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# Recommendations for the Conservation of Estuaries and Restoration of Mangroves in Central and South America

## Authors

Edgardo Díaz-Ferguson, Luisa F. Echeverria-King, Branislav Pantović, Johanna Segovia, Yani Aranguren, Ernesto Brugnoli, Pablo Muniz, Andrea Weiler, Eric Flores de Gracia, Álvaro Morales Ramírez, Eloisa Lasso, Joel Sánchez-Gallego, Karly Urriola-Garcia, Rodrigo Sant Ana, Sofía Zapata, Andrea Cancela da Cruz, Anabella Vásquez Fábrega, Claudia Alarcón-López, Marcella Ohira



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## RECOMMENDATIONS FOR THE CONSERVATION OF ESTUARIES AND RESTORATION OF MANGROVES IN CENTRAL AND SOUTH AMERICA

Edgardo Díaz-Ferguson<sup>1</sup>\*, Luisa F. Echeverria-King<sup>2</sup>, Branislav Pantović<sup>3</sup>, Johanna Segovia<sup>4</sup>, Yani Aranguren<sup>2</sup>, Ernesto Brugnoli<sup>5</sup>, Pablo Muniz<sup>5</sup>, Andrea Weiler<sup>6</sup>, Eric Flores de Gracia<sup>1</sup>, Álvaro Morales Ramírez<sup>7</sup>, Eloisa Lasso<sup>1</sup>, Joel Sánchez-Gallego<sup>1</sup>, Karly Urriola-Garcia<sup>8</sup>, Rodrigo Sant Ana<sup>9</sup>, Sofía Zapata<sup>10</sup>, Andrea Cancela da Cruz<sup>10</sup>, Anabella Vásquez Fábrega<sup>11</sup>, Claudia Alarcón-López<sup>3</sup>, Marcella Ohira<sup>3</sup>

#### **EXECUTIVE SUMMARY**

This white paper highlights the critical importance of estuaries and mangroves in Central and South America, emphasizing their role in biodiversity, climate regulation, and coastal protection. These ecosystems, fundamental for carbon capture and climate change mitigation, face threats such as climate change, pollution, and urbanization. Based on a scientific diplomacy workshop held in Panama in 2024, recommendations are offered for public policies focused on the conservation and restoration of these habitats. It proposes implementing conservation programs, biodiversity monitoring, water management, pollution reduction, and protection of vulnerable species. In addition, it highlights the need for sustainable activities, investment in research, public education, and inclusive governance, as well as transboundary cooperation and the active participation of local communities. Case studies of the Coiba Archipelago in Panama and the Gulf of Nicoya in Costa Rica are included, exemplifying successful sustainable management strategies. This comprehensive framework aims to guide decision-makers in implementing sustainable strategies to address environmental challenges and ensure the health and resilience of estuaries and mangroves in Central and South America.



<sup>1</sup> Estación Científica COIBA, Panamá.

- <sup>2</sup> Universidad Simón Bolívar, Colombia.
- <sup>3</sup> Inter-American Institute for Global Change Research
- <sup>4</sup> Universidad Francisco Gavidia, El Salvador.
- <sup>5</sup> Universidad de la República, Uruguay.

<sup>6</sup> Universidad Nacional de Asunción. Paraguay.

<sup>7</sup> Universidad de Costa Rica, Costa Rica.

- <sup>8</sup> Universidad Marítima Internacional de Panamá, Panamá.
- Universidad de Vale do Itajaí, Brasil.
- <sup>10</sup> Ministerio de Ciencia, Tecnología, Conocimiento e Innovación de Chile, Chile.
- <sup>11</sup> Secretaría Nacional de Ciencia. Tecnología e Innovación (Senacyt). Panamá.
- \* Corresponding author: ediaz@coiba.org.pa

# Introduction

Estuarine ecosystems, including mangroves and gallery forests, are essential for maintaining biodiversity and acting as natural climate regulators.

Mangroves and estuaries capture carbon, recycle nutrients, and protect coastlines from storm surges, reducing flood risk and ensuring food security for coastal communities by filtering pollutants. However, these vital areas are threatened by the effects of climate change, land use change, pollution, non-native species, habitat degradation, lack of urban planning, and industrial pressures. The loss of these habitats not only reduces biodiversity and its values, but also weakens our ability to combat and mitigate climate change (Malhi et al., 2020; Neugarten et al., 2024). This is why marine-coastal ecosystems (including estuaries and in particular their mangroves) are primarily responsible for all the biological carbon captured from the blue oceans, hence their name blue carbon (Nellemann y Corcoran, 2009). By keeping mangroves healthy and rehabilitating degraded areas, we can maximise the carbon sequestration potential essential for national climate strategies. Therefore, the conservation, restoration, monitoring and safeguarding of these blue carbon ecosystems must be a priority. Adopting these measures offers a natural and scalable climate solution that can significantly impact national and regional environmental health (Bernardino, 2016).

These ecosystems are indicators of coastal oceanographic changes caused by Climate Change, which is defined as "change attributed directly or indirectly to human activity that alters the composition of the global atmosphere." These processes have also been intensified due to a greater frequency and magnitude of El Niño-La Niña (Muniz et al. 2019; Cai et al, 2015). Two-thirds of the human population lives in coastal areas. Therefore, people living in estuaries could benefit from ecosystem services such as education, scientific tourism, recreational activities, culture and the history of this area (Booi et al., 2022; Echeverría-King, 2024). In addition to these benefits, human populations near estuarine areas are vulnerable to natural disasters and anthropogenic factors inherent to urbanization, such as pollution, sedimentation, nutrient runoff, microplastics, pesticides, heavy metals and hydrocarbons (Woodroffe, 2021).

Mangroves offer a wide range of environmental, cultural, identity and indigenous knowledge goods and services that do not have an explicit (intangible) market value (Barbier et al., 2011; Booi, Mishi and Andersen, 2022), making it necessary to use economic valuation techniques to understand their contribution to the economy.

Although several studies have been conducted to estimate the economic value of mangroves, especially in terms of protection to commercial fisheries, little attention has been paid to the importance of social organization in this economic valuation (Sanjurjo et al., 2005).



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## **OBJECTIVE**

The objective of this whitepaper is to provide policy recommendations aimed at the conservation and restoration of estuaries and mangroves in Central and South America. Based on discussions and collaborations during a science diplomacy workshop in Panama, this document seeks to offer a comprehensive framework to guide policymakers and researchers in implementing sustainable strategies for the management and protection of these vital ecosystems, addressing critical dimensions such as marine ecology, ecosystem interactions, ecosystem services, community and governance, and marine spatial planning.



Figure: Global distribution of mangroves (blue shading), showing diversity as number of specific taxa (nominal species and hybrids). Source UNEP, 2014.

The ecological, economic and social importance related to estuaries and mangroves comes from theories, concepts and scientific knowledge based on temperate estuaries in Europe and North America. In Central and South America, the available information on estuaries belongs to the South American temperate estuaries, for example: the estuary of the Río de la Plata (Muniz et al. 2019) to the North of Brazil (Barletta et al., 2023). For the estuaries of Central America and the Caribbean, the studies are limited (León, 1972; Brugnoli et al., 2004; Díaz-Ferguson et al, 2023).

Emphasizing the problem, the legislation and governance of estuarine areas is diverse and complex, focusing so far on estuaries located in marine protected areas. For an adequate monitoring and management strategy, it is a priority to understand what a healthy ecosystem is, which is why the development of a health index has been a recurring theme in the scientific literature (Lal, 2021).

# **Participatory Methodology**

The recommendations presented are based on discussions and collaborative efforts during the Workshop "Building Bridges between Science and Sustainable Public Policies: Scientific Diplomacy for Estuaries and Mangroves in Central and South America" held in Panama in June 2024. Evidence from the meeting is presented below.





*Various critical dimensions of estuarine and mangrove ecosystems are addressed. The dimensions of the recommendations collected are the following:* 



### Ecology of estuaries and mangroves in the Americas

- Analysis of marine life, the physicochemical and hydrological structure of habitats and the importance of biodiversity in estuaries and mangroves.
- Focus on the conservation and restoration of estuaries and mangroves and their biodiversity; from genes to ecosystems.
- Assessment of the structure and function of estuaries and mangroves.
- Understanding interactions within estuaries and mangroves and their implications for ecosystem health and stability.



### Ecosystem services of estuaries and mangroves in the Americas

- Identification and assessment of the various services provided by estuaries and mangroves, including carbon sequestration, water quality, sustainable tourism, food security and storm protection, among others.
- Assessment of strategies to improve and sustain these services for the benefit of local communities and indigenous peoples.



# Marine spatial governance and planning at different scales of estuaries and mangroves in the Americas

- Sustainable management practices and inclusive local, national and regional decision-making processes.
- Spatial planning approaches that integrate ecological, social and economic considerations support the sustainable use and conservation of estuarine and mangrove areas.



### Community action on estuaries and mangroves in the Americas

- Analysis of the roles and participation of local communities and indigenous peoples, as well as transboundary/regional relationships for the management of estuaries and mangroves.
- Strengthening capacities and ancestral knowledge in the management of these ecosystems.
- Linking communities in sustainable economic activities, such as: ecotourism, scientific tourism, sustainable fishing, etc.
- Recognition and preservation of cultural and spiritual values associated with mangroves and estuaries.

## The role of strategic alliances and scientific diplomacy

Multinational collaboration in science and public policy is essential to address these challenges and ensure the long-term conservation of estuaries and mangroves. For its part, scientific diplomacy in emerging economies is characterized by the conscious joint work of various actors, levels and combinations of policy instruments and strategies at the interstice of foreign affairs and science, technology and innovation. This approach can help solve complex problems arising from the current crisis, such as climate change, which affects Central and South America and various parts of the world (Echeverría-King, 2021).

Given this, it is necessary to implement strategies that foster the integration of diverse actors and disciplines. Conservation science must transcend the barrier between knowledge and action, contributing to both scientific advancement and decision-making (Cook et al., 2013). Collaboration between scientists, decisionmakers, and stakeholders enables the addressing of complex conservation problems (Diffendorfer et al., 2023). Furthermore, research that involves government collaborators and prioritizes networking and stakeholder engagement increases the likelihood that scientific findings will inform and contribute to management and conservation (LeFlore et al., 2021), as well as restoration.

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Furthermore, citizen participation and community-based environmental monitoring are powerful tools to improve natural resource management and protected area conservation (Conrad and Hilchey, 2010). Citizen science contributes significantly to conservation science, and its promotion can improve natural resource management and environmental protection of mangroves and estuaries (McKinley et al., 2017). Likewise, alliances between scientists and stakeholders, such as collaborations between scientists and private companies, are essential to address environmental issues, inform the public and contribute to public policies (Qu and Irani, 2018).

Likewise, establishing interdisciplinary and transdisciplinary collaborations that involve diverse sectors (public, private and community) in the implementation of monitoring and restoration projects can improve conservation, governance and resource management efforts (Gerona-Daga et al., 2022). Finally, conservation science must be integrated into collaborative social and decision-making processes, where political scenarios and community actions are developed (Toomey, 2016).



## **Case studies of estuaries in Central America**

The case studies of estuaries in Central America highlight the biodiversity and ecological dynamics of these ecosystems, offering a comprehensive view of their conservation status and the environmental challenges they face. They are examples that illustrate sustainable management strategies and conservation policies that promote the resilience of estuaries in the face of climate change and human activity.

### The Gulf of Nicoya (Costa Rica)

The Gulf of Nicoya, in the central Pacific of Costa Rica, is one of the most studied tropical estuaries (Vargas, 2016) with high primary productivity (1200 gr C ha year) (Córdoba-Muñoz 1998), and is the main fishing center of the country. It has a large area of mangroves, however some mangrove systems show significant degrees of degradation, especially to make way for the establishment of shrimp farms and salt flats, or due to the felling of forests for use by coastal communities. Thanks to the national strategy for landscape restoration, academia and NGOs have conducted research and construction restoration experiences mainly in the internal area of the Gulf of Nicoya (e.g. Chira Island, Manzanillo). These have a gender focus, where women's groups are responsible for planting mangroves and accompany these activities with educational campaigns, rural tourism and gastronomy.



The Gulf of Nicoya (Costa Rica)

## **Case studies of estuaries in Central America**

### The Coiba Archipelago (Panama)

The Coiba Archipelago, located in the Gulf of Chiriquí, Republic of Panama, has a surface area of 275,000 hectares, of which 216,543 correspond to its marine area (ANAM, 2009). Coiba Island stands out as the largest in the Central American Pacific, with a surface area of 50,314 hectares, which together with other smaller islands and islets is inserted in the marine corridor of the Eastern Tropical Pacific. Due to its large size, strategic position and incredible state of conservation, Panama designated Coiba as a national park in 1991, and it was declared a World Heritage Site in 2005. Recent approaches to the zooplankton composition and oceanographic conditions in the northeast of the island, descriptions of beaches and surveys of some taxa such as estuarine fish, as well as molecular lists of teleosts, nudibranchs and nematodes stand out (Brugnoli et al., 2023; Díaz Ferguson et al. 2023; Crowford et al. 2024; Botero et al. 2024).

This pristine site is considered a living laboratory of evolution (Enright et al., 2021), where marine and coastal ecosystems such as coral reefs, sandy beaches, rocky coasts, open waters can be found, and in the land-sea transition at the mouth of its rivers, we find gallery forests and mangroves in the estuaries (ANAM 2009). Due to its history as a penal colony and the little human intervention in most of its territory, Coiba presents some of the best-preserved mangroves in Central America with six species of mangroves; including the rare piñuelo mangrove and other associated species such as cork oaks and cativales, threatened on land, but in an excellent state of conservation. Its 1,500 mangroves, especially in Catival, Juncal, San Juan, Boca Grande, Sta. Cruz and Rio Negro, as well as its 18 pristine rivers offer an opportunity for Coiba to become a model site that serves as a reference for what a healthy estuary and mangrove should be like, to establish methodologies for monitoring and evaluating the state of other tropical estuaries in the region and to be able to decide on conservation and restoration strategies.



The Coiba Archipelago (Panama)

# Recommendations

Key recommendations for the development of public policies in estuaries and mangroves based on the evidence are mentioned below. The heterogeneity in progress between different countries in the related measures is highlighted, and the same are applicable to Central and South America:

Establish measures to reduce pollution from land and marine sources that affect the quality of these ecosystems.

Develop policies and protocols for periodic monitoring of water and ecological flows that integrate the dynamics of freshwater and saltwater flows to maintain balance in these ecosystems.

Implement conservation plans for emblematic and vulnerable species that depend on these ecosystems for their survival.

Establish monitoring programs for biodiversity and the factors that affect it, such as climate change, invasive alien species, habitat degradation and fragmentation, overexploitation of resources, among others.

## ECOLOGY OF ESTUARIES AND MANGROVES IN THE AMERICAS



Implement conservation and restoration programs to recover the biodiversity and functionality of these ecosystems, considering progress indicators.

### ECOSYSTEM SERVICES OF ESTUARIES AND MANGROVES IN THE AMERICAS



Assessment of strategies to improve and sustain these services for the benefit of local communities and indigenous peoples.

Implement regulations and measures to promote sustainable productive activities, thus ensuring the provision of drinking water, the filtration of contaminants and the regulation of the hydrological cycle.

Identification and assessment of the various services provided by estuaries and mangroves, including carbon sequestration, water quality, sustainable tourism, food security and storm protection, among others.

# Recommendations

### MARINE SPATIAL PLANNING AND GOVERNANCE



Spatial planning approaches that integrate ecological, social and economic considerations that support sustainable use and conservation.

Develop governance and cooperation frameworks that promote sustainable management practices and inclusive local, national and regional decisionmaking processes through tools such as: marine spatial planning, economic valuation of ecosystem services, economic incentives, ecological connectivity, integrated watershed management, environmental impact assessment, among others.

Ensure transparency in financing processes, decision-making and public access to relevant information on the management and conservation of estuaries and mangroves, promoting accountability.

Promote cooperation and coordination between countries in the management of shared estuaries and mangroves, promoting agreements that safeguard these transboundary ecosystems, considering scientific diplomacy as a tool.

Sustainable management practices and inclusive local, national and regional decisionmaking processes.

Analysis of the roles and participation of local communities and indigenous peoples, as well as transboundary/regional relationships for the management of estuaries and mangroves.

Design and implement education, communication and public awareness strategies on the environmental, social and economic importance of these ecosystems. COMMUNITY ACTION OF ESTUARIES AND MANGROVES



Linking communities in sustainable economic activities, such as: ecotourism, scientific tourism, sustainable fishing, etc.

Recognition and preservation of cultural and spiritual values associated with mangroves and estuaries.

Strengthening capacities and ancestral knowledge in the management of these ecosystems.

Ensure investment, funding and management in targeted research and capacity building for estuaries and mangroves to better understand the dynamics of these ecosystems and guide decision-making based on scientific evidence.

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Inter-American Institute for Global Change Research - www.iai.int marcella.ohira@dir.iai.int

COIBA Scientific Station, Panama - www.coiba.org.pa

🔀 ediaz@coiba.org.pa









