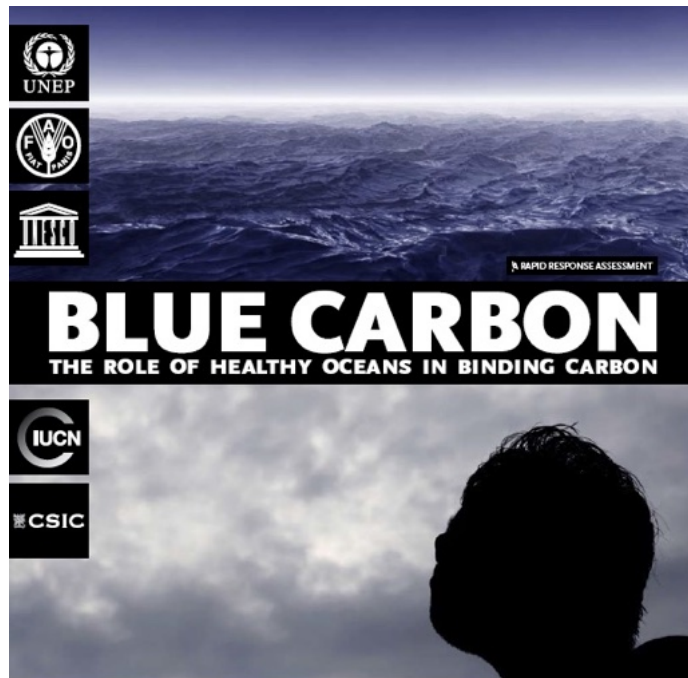
Duarte et al. (2005)



About half of marine coastal forests have been lost



Blue Carbon



Nellemann, C., Corcoran, E., **Duarte, C. M.**, Valdes, L., DeYoung, C., Fonseca, L., Grimsditch, G. (Eds). 2009. Blue Carbon. A Rapid Response Assessment. United Nations Environment Programme, GRID-Arendal. 80 p.

EDITORIAL

Blue carbon can't wait

When the United Nations released its World Ocean Assessment in 2015, it was clear that the oceans were seriously degraded, with stressors on these environments projected to increase. The 2021 Assessment, released in April, shows that they have further declined, bringing us ever closer to losing the structure, function, and benefits of Earth's marine systems. One way forward might be to focus on "blue carbon" ecosystems and the incentives they offer through carbon credits linked to decreasing carbon emissions.

Blue carbon ecosystems include seagrass meadows, tidal marshes, and mangroves, all of which are among Earth's most efficient absorbers and long-term storers of carbon. This capacity for carbon storage also makes them sources of CO₂ emissions when they are degraded or destroyed.

As the United Nations Environment Programme states in its April 2021 report *Making Peace with Nature*, "Ecosystem restoration can simultaneously mitigate climate change, slow and reverse biodiversity decline and increase the benefits that people get from nature." Restoring blue carbon ecosystems could remove about 0.5% of current global emissions, with co-benefits for local ecosystems and liveli-

ment, and climate change. For the 79% of blue carbon ecosystems outside of UNESCO protection—harboring the remaining 86% of the ocean's stored carbon—marine protected areas (MPAs) can benefit climate mitigation by keeping billions of additional CO₂ emissions from entering the atmosphere. At the same time, MPAs also have been shown to protect biodiversity and boost fishery yields.

Where will the funding come from to support conservation? In part, through the use of blue carbon credits. Blue carbon ecosystems can help nations avoid releasing additional CO₂, and other greenhouse gases. The growing blue carbon credit market allows organizations and countries that conserve and restore blue carbon ecosystems to claim or sell credits in global carbon credit mar-

kets. For example, a country that protects seagrass meadows, and hence reduces the risk of future carbon emissions, may receive carbon credits that fund their future protection. Carbon credits can also be claimed for areas damaged by natural events. Wherever blue carbon habitats have suffered losses, blue carbon credits may help support their restoration.

So far, few countries have incorporated blue carbon strategies into their climate change mitigation



Fanny Douvère is head of the Marine Programme at UNESCO's World Heritage Centre, Paris, France. f.douvere@unesco.org

"Blue carbon ecosystems can help nations avoid releasing ... greenhouse gases."

A strategy to mitigate and adapt to climate change through the conservation and restoration of marine forests

The Mekong Delta Mangrove Forest (Vietnam): The largest ecosystem restoration yet in human history



57 % of all Mekong Delta Mangrove Forest destroyed between (1964 – 1970)

2700 Km² planted between 1978–1998

Carbon storage in restored mangrove:
 $889 \pm 111 \text{ MgC ha}^{-1}$

Carbon storage in natural mangrove:
 $844 \pm 58 \text{ MgC ha}^{-1}$

Nam et al. (2016)

The afforestation of the Mekong Delta, the largest mangrove forest in the world, 15 years after its destruction by the US Air Force is the largest-scale ecosystem restoration ever undertaken.

Duarte et al. (2008)

The great Indian Ocean Tsunami of 26 Dec. 2004: The life-saving value of mangroves



250,000 deaths and huge economic impacts.

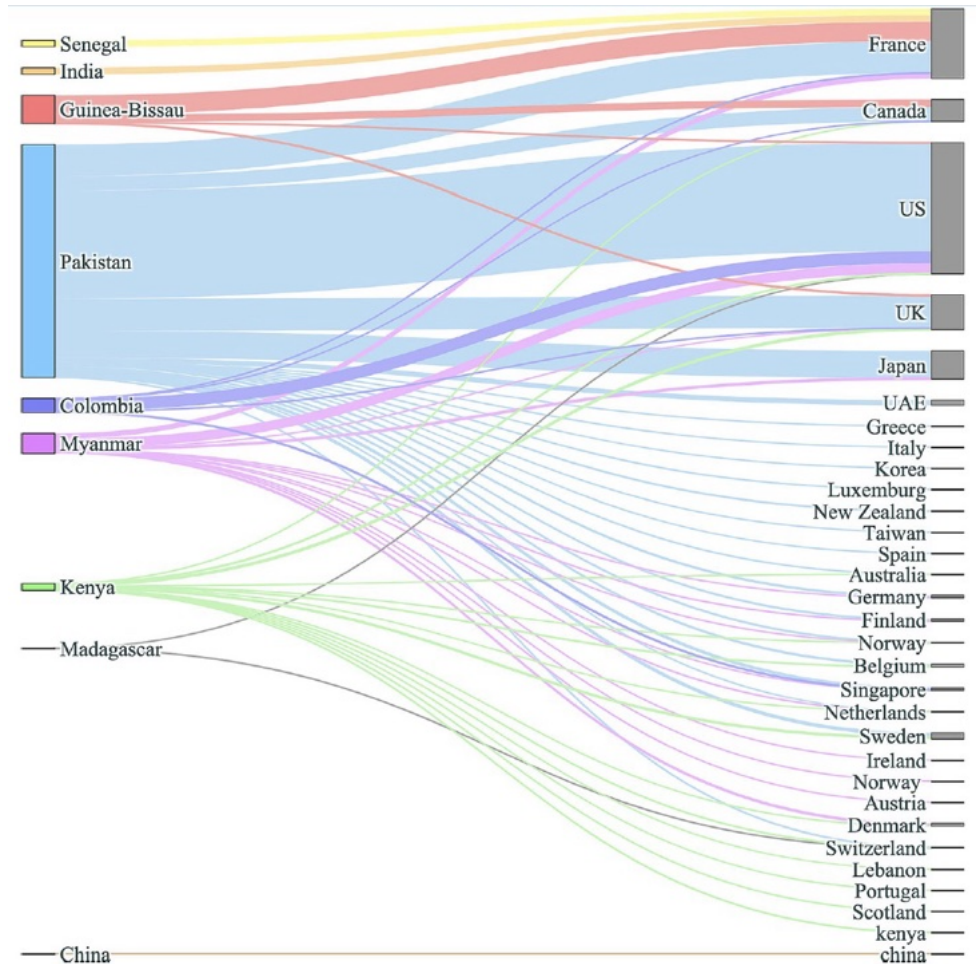
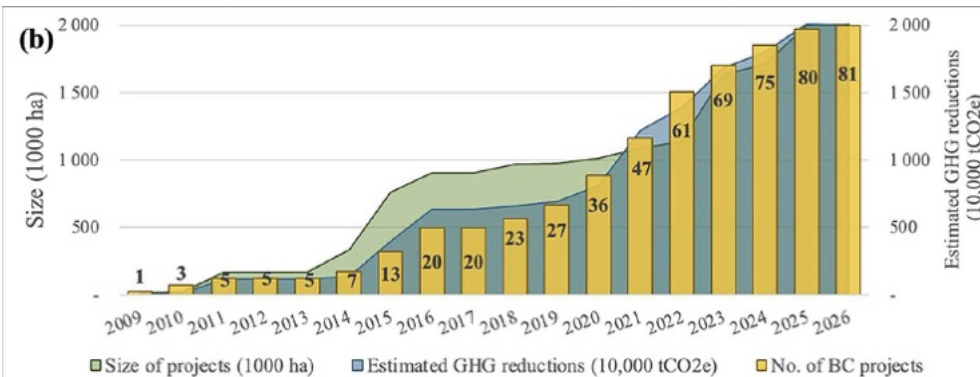
Where mangroves persisted, no human lives were lost

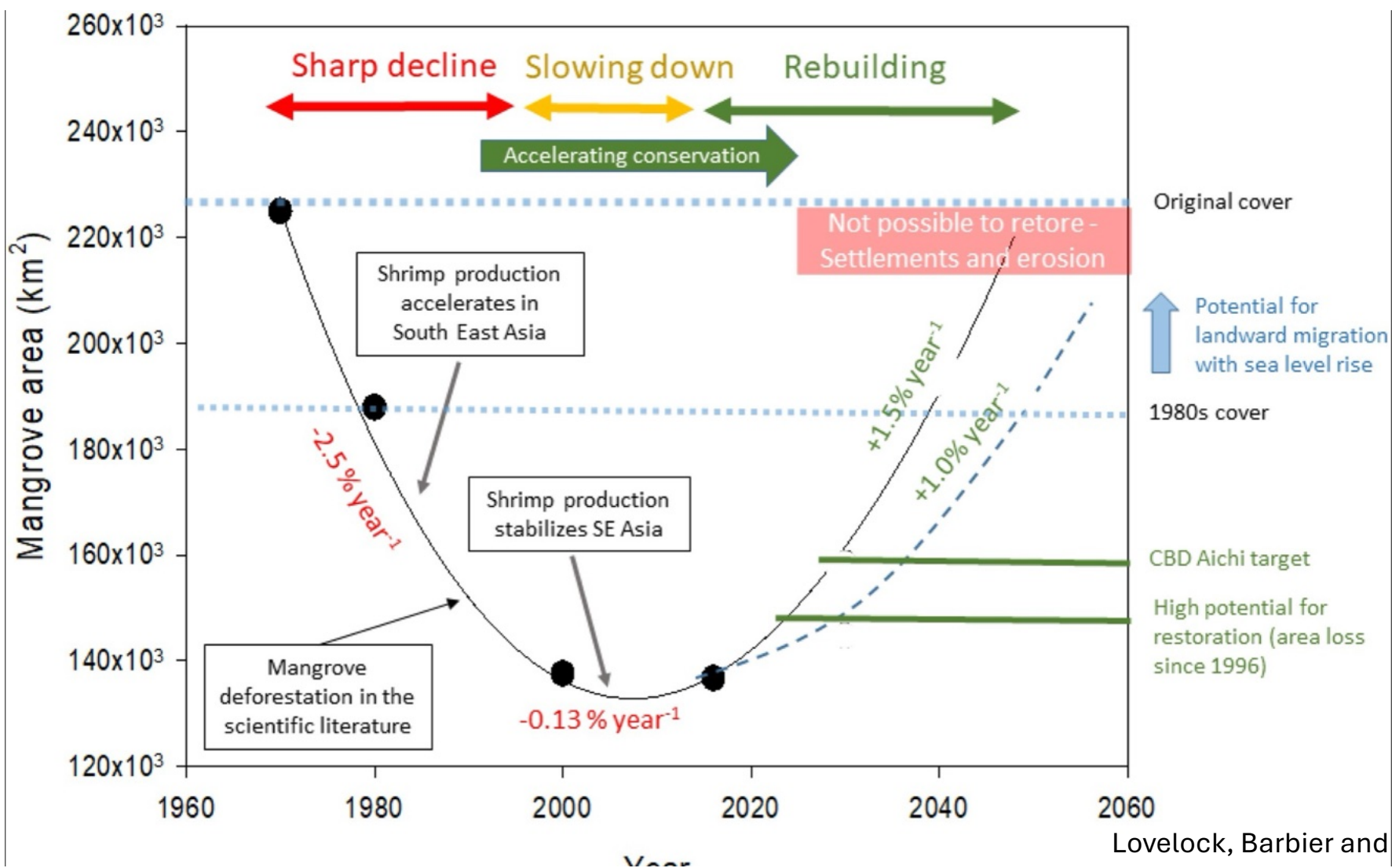
Western Indian Ocean Governments initiated large-scale mangrove afforestation programs


<https://doi.org/10.1038/s44183-025-00141-6>

The rise and flows of blue carbon credits advance global climate and biodiversity goals

Check for updates

 Shekoofeh Farahmand^{1,2,4}, Nathalie Hilmi^{1,4} & Carlos M. Duarte^{3,4}




Review

A tide of change: What we can learn from stories of marine conservation success

Susann Roszbach,^{1,2,5,*} Alexandra Steckbauer,^{1,5} Shannon G. Klein,¹ Silvia Arossa,¹ Nathan R. Gerald,^{1,3}
Kah Kheng Lim,¹ Cecilia Martin,^{1,2} Felix I. Roszbach,⁴ Marc J. Shellard,¹ Letizia Valluzzi,¹ and Carlos M. Duarte¹

A

Stakeholders contributing to conservation success

