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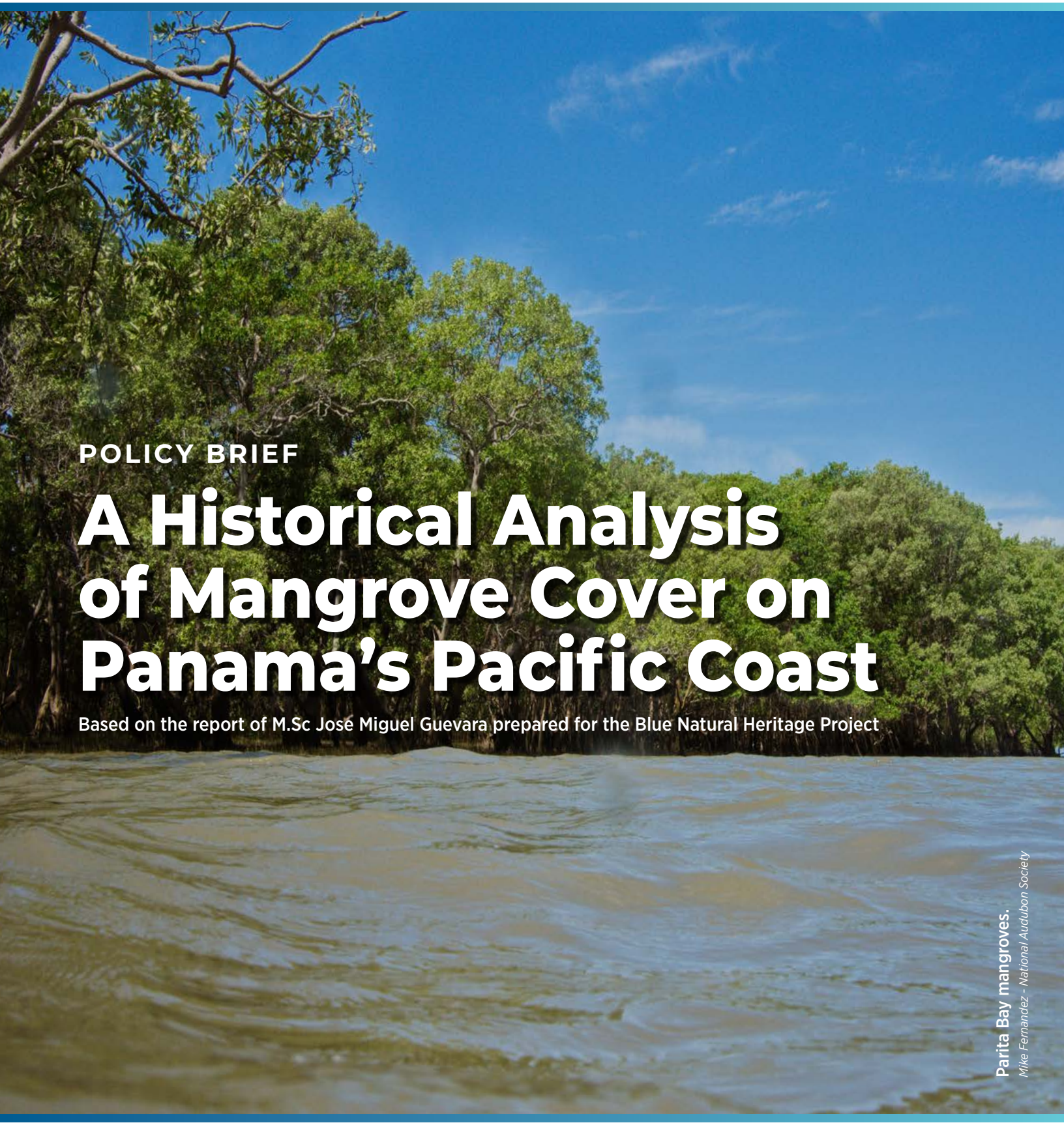

POLICY BRIEF

A Historical Analysis of Mangrove Cover on Panama's Pacific Coast

Based on the report of M.Sc José Miguel Guevara prepared for the Blue Natural Heritage Project

Parita Bay mangroves.
Mike Fernandez - National Audubon Society

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Introduction

In the face of an uncertain future marked by climate change, urban development, and other threats to biodiversity, efforts to ensure Panama's coastal resilience depend on understanding trends in mangrove cover. To date, there have been few studies on mangrove cover change in specific sites in Panama using advanced resources and methodologies.

To fill this gap, the Blue Natural Heritage project carried out an analysis of mangrove cover using satellite imagery collected between 1982 and 2022, at two key sites on Panama's Pacific coast. This view of the evolution of ecosystems over four decades provides a basis for understanding trends, identifying areas of change and possible drivers, and assessing the resilience of mangroves to factors including climate change and human activities.

The data collected from these analyses can be used to effectively monitor and manage natural resources and make decisions about urban planning and environmental management that can help to protect the essential environmental services offered by these crucial ecosystems. This policy brief summarizes the findings of the study.

Areas of Focus

In Panama, researchers have identified 53 Important Bird Areas (IBAs), which provide essential habitat for birds during breeding, wintering, or migration. Among these, two IBAs stand out as exceptional environments for migratory bird species: Panama Bay Wetland Wildlife Refuge and Parita Bay IBA. The mangrove forests, mudflats, and other associated ecosystems in these study areas are essential not only for wildlife, but also for the wide range of resources and benefits they provide to local communities.

Summary of Results

Mangrove cover decreased in Panama Bay during most of the periods studied, with a slight recovery between 2000 and 2009. Although the loss of cover was not uniform, the overall study area experienced a 0.28 percent loss over 40 years, with a loss rate of 0.01 percent per year. Among the most notable causes of mangrove coverage loss are agriculture and aquaculture expansion, and urban development.

In the Parita Bay study area, mangrove cover steadily increased, with a total gain of 1,013.96 hectares over 40 years, at a rate of 0.21 percent per year. Two areas stood out for coverage increases: the Palo Blanco estuary in the northeastern area of Parita Bay and the shrimp ponds south of the city of Aguadulce.

Mangrove coverage gains may be attributed to increased sedimentation of rivers that flow into the wetlands, decreased pressure from logging, the establishment of protected areas, and other local conservation measures. Also, the latter years of the study period coincide with an increase in environmental awareness and the development of environmental education initiatives.

Nevertheless, these areas continue to be vulnerable. Continued efforts — involving the scientific, regulatory, and local stakeholder communities — will be essential to protect these sensitive coastal areas and the prosperity of the people who depend on them.

View of Panama City from Bay of Panama Wetlands Wildlife Refuge.

Threats to Pacific Coast Mangroves

In addition to the development-driven deforestation and pollution noted above, Pacific coast mangroves suffer from contamination by agrochemicals and pesticides and a lack of enforcement of environmental-protection regulations.

Some threats have diminished thanks to a variety of wetland conservation programs, formal protection measures, and education/public-awareness efforts. Nevertheless, significant challenges remain and new risks are emerging. The effects of climate change — such as sea level rise, more powerful storms, and variations in precipitation and temperature — will continue to affect all marine-coastal ecosystems. Therefore, efficient coastal management is essential to anticipate risks and threats, as well as to plan for different climate change scenarios.

Methodology

Researchers conducted a multi-temporal analysis of mangrove cover in the Bay of Panama and Parita Bay IBAs, from 1982 to 2022, using satellite imagery. The goals of the study were to:

- understand trends over time
- identify areas of gain and loss
- assess mangroves' resilience to environmental changes and human activities

Multi-temporal analysis is an efficient way to study changes on the Earth's surface by evaluating data sets from different time periods to determine temporal changes to specific features. Researchers employed supervised classification — a digital classification method that involves assigning pixels in satellite images to defined categories — to quantify transformations in mangrove cover. The method provided valuable information for the planning and management of these key coastal ecosystems. It also provided a useful baseline for future in-depth studies that can lead to increasingly effective and more focused conservation measures.

Mike Fernández - National Audubon Society

Study Area 1: Panama Bay Wetlands Wildlife Refuge

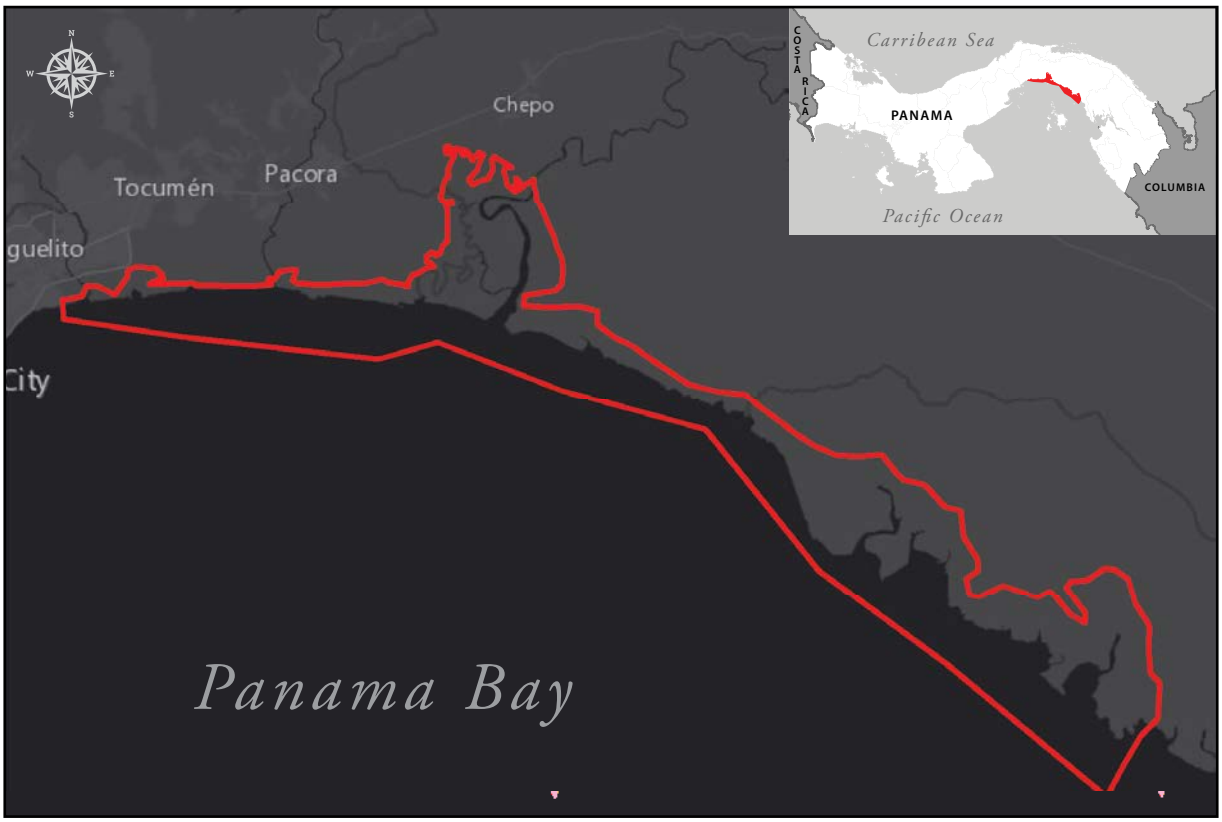
The 85,652-hectare Panama Bay Wetlands Wildlife Refuge, recognized in 2002 as a Ramsar Site (a wetland of international importance) contains some of the most mature and robust mangrove forests in the Americas. These have been identified by the World Wildlife Fund as the most important intact mangroves in the world. The fish that inhabit and breed in this environment play fundamental ecological roles and sustain local artisanal fisheries.

As one of the most important bird migration sites in the Western Hemisphere, the bay hosts an estimated one to two million shorebirds. The site serves as habitat for 14 percent of the world's population of the Western Sandpiper (*Calidris mauri*) and 20 percent of the population of the Semipalmated Plover (*Charadrius semipalmatus*). The area's diverse ecosystems also provide shelter and habitat for the endemic *Annona spraguei* tree and endangered mammals including the Geoffroy's spider monkey (*Ateles geoffroyi*) and Baird's tapir (*Tapirella bairdii*).

Results

The analysis revealed significant patterns of gain and loss of mangrove cover in the Panama Bay Wetlands Wildlife Refuge. Over the entire 40-year period, the refuge has experienced a loss of 0.28 percent of its mangrove cover, equivalent to 64.71 hectares. Declines were observed during the periods 1990-2000, 2010-2019, and 2020-2022, with a single recovery recorded during the period 2000-2009.

Mangrove loss was not uniform throughout the study site, and in some areas an increase in mangrove cover was detected. Surprisingly, mangrove cover in areas near Panama City increased. This is attributed to sedimentation processes on the coastline at the mouth of the Juan Díaz River, probably influenced by environmental changes in the upper watershed. The accumulation of sediment on the coastline may have created the appropriate habitat for the natural regeneration of mangroves. Similarly, in the sector of La Maestra, district of Chimán, natural regeneration was observed, also due to sedimentation processes.



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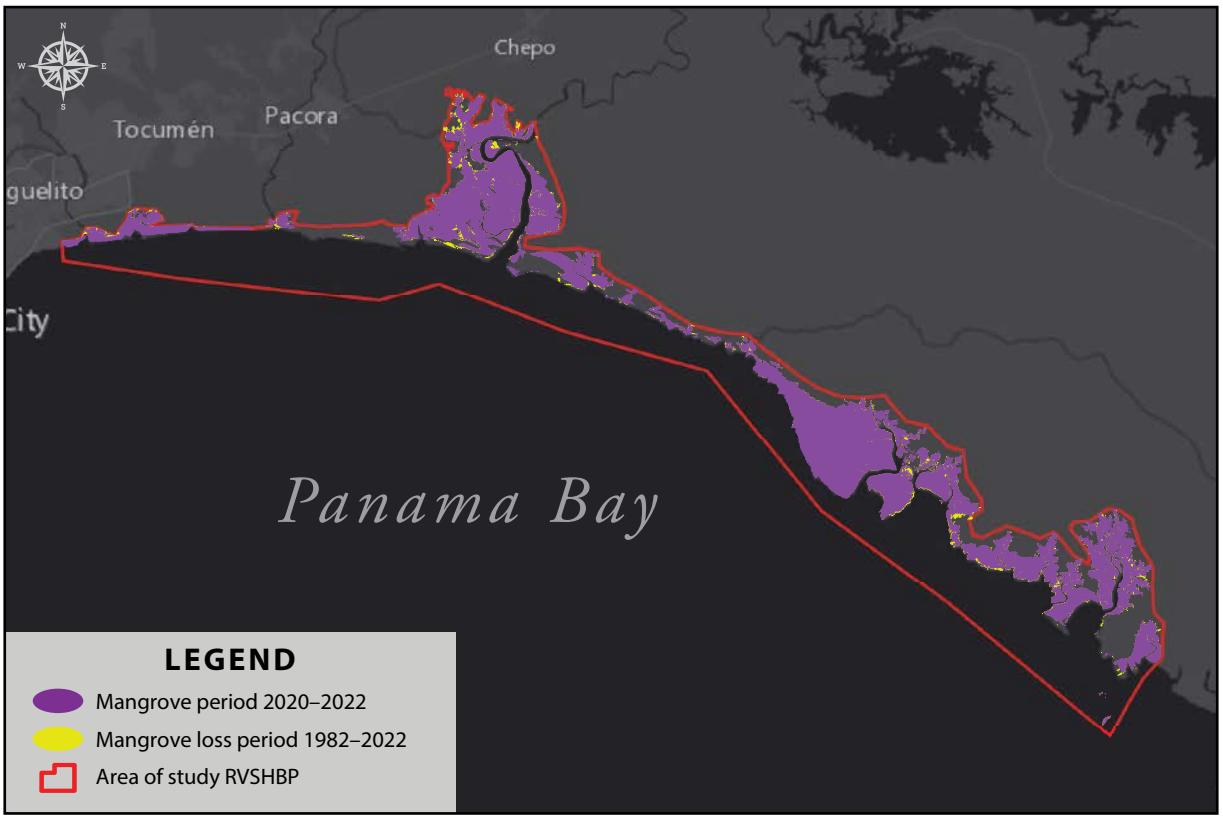
Location of study area: Panama Bay Wetlands Wildlife Refuge.

Mangrove cover decreased due to urban development in the west of the study area. Deforestation also occurred in the central sector, due to expansion of fields for rice cultivation. Significant losses of cover were recorded on Cocotillo Island, which experienced a decline of 89.55 hectares between 1990 and 2022. Loss of this area could be attributable to coastal erosion caused by wave impact on the island, tides and sea currents, or possibly sea-level rise.

A map from a parallel analysis of the mangrove condition of the site´s mangroves from the project's ecosystem services valuation is added below. This information on current status and risk complements the historical analysis by allowing for a more contextualized and geographically-focused development of management responses.

Change in mangrove cover and rate of change in Panama Bay from 1982 to 2022, rounded to the nearest hectare.

Period	Years	Area (ha)	Change (ha)	Change (%)	Change rate (% per year)
I	1982-1989	23,370	-	-	-
II	1990-1999	23,318	-53	-0.22	-0.02
III	2000-2009	23,332	14	0.06	0.01
IV	2010-2019	23,327	-5	-0.02	0.00
V	2020-2022	23,305	-22	-0.09	-0.03
Complete	**1982-2022**	**-**	**-65**	**-0.28**	**-0.01**



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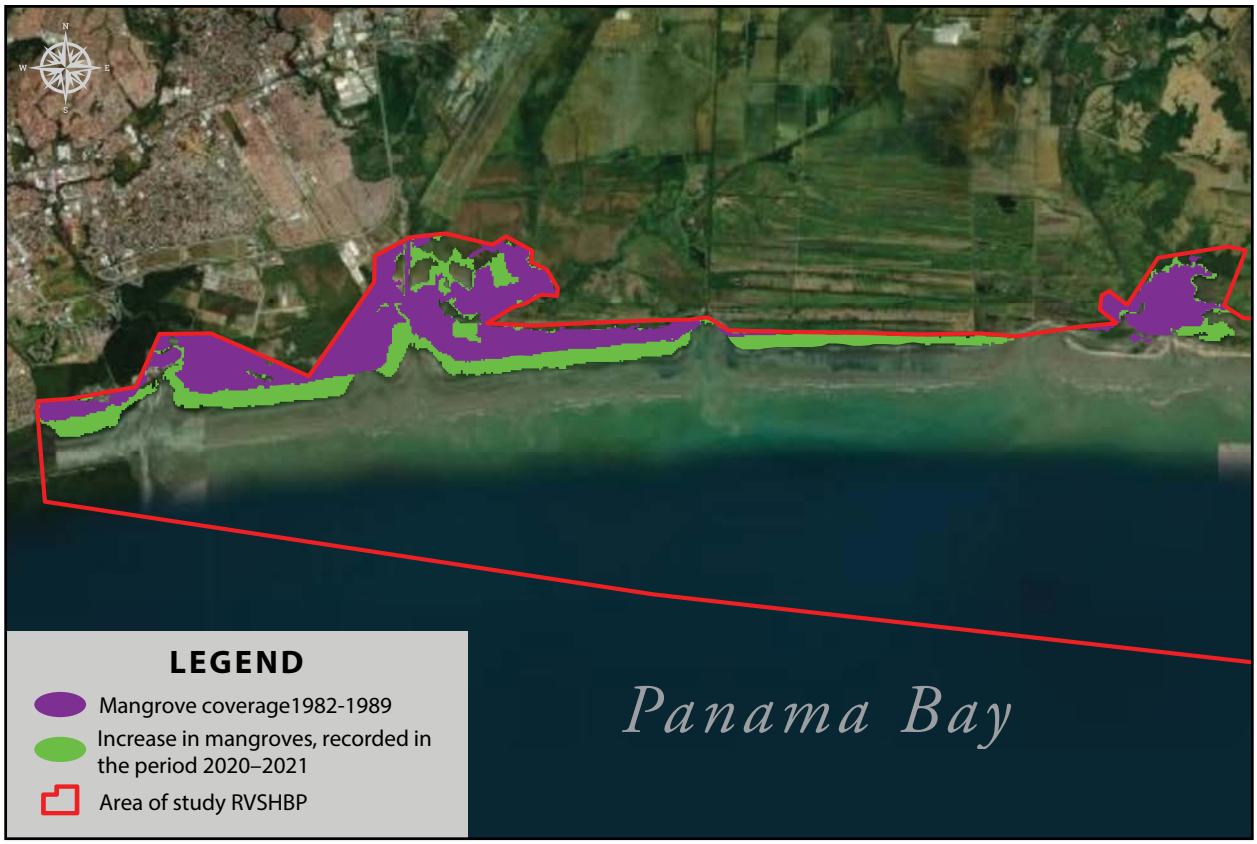
Mangrove forest loss in the Bay of Panama Wildlife Refuge during the study period (1982–2022).



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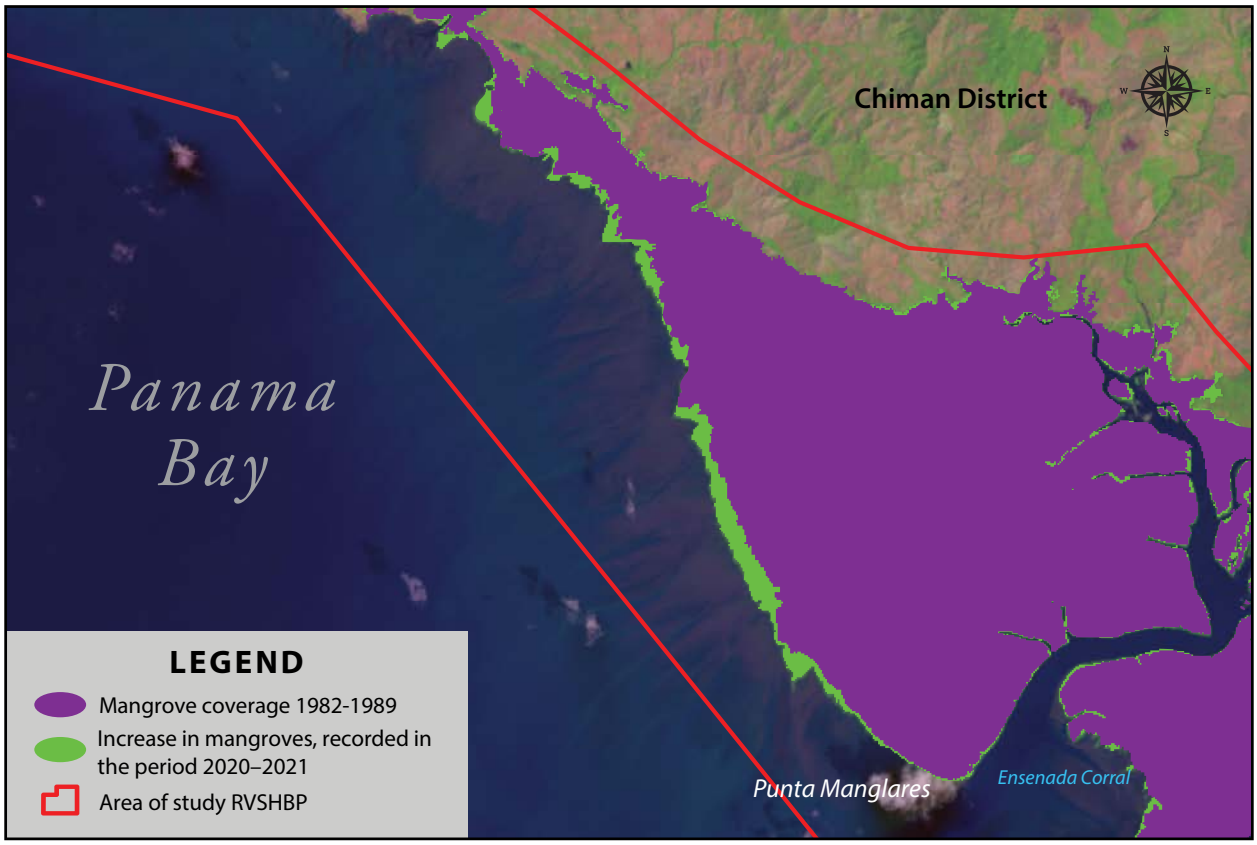

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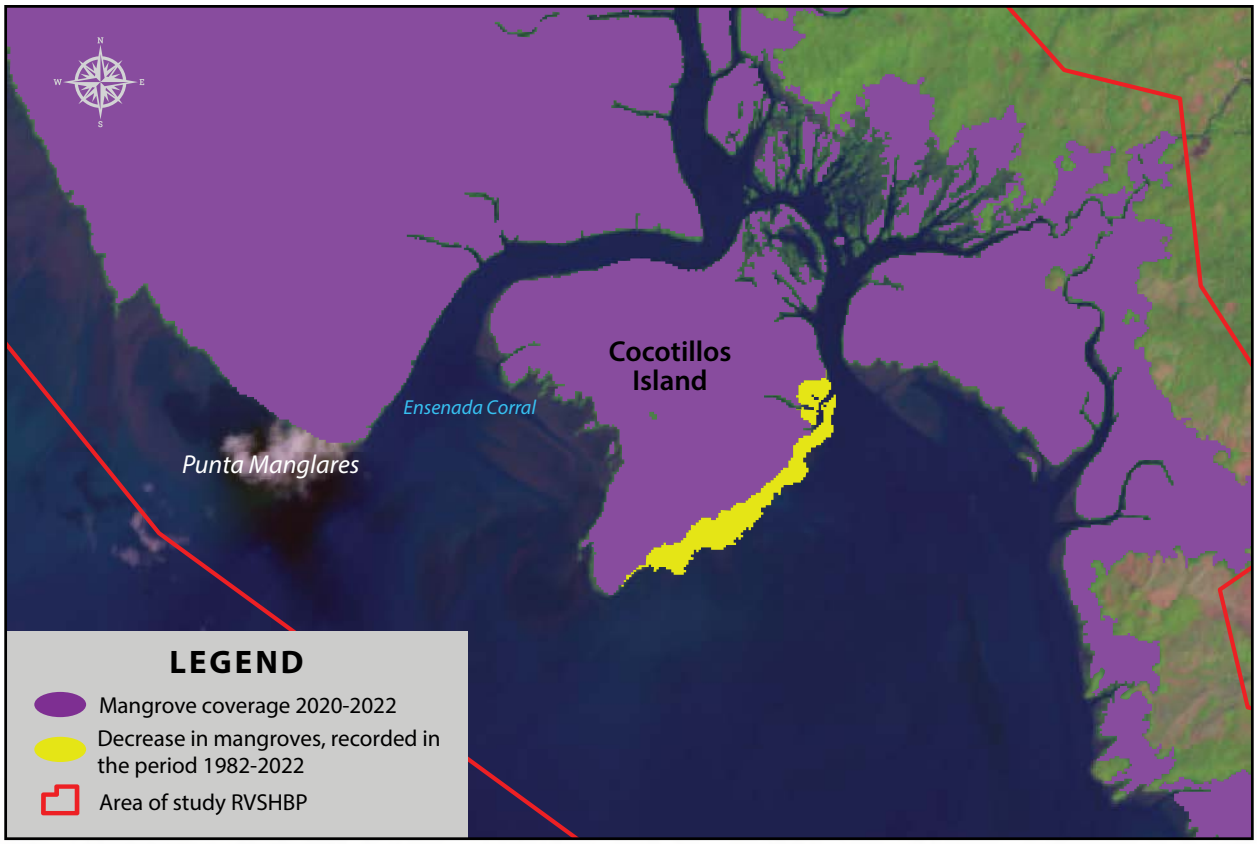
Increase in mangrove coverage between 1982 and 2022 in Juan Díaz (top, 425.29 hectares) and Chimán (bottom, 284.69 hectares).



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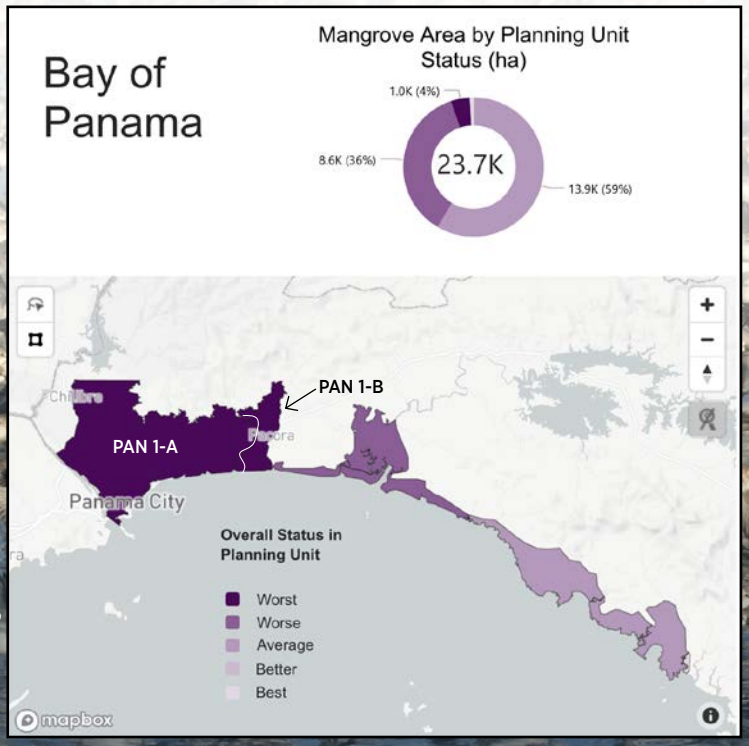
Loss of land area on Isla Cocotillo, Chimán District.



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Mangrove coverage condition in Panama Bay: Mangroves near Panama City (PAN 1-A and 1-B) have the worst ecological condition and highest risk of removal in the study area.

Shorebirds.
Yenifer Díaz - Panama Audubon Society

Study Area 2. Parita Bay Important Bird Area

The Parita Bay IBA is Panama's second most important site for shorebirds, after Panama Bay. Within a mostly rural-agricultural landscape, it includes three protected areas that encompass a variety of habitats: mangroves, estuaries, marshes, sandbanks, mudflats, shrimp ponds, and salt flats.

According to the Parita Bay Conservation Plan, direct threats to the area's mangroves include climate change, pollution, human disturbances, modification of the hydrological regime, habitat loss, and overexploitation of fisheries. Because the terrestrial landscape is mainly agricultural, the management of watersheds and water resources plays a determining role in the health of these marine-coastal ecosystems.

Results

The multi-temporal analysis of satellite images of Parita Bay shows a net increase of 1,013.96 hectares of mangrove cover between 1982 and 2022. Overall, a rate of increase in mangrove coverage of 0.21 percent per year was observed. The greatest increase was recorded between 1990 and 1999.

The analysis shows an increase in mangrove cover in almost the entire bay. The largest increases were observed in the northeast region, specifically at the mouth of the Palo Blanco Estuary, and in shrimp farming ponds in the Aguadulce area.

During the 1970s, the shrimp farming industry constructed walls to stop the ebb and flow of tidal waters, resulting in the slow but progressive death of trees. Recent satellite imagery shows some natural regeneration within and adjacent to aquaculture ponds that are presumably abandoned. This suggests that hydrological conditions remain adequate, in some places, for the natural regeneration of mangroves. In other places, natural restoration may be impossible without prior hydrological restoration.

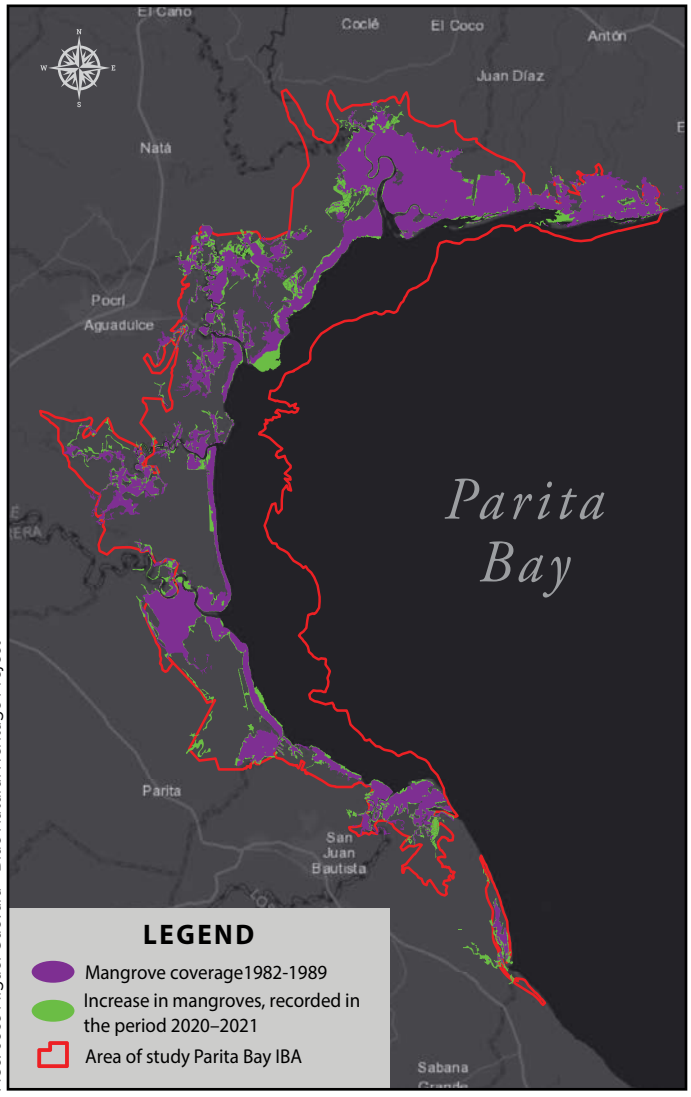
MSc. José Miguel Guevara - Blue Natural Heritage Project

Location of the Parita Bay study area.

Although the increase in mangrove coverage is a positive development, mangroves continue to face significant threats, including deforestation and climate change pressures. Restoring forests with new plantings is insufficient compensation, since carbon sequestration and other ecosystem services provided by mature mangroves cannot be quickly or equally replaced by new ones (for example, mature mangroves offer far greater protection against coastal erosion than young ones). Therefore, protection of established mangrove forests should be the highest priority.

Change in mangrove cover and rate of change in Parita Bay from 1982 to 2022, rounded to the nearest hectare.

Period	Years	Area (ha)	Change (ha)	Change (%)	Change rate (% per year)
I	1982-1989	11,880	-	-	-
II	1990-1999	12,695	815	6.86	0.69
III	2000-2009	12,789	94	0.74	0.07
IV	2010-2019	12,861	73	0.57	0.06
V	2020-2022	12,894	33	0.25	0.08
Complete	**1982-2022**	**-**	**1014**	**8.54**	**0.21**



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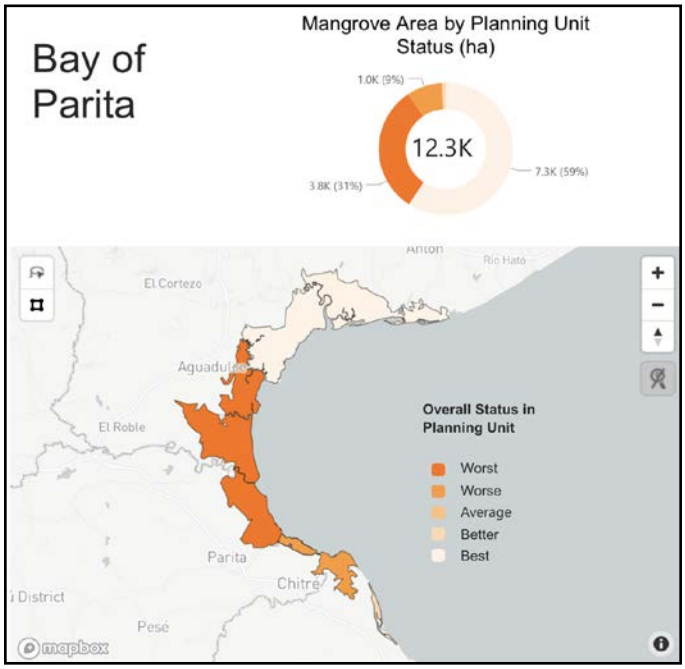
Mangrove cover for the Parita Bay IBA, showing increase in coverage through 2022.



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Mangrove coverage condition in Parita Bay: the poor status of these planning units is primarily driven by aquaculture expansion, agricultural encroachment, industrial and urban development, sea level rise, and agricultural pollution.

Parita Bay fisherman.

Oscar López - Panama Audubon Society

Conclusions

The mangroves of Panama's Pacific coast support an extraordinary variety of animals and plants. These ecosystems play a crucial role in the food chain, acting as nurseries for important marine species. The mangroves' distinctive roots also serve as a natural barrier against coastal erosion and storm surge, protecting thousands of people who live in flood-prone areas.

In the face of growing threats of development and climate change, an understanding of trends in mangrove cover is essential to the development of effective measures to protect these crucial ecosystems and the valuable environmental services they generate. These trends include a net increase of 1,013.96 hectares in mangrove cover in the Bay of Parita, and a net decrease of 64.71 hectares in the Bay of Panama. In both study locations, significant local variation was evident.

Francisco Málaga - Blue Natural Heritage Project

Juliana Chavarria directing the Blue Natural Heritage Project fieldwork.

Causes of mangrove coverage loss include urban development and conversions to agriculture and aquaculture uses, as well as coastal erosion caused by wave impact, sea currents, and sea-level rise. Mangrove coverage gains may be attributed to decreased pressure on mangrove timber resources, abandonment of agricultural activities, the establishment of protected areas, and other conservation measures.

Yenifer Díaz - Panama Audubon Society

Shorebirds feeding in the mudflats.

These gains have coincided with conservation practices and localized programs focused on education and public awareness of the importance of mangroves and the need for conservation. Without these interventions, the outcomes for mangroves may have been much worse.

In the case of both sites, it is important not to focus only on net gain or loss,but also on the specific situations that occur in the different sections within each site. As well as to remember that reforestation cannot immediately provide the same level of ecosystem services from the mature mangroves that we must conserve.

Further research is undergoing to pinpoint areas that require prioritized protection, improved management, and/or restoration efforts, while taking into account the needs and capabilities of local communities.

Despite these limited successes, Panama's Pacific mangroves remain vulnerable to growing threats from development as well as threats associated with climate change, including rising sea levels and more powerful storms that can damage these fragile ecosystems.

Yenifer Díaz - Panama Audubon Society

Mudflats of El Retén beach.

Francisco Málaga - Blue Natural Heritage Project

El Gago Port, Penonomé.

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