



# Coastal wetlands of the north of Peru: preservation progress

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**ABSTRACT.** Wetlands provide several ecological, biological, and environmental benefits, including their role in the hydrological cycle, especially in coastal areas. Coastal wetlands are affected by anthropogenic threats, as these are in constant synergy with local populations and agricultural expansion, which is one of the main factors causing their depletion. In addition, the ravages of climate change accentuate their vulnerability, which may lead to their irreparable loss. In this regard, the objective of this work was to identify the coastal wetlands of northern Peru and in order to verify the progress made in their conservation. For this purpose, a search was performed in wetlands atlas and similar studies, and a check was made to see if those wetlands had records of flora and fauna studies. Finally, information was sought on protection measures in the area. Consequently, 22 coastal wetlands were registered, and among them, three are internationally recognized as Ramsar sites: Mangroves of Tumbes, Mangrove of San Pedro de Vice, and the Virrilá Estuary, where commendable conservation efforts are underway. However, it was found that more than 77% of the coastal wetlands in northern Peru do not have preservation actions or scientific evidence describing their biodiversity.

**Keywords:** conservation; ecological status; mangrove; preservation; Ramsar.

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## Introduction

Wetlands are known as water-covered areas that are extensions of swamps, marshes, and peatlands and are home to resident and migratory species. In the case of the Peruvian coast, these regions are formed by the upwelling of the water table in areas near the sea (Pacheco et al., 2020; Gómez-Sánchez, Cuba, & Aponte, 2022). Although they occupy only 6% of the Earth's surface, wetlands play a vital role in many hydrological and biogeochemical processes and harbor a crucial part of biodiversity globally (Lefebvre et al., 2019). In turn, these ecosystems provide services indirectly to humans and even represent a source of economic incomes for humans (Xu et al., 2019).

Wetlands are crucial for their role as a buffer against floods and ecosystem services. However, these regions currently suffer from ecosystem degradation and loss for poor management and governance of these ecosystems (Rodríguez, Senhadji-Navarro, & Ruiz, 2017). The decline in the benefits provided by coastal wetlands due to their misuse is increasingly alarming, and their deterioration has been increasing until reaching critical levels. The human presence threatens its stability and preservation given its accelerated pace of urbanization, propitiating harmful activities such as waste dumping in surrounding areas (Ghosh & Das, 2019).

Both the human activities and their impact on climate change have had significant adverse effects on these regions, such as sea-level rise, decreased sediment supply, and acidification of water and soil (Li, Bellerby, Craft, & Widney, 2018). Among the several human threats that intensify the impact are: the preservation of wetlands into cultivated and urban areas, as well as the construction of structures such as dams, roads, dykes, canals, among others. The intensification of these activities has also increased the water deficit as a climate change consequence in the last decades (Al-Mahfadi & Dakki, 2019; Lefebvre et al., 2019).

Due to the importance of these regions, there is a growing concern to improve their conservation policies. These efforts bring together scientists, citizen organizations, and authorities to determine the best measures to adequately preserve these ecosystems (Aponte & Tabilo, 2021). Therefore, it is crucial to develop sustainable habits and practices that allow the exploitation of its educational, scientific, and tourism potential in a sustainable way (Vivanco, 2020).

Considering the wetlands' fragility to protect the highest biodiversity of these regions, it is crucial to maintain their continued protection, carry out constant monitoring, and propose restoration measures to mitigate adverse effects (Pacheco et al., 2020). Therefore, initiatives have been developed several decades ago to preserve wetlands worldwide, such as Ramsar conservation (Davidson, 2018). The main objective is the conservation and wise use of wetlands through local, regional, and national actions, in addition to international cooperation, as a contribution to achieving sustainable development worldwide. However, better efforts are still required to improve protection measures for these ecosystems (Ramsar, 2016).

The Ramsar Convention is one of many existing management tools to ensure the preservation of wetlands, established at the regional, national or international level. Although Peru is a participating member of the convention, it has a National Wetlands Strategy established in 2015, which is the main instrument of the country for preserving these regions (Ramírez & Aponte, 2018). However, further efforts are still required to improve protection measures for these ecosystems (Ramsar, 2016).

Wetlands are one of the ecosystems with a high vulnerability rate, especially coastal wetlands. These natural structures are more vulnerable because they have a higher interaction with local populations, who exert pressure on them. Therefore, the efforts of the government, non-governmental organizations, and the academic sector are necessary to generate more information on the diversity of flora and fauna species, potential threats, and preservation efforts that are being developed in these ecosystems, in order to establish goals and achieve considerable progress in their conservation (León, 2020).

According to the National Wetlands Strategy (Perú, 2015), an adequate wetland regulatory framework should be promoted to achieve proper national wetland management. The prevention instruments should be used to help carry out continuous monitoring and to setting indicators. Therefore, the management of these ecosystems will be improved, and the environmental services provided by wetlands will be valued economically; in addition, the loss of these important ecosystems will be prevented.

The coastal wetlands of northern Peru are part of the Peruvian coastal ecosystem belt that is influenced by the Humboldt Current, the centers of oceanic urgency, and the effects of the *El Niño-Oscilación del Sur* (ENSO) phenomenon (Tabilo, Burmeister, Chávez, & Zöckler, 2016). These ecosystems located in the Peruvian coastal strip represent a large corridor that harbors fundamental sites for biodiversity (Aponte, 2017).

The efforts of the government, non-governmental organizations, and the academic sector made it possible to generate information on the diversity of flora and fauna species, potential threats, and conservation efforts (León, 2020).

## Materials and methods

The coastal wetlands of northern Peru were identified through a search in wetland atlases and similar studies, and it was also verified whether these wetlands had records of flora and fauna studies. Finally, information was sought on protection measures in the area. Under these criteria, Table 1 was performed. The information was obtained from the qualitative analysis of environmental instruments, such as the Atlas of shorebirds of Peru (Senner & Angulo, 2014) and the Atlas of coastal wetlands of the arid-semiarid coast of the South American Pacific (García et al. 2020).

For the location and marking of the northern wetlands declared Ramsar sites, the free and open-source Geographic Information System software QGIS version 3.16 was used (QGIS, 2022).

## Results and discussions

Table 1 shows the northern coastal wetlands of the country. It indicates the region to which it belongs, the type of wetland, whether flora and fauna studies have been recorded, and whether conservation efforts or initiatives exist.

Based on available information, 22 wetlands were reported along the northern coast of Peru, specifically in the departments of La Libertad, Lambayeque, Piura, and Tumbes, which have at least basic information on the biological diversity of these harbors, their ecological functions, and their threats.

Figure 1 shows the location of the northern wetlands on the map of Peru. Of the total wetlands, five are located in the Tumbes region, seven in the Piura region, three in the Lambayeque region, and seven in the La Libertad region. Twelve wetlands are estuarine, eight are coastal lagoons, and there are only two mangroves.

Table 1. Northern coastal wetlands.

Region	Wetland name	Wetland type	Flora and fauna	Preservation measures
Tumbes	Mangroves of Tumbes	Mangrove	With study	Yes
	Tumbes Bay	Estuary	Without study	No
	Bocapán	Estuary	Without study	No
	Vejal estuary	Estuary	Without study	No
	Punta Mero lake	Coastal lagoon	Without study	No
	Máncora	Estuary	Without study	Yes
	Punta Balcones	Coastal lagoon	Without study	No
Piura	Chira river mouth	Estuary	Without study	No
	Mangrove of San Pedro de Vice	Mangrove	With study	Yes
	Virrilá estuary	Estuary	With study	Yes
	Ñapique lagoon	Coastal lagoon	Without study	No
	Ramon lagoon	Coastal lagoon	Without study	No
Lambayeque	Wetlands of San José	Estuary	Without study	No
	Eten port	Estuary	With study	Yes
	Zaña river mouth	Estuary	Without study	No
	Faclo Grande	Estuary	Without study	No
	Malabrigo port	Coastal lagoon	With study	Yes
La Libertad	El Tubo wetland	Coastal lagoon	With study	No
	Wetlands of Huanchaco	Coastal lagoon	Without study	Yes
	Moche river mouth	Estuary	Without study	No
	Morin port	Coastal lagoon	Without study	No
	Virú river	Estuary	Without study	No

Source: Adapted from Senner and Angulo (2014), Tabilo et al. (2016), Garcia et al. (2020).

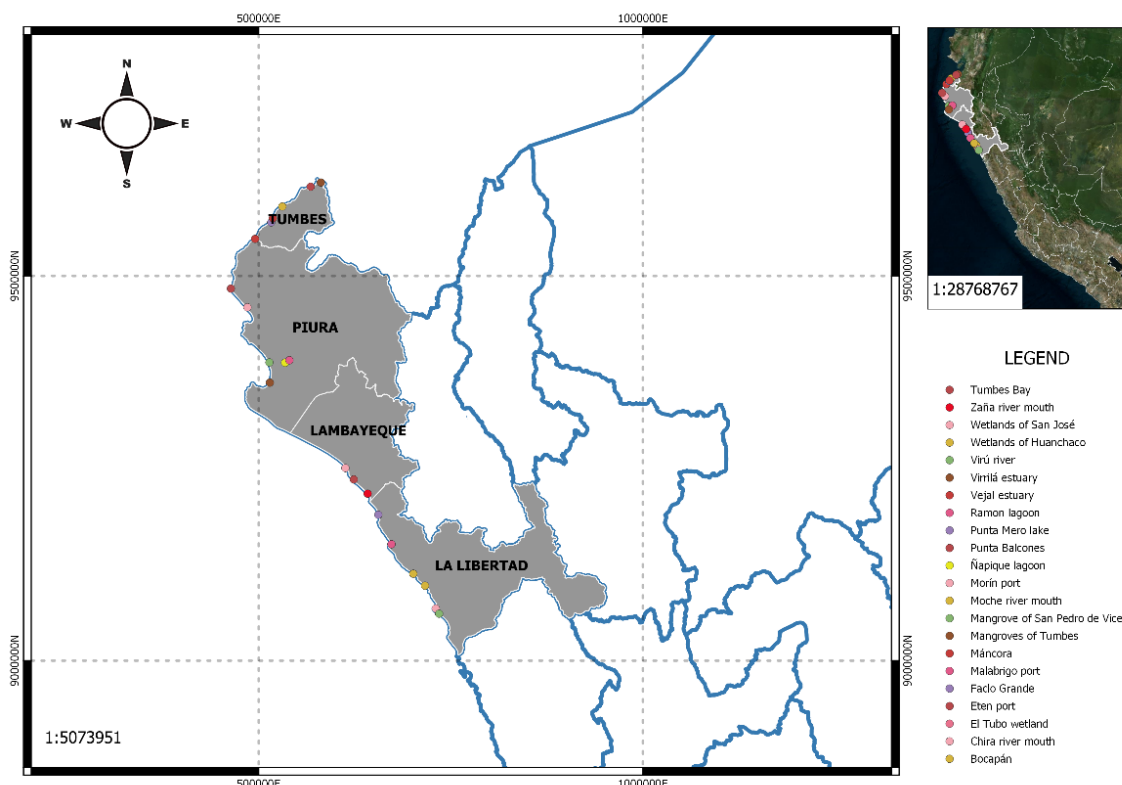


Figure 1. Location of the northern wetlands on the map of Peru.

Unfortunately, estuarine wetlands and coastal lagoons are not valued in the same way as mangroves. These wetlands lack scientific information to inform decision-making (Senner & Angulo, 2014; Tabilo et al., 2016). Of the twelve estuarine wetlands, only the Virrilá estuary and the Eten wetland have scientific studies describing the ecosystem and the existing flora and fauna.

As the eight coastal lagoons, research-related activities were only carried out in the El Tubo and Malabrigo port wetlands. In relation to the protection efforts, in 22 wetlands, only five have local or regional preservation initiatives.

### Wetlands considered within the Ramsar Convention

Table 2 shows the wetlands that, according to the Ramsar Convention's Wetland Classification System, are considered Ramsar sites because these are central centers of biological diversity, are sources of water, and provide multiple ecosystem benefits to local communities (Ramsar, 2020). In addition, two mangroves located in the north of the country and the Virrilá estuary are included, which was declared a Ramsar site in 2021.

**Table 2.** Northern coastal wetlands considered Ramsar sites.

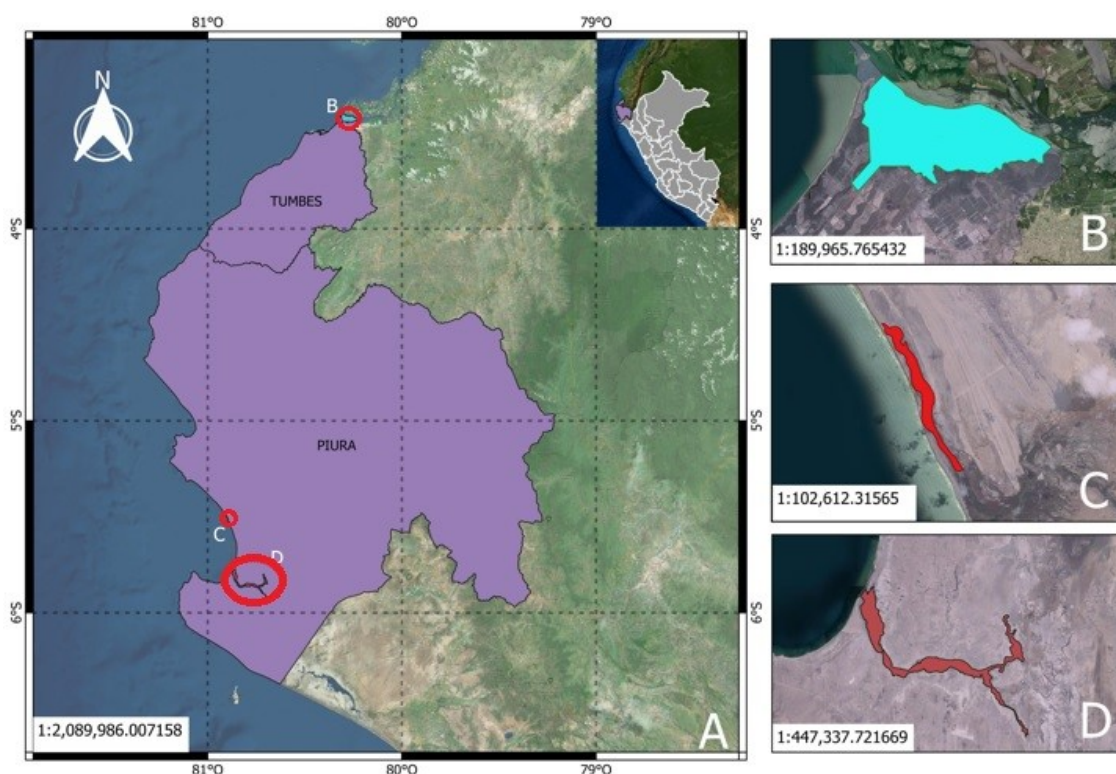
Wetland name	Region	Wetland type
Mangroves of Tumbes	Tumbes	Mangrove
Mangrove of San Pedro de Vice	Piura	Mangrove
Virrilá estuary	Piura	Estuary

The Mangroves of Tumbes are part of the National System of Natural Protected Areas (SINANPE) in the National Sanctuary category, and these are part of the Northwest Amotape – Mangares Biosphere Reserve. In addition, it was included in the Ramsar List in 1997.

At the national level, the Mangrove of San Pedro de Vice has the category of Municipal Conservation Area and Regional Conservation Sanctuary. In addition, at the international level, it is also considered an Important Bird Area (IBA) and a Western Hemisphere Shorebird Reserve Network (WHSRN) (Devenish, Díaz Fernández, Clay, Davidson, & Yépez, 2009) and was declared a Ramsar site in 2008.

Likewise, the Virrilá estuary was declared a Regional Conservation Area and was listed as an IBA and WHSRN area (Tabilo et al., 2016). It was included in the Ramsar List in 2021.

Figure 2 shows the location of the wetlands considered Ramsar sites, circled in red (A), and each wetland highlighted on the right side, the Mangroves of Tumbes (B), the Mangrove of San Pedro de Vice (C), and the Virrilá Estuary (D).



**Figure 2.** Location of wetlands in northern Peru considered Ramsar sites (A). Mangroves de Tumbes (B). Mangrove of San Pedro de Vice (C). Virrilá estuary (D).

It should be noted that including a wetland as a Ramsar site is a crucial achievement since this list is the best tool currently available to ensure its preservation. However, light penalties for poor wetlands management or monitoring result in poor conservation of these sites (Davidson, 2018).

Table 1 shows the preservation efforts of the different wetlands, and these are promoted in most cases by local and regional governments, except for the Mangroves of Tumbes Natural Protected Area. However, it is also necessary for citizens to participate in conservation efforts, as in the case of the participatory social management for the conservation of the mangroves of San Pedro de Vice, which is a clear example of the integration of citizens efforts, local authorities and non-governmental organizations for the preservation of this wetland.

In order to change the cultural model impregnated in the thinking of the parties involved, it is crucial to implement environmental awareness programs and look for new preservation alternatives such as economic valorization. This alternative would act as a complement to its veritable ecological, biological and social value. The information of this paper opens the possibility of making it a priority issue for competent organizations and allows for higher investment in restoration and recovery projects for these ecosystems.

On the other hand, it is necessary to promote scientific research and environmental education on Peru's coastal wetlands since most of them still lack basic information and are not perceived as fundamental natural systems for biological diversity and the development of local communities.

Peru's wetlands are in a critical situation due to problems caused by their vulnerability to anthropic pressure, the weak institutional framework of the State, and insufficient training of its authorities to make decisions that guarantee the protection of these ecosystems. In this regard, a better study of the wetlands of the country is recommended. Likewise, more wetlands should be included in the list of Ramsar sites, as this initiative is a higher step towards establishing protection measures for these ecosystems, as well as integrating protection and planning policies that prioritize their financing and monitoring plans, and the development and strengthening of a specific regulatory framework for wetlands together with an educational and awareness-raising strategy aimed at the population.

An excellent example is the Laguna de los Patos wetland, an ideal place for activities such as birdwatching, since it has a great diversity of aquatic bird species that live there or come for reproductive, migratory, or resting purposes (Seminario-Córdova, Barrutia & Estrada, 2022). To date, 92 species of birds have been reported, including endemic and migratory birds, as well as 7 species of mammals, 8 reptiles, 2 amphibians and fish. In recent studies there are some species that have no longer been found, such as *Buteo polyosoma*, *Mycteria americana*, *Fregata magnificens*, *Pandion haliaetus*, *Porphyrio martinicus* and *Charadrius semipalmatus* (Seminario-Córdova, Barrutia, & Estrada, 2022). This situation may be due to adverse situations in this region, such as a decrease in water volume, the scarcity of precipitation in the area, in addition to being exposed to a constant degree of anthropogenic alteration such as road construction, burning of a large part of the 'totora' (*Typha angustifolia*), furtive hunting of ducks and other causes that alter their feeding or resting habits, depending on the case.

## Conclusion

Twenty-two wetlands (mangroves, estuaries, and coastal lagoons) were identified along the coast of northern Peru, of which three are considered Ramsar sites: the Tumbes Mangroves, the San Pedro de Vice Mangrove, and the Virrilá Estuary; the latter are IBA sites and WHSRN members.

In 73% of the coastal wetlands in northern Peru, there are no scientific research activities, and in 68%, conservation activities are not promoted.

It is necessary to promote scientific research and environmental education in the coastal wetlands of northern Peru, since most of them still lack basic information.

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