

## Abstract

Mangrove ecosystems are important coastal environments because they protect shorelines, support many living organisms, and help keep water and air clean. However, mangrove health can change depending on environmental conditions and human activities. The purpose of this project is to compare the health of mangrove ecosystems in different locations.

To do this, we will collect field data using GLOBE protocols, such as cloud observations, air temperature, water temperature, pH, salinity, dissolved oxygen, nitrates, alkalinity, and water transparency. We will also use non-GLOBE observations, including vegetation observations, bird counts, and general ecosystem conditions. In addition, we will use satellite images to study vegetation cover using the Normalized Difference Vegetation Index (NDVI).

By combining field measurements, satellite data, and ancestral knowledge shared by community members, we will compare different mangrove sites and identify similarities and differences in their ecosystem health. This project will help us understand how environmental factors influence mangrove ecosystems and why mangrove conservation is important.

Keywords: mangrove ecosystems, birds, bioindicators, water quality, ancestral knowledge, GLOBE protocols

## Problem Question

How can we determine the health of a mangrove ecosystem by using the structure of bird communities, water physicochemical parameters, ancestral knowledge from local communities, and satellite data in Ciénaga de la Virgen and Punta Arena?

## Hypothesis

We hypothesize that the health of a mangrove ecosystem can be determined by combining the structure of bird communities, water physicochemical parameters, ancestral knowledge from local communities, and satellite data in Ciénaga de la Virgen and Punta Arena.

## Data Collection Plan

Data will be collected at two main locations: Punta Arena, on Tierra Bomba Island in Cartagena, and the Ciénaga de la Virgen wetland. In Ciénaga de la Virgen, data will be collected at three sampling stations: Bajo Aves, Bajo Meza, and Juan Polo.

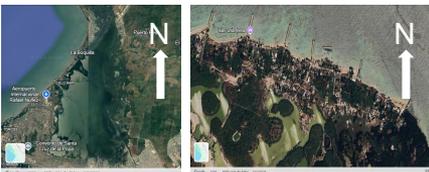
Data collection will take place during the second rainy season (mid-August to late November) and the first dry season of the year (December to late March). The group has already collected some data during the rainy season.

## Background and Supporting Information

Recent research studies show that water quality, soil conditions, and mangrove community structure are important factors that influence the diversity and distribution of bird species in coastal ecosystems (Zhu et al., 2024). Other studies have found that habitat variables, such as vegetation biomass measured using the Normalized Difference Vegetation Index (NDVI), are related to bird abundance through changes in forest structure (Knudson et al., 2025).

In addition, several authors have combined physicochemical water parameters, NDVI spatial analysis, and bird surveys to evaluate the environmental health and conservation status of mangrove ecosystems (Tavera et al., 2021). These studies support the use of birds, water quality, satellite data, and local knowledge as indicators of mangrove ecosystem health.

## Description of study site



Ciénaga de la Virgen, Google Earth

Punta Arena, Google Earth

### Study sites and climate

Our study sites are located in coastal mangrove ecosystems near Cartagena, Colombia. The geographic locations of the sites are:

#### Ciénaga de la Virgen (left):

- Bajo Aves: 10.485858° N, -75.484104° W
- Bajo Meza: 10.495012° N, -75.481803° W
- Juan Polo: 10.492531° N, -75.488353° W

#### Punta Arena (Tierra Bomba Island) (right):

- Punta Arena: 10.362618° N, -75.553675° W

The region has a bimodal rainy season, with rainfall occurring mainly from April to mid-July and from mid-August to late November

## Expected Indicators of a Healthy Mangrove Ecosystem

### Bird communities

Presence of specialized aquatic bird species rather than mainly generalist species

### Margalef diversity index above 4

### Water quality

- Dissolved oxygen equal to or above 3 mg/L
- Nitrates (NO<sub>3</sub>-N) lower than 0.5 mg/L
- Alkalinity between 60 and 200 mg/L as CaCO<sub>3</sub>
- Salinity not higher than 30 ppt
- pH between 6.5 and 7.5

### Ancestral knowledge

Evidence of multiple ecosystem services identified by local community members

### Satellite data

NDVI values equal to or higher than 0.3

## Expected Outcomes

- Bird counts in four locations during two climatic seasons of the year.
- Analysis of bird diversity using the Margalef and Shannon-Wiener diversity indices for each location.
- Measurement of water physicochemical parameters in the four locations during two climatic seasons of the year.
- Analysis of NDVI values for the four locations in two climatic seasons of the year.
- Collection of testimonials from community members about how these mangrove areas have changed over time.
- Using all these data, a comparative analysis of mangrove ecosystem health between Ciénaga de la Virgen and Punta Arena.

## Challenges and Considerations

- Using different means of transportation, such as canoes and motorboats, to reach the sampling sites.
- Early morning sampling, which requires waking up earlier than 3:00 a.m.
- Working under extreme weather conditions at some sampling sites.
- Learning and applying new concepts and skills, such as bird species identification, diversity indices, NDVI, the use of new tools and equipment, and basic statistics.

## Badges

Our research group aims to obtain the following badges:

**I Am an Earth System Scientist:** We study how the atmosphere, water, living organisms, land, and human activities are connected to understand mangrove ecosystem health.

**I Am a Collaborator:** This project is possible because students, teachers, community members, and partner organizations work together to collect data and learn from each other.

**I Make an Impact:** Our research helps local communities understand mangrove ecosystem health and supports actions to protect and conserve these ecosystems.

## References

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