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RAISING AWARENESS TO PROTECT: COASTAL AND MARINE ENVIRONMENTAL EDUCATION APPLIED TO THE BIODIVERSITY CONSERVATION IN THE SOUTH ATLANTIC AMERICA

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Abstract

This article sought to identify environmental education initiatives focused on biodiversity conservation that exist in the coastal and marine zone of Paraíba State (Northeastern Brazil), evaluating their foundations through the construction of scientific-pedagogical models. Being presented in a transversal and multidisciplinary way, in formal and non-formal education, integrated with government policy in its different spheres (national and international), with the target audience involving the entire society. Advances in environmental education and their impact on the resolution of the main environmental conflicts in the marine and coastal areas are discussed, in particular, the protection of living beings and marine natural resources. The need for ecological literacy in the twenty-first century was verified, and its importance in the formation of ecological awareness and the exercise of environmental citizenship, placing emphasis on current processes in Paraíba. As a result of the Discipline of Environmental Education for Biodiversity Conservation of the Post-Graduation Program in Ecology and Environmental Monitoring (PPGEMA) at the Federal University of Paraíba (UFPB), subsequently counting on the collaboration of the Institute of Research and Action (InPact), of the Guajiru Association, of the SISFAUMAR-PB (Paraíba Marine Fauna Monitoring System) and the Paulo Young Invertebrate Laboratory of the Department of Systematics and Ecology of the Federal University of Paraíba (LIPY-DSE-UFPB), it is expected to contribute to the knowledge, information and instruments that assist in environmental management and the implementation of government policies for the coastal and marine environment of South Atlantic America.

Keywords: Environmental education. Citizen science. Ocean literacy. Marine fauna conservation. State of Paraíba.

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1 Introduction

All life forms on Earth depend on biodiversity, and since humans have the cognitive capacity to create and transmit culture, as well as the ability to transform and shape the existing natural reality in a much more complex and comprehensive way than other species, they must understand that conserving biodiversity means protecting the multiplicity of these life forms. According to Pazoto, Duarte and Silva (2023), understanding marine and coastal biodiversity is fundamental to maintaining the health and sustainability of ecosystems. The authors highlight that knowledge about the interdependencies between the ocean and human life is essential to preserving these vital systems. The perpetuity of the natural system requires a global commitment to conservation and sustainability, ensuring harmonious coexistence between human needs and the preservation of biological diversity (GANEM, 2010).

In this way, the drastic declines in biodiversity in the face of various negative impacts on an increasing scale, mainly due to the contribution of human practices, have generated global concern in recent decades. Motivate the generation of international agreements and commitments, such as the creation of the Earth Charter - which establishes the principles for the sustainable use of the planet's natural resources; the Convention on Climate Change; the United Nations Convention on the Law of the Sea, the Ramsar Convention and; the Convention on Biological Diversity (CBD). As per the agreement foreseen at COP15, held in Montreal in 2022, global nations have shown growing concern about the loss of biodiversity, driven by human activities. The "Kunming-Montreal Global Biodiversity Framework" sets targets to protect 30% of terrestrial and marine areas by 2030, as well as to restore degraded ecosystems. The agreement also aims to mobilize significant financial resources and promote the sustainable use of biodiversity, ensuring a fair sharing of benefits derived from genetic resources (THE NATURE CONSERVANCY, 2022; UN DECADE ON ECOSYSTEM RESTORATION, 2024).

In the case of marine biodiversity, divided into different categories for the purposes of study, management, use and exploitation in a sustainable manner, knowledge from its most evident interfaces, such as terrestrial, coastal and oceanic processes - including the communities that make use of marine and fishing resources – where impacts can only be perceived through scientific research, technological development, training and qualification of personnel, and scientific dissemination in the most different areas of society. Although ocean exploration is still limited by technology, where its use is considered both high cost and difficult to manipulate, there is a need for greater production and less impact. Efforts have taken place in recent decades to collect information, diagnose the situation and plan use.

The need was corroborated by the publication of the First World Ocean Assessment, which highlighted the urgency of sustainable management in the ocean. As the main outcome of this assessment, in 2017, the Decade of Ocean Science for Sustainable Development was proclaimed, with this agenda being implemented between 2021 and 2030. Seeking to fulfil the commitments of the 2030 Agenda, focusing on SDG 14 and related issues (ONU, 2021).

According to Pazoto, Duarte and Silva (2023), Brazil has approximately 7,500 km of coastline, home to a vast diversity of coastal and marine ecosystems. Is a signatory to the Convention on Biological Diversity (CBD), is present on the scientific committee of the Intergovernmental Oceanographic Commission (IOC/UNESCO), as well as the Ministry of Science, Technology, and Innovations (MCTI) responsible for implementing the Decade of Ocean Science (ONU, 2020) in the country.

In Brazil, Environmental Education, implemented based on the National Environmental Education Policy – PNEA (Brazil, Law No. 9,795/1999), aims to transform society by raising awareness and educating citizens capable of relating their actions to the various damages caused to the environment, encouraging them to change their habits, understand the value of biodiversity, making them aware of their rights and duties (BRASIL, 1999).

The conservation of marine biodiversity in Paraíba, despite other states in Brazil, is still considerably inadequate in view of current legislation. According to the Marine Mammal Protected Areas Task Force (www.marinemammalhabitat.org), states such as Paraíba face challenges in protecting marine biodiversity due to the limited implementation of conservation units. The main factor is the lack of management of coastal and marine protected areas, specifically the state ones implemented previously and recently.

The coastal region is impacted, in addition to legal and local management factors, by the results arising from various anthropic problems on a global scale (climate change), regional (thermal anomaly and pollution) and local (works and infrastructures compromised due to the lack of planning, predatory fishing and overfishing, disorderly tourism, ineffective sewage system and disposal of pollutants), compromising well-being, quality of life and human health.

In view of the various impacts in recent years, those interested in Paraíba's coastal and marine system, in the most different spheres of government (private sector, research and teaching institutions, civil society organizations, among others), have carried out initiatives in the form of programs, projects and actions to raise awareness between Paraíba society and promote biodiversity conservation.

In this sense, this study had as its central objective, based on the debates of the Escola Azul in progress and the Marine and Coastal Environmental Education, in formation, to produce a synthesis between the social actors that have been working in Paraíba with initiatives of sensitizing and educational practices applied to Conservation of Marine Biodiversity. To understand how much progress has been made in this production of knowledge, to serve as a tool for public environmental management in municipalities located on the coast of the state of Paraíba and subsidize future management actions in favour of a sustainable ocean.

This work began in the Environmental Education for Biodiversity Conservation discipline of the Postgraduate Course in Ecology and Environmental Monitoring (PPGEMA) at the Federal University of Paraíba (UFPB), later counting on the collaboration of other institutions and partners that work with the theme, such as the Research and Action Institute (InPact), Guajiru Association and Paulo Young Invertebrate Laboratory of the Department of Systematics and Ecology of the Federal University of Paraíba (LIPY-DSE-UFPB).

The search for the field of Marine Biodiversity

Although the study of biodiversity was initiated by naturalists when they described species during their expeditions (VITALI, 2010), the term "biodiversity" came to be used for the first time only in the 1980s, as a derivative of "biological diversity" (WILSON, 1997).

To refer, in this case, to the number of species of living beings existing on the planet, including all animals, plants, fungi, prokaryotes and others. It is one of the most frequently cited terms in current times, both in ecological research and in environmental management and conservation.

As an official concept in environmental literacy, the term "biodiversity" appeared in 1992 during the United Nations Conference on Environment and Development (UNCED) – the notorious ECO-92 -, when the Convention on Biological Diversity (CDB, 1992) was signed on three main bases: (i) the conservation of biological diversity, (ii) the sustainable use of biodiversity, and (iii) the fair and equitable sharing of benefits arising from the use of genetic resources, considering the three levels: ecosystems, species and genetic resources.

In the case of marine biodiversity, there are countless benefits gained, the most relevant of which are: the supply of protein from fishing resources, active ingredients in pharmaceuticals, production of oxygen (cycling of elements), carbon fixation (climate regulation), digestion of organic matter by decomposer species, and supply of raw materials (MILLER-THORNE, 1999; EARLE, 2009).

The practice of Marine and Coastal Environmental Education in Brazil, in general, and in Paraíba specifically, is necessary due to the pressing need to interpret marine and coastal life for a large number of citizens. These need guidance and a change of attitude in the face of current issues of increasingly negative impact on coastal and marine environments (PEDRINI, 2010).

According to data from the Interministerial Commission for Sea Resources (CIRM - *Comissão Interministerial para os Recursos do Mar*), approximately a quarter of the Brazilian population lives in the coastal zone, totalling 50 million inhabitants. The Brazilian coastal population concentration indicates a high degree of human (or anthropogenic) intervention in the biome's natural resources, as it presents intense trade and transport activity, in addition to suffering a high environmental impact caused by oil exploration. As elements such as beaches, green areas, and other amenities become factors in increasing the value of coastal spaces, land use and occupation intensify. This process, in turn, leads to the degradation of these natural resources. When intensive exploitation compromises these qualities, new areas tend to become targets for investment, following a paradoxical dynamic of continuous development and deterioration (BARBOSA, 2011). These ecosystem services can be grouped into provision, regulation, support, and cultural services, which after adding complementary human assets, in turn, lead to social benefits (TURNER; SCHAAFSMA, 2015).

The coastal and marine ecosystem represents a true genetic bank for the current and future generations, as it houses rich and diverse fauna and flora, both for fishing and for coastal protection through coral reefs, sandbank vegetation (*restingas*), and mangrove forests. This reef environment, in particular, is classified as a true heritage of humanity and a biodiversity hotspot (UNESCO, 1997).

To protect this marine and coastal biodiversity, marine and coastal environmental education such as emerging measures, as listed by Earle (2009): integrated management (scientific cooperation and political understanding), creation and maintenance of protected areas, control of continental waters and international research, scientific research (generating knowledge and understanding), recognition of marine biodiversity, and popularization of science through environmental education and citizen science.

Conservation Units in the marine education process

With the aim of preserving Brazil's natural and cultural heritage environments, National Law No. 9,985 (BRASIL, 2000) was created in 2000, providing the Union, States and Municipalities with the opportunity to create Conservation Units (CUs).

CUs, in their role as institutionalized spaces to preserve and conserve flora, fauna, water resources, geological and cultural characteristics, natural beauty, recovering degraded ecosystems, promoting sustainable development and other factors, contribute to the principle of environmental protection.

In the case of Conservation Units in coastal areas or even Brazilian Marine Protected Areas (MPA) established in Brazil, studies on Marine and Coastal Environmental Education (EAMC) actions were implemented only in 1997, in this case, the pioneering areas to adopt as a theoretical reference the use of the Treaty on Environmental Education for Sustainable Societies and Global Responsibility (TEASS), based on a broad evaluation by the authors Madureira and Tagliani (1997) of Environmental Education for Sustainable Societies (EESS).

In the case of Paraíba State, the marine and coastal territory has its protection defined by a special management and administration regime in the following Conservation Units: Areia Vermelha Marine State Park (SUDEMA); Burnt Shipwreck Environmental Protection Area (SUDEMA); Barra do Rio Mamanguape APA (ICMBio); APA of Tambaba (SUDEMA) and APA of Jacarapé (SUDEMA). To date, in terms of the functionality of marine and coastal education practices, it is possible to visually and physically witness effective actions only in the Barra do Rio Mamanguape APA. Where, in fact, and not just in law, there is direct management running awareness programs, sustainable use and an Aquatic Mammal Recovery Center with constant activities aimed at the residents and visiting public, with its effective results being witnessed locally in the non-formal process, mainly.

Coastal and Marine Environmental Education

The term Environmental Education (EE) was used for the first time in an education event promoted by the Royal Society of London, in the United Kingdom, at the University of Keele, in 1965 (GAYFORD; DORION, 1994; LOUREIRO; ALBUQUERQUE; BARRETO, 2004), becoming widely used with the growth of the environmental movement. This movement began to use the term EE to sensitize people not only about environmental issues, but the understanding of this interdependence between human beings and the environment, based on their actions. The perception of the environment is not only seen as something to be regulated and equipped with technologies to produce less impact but also its use as sustainable attitudes, engagement and introduction to the topic in formal education.

A series of publications continued to emphasize the inclusion of environmental issues not only in education but in the economy and public planning. The "limits to growth" were discussed by the Club of Rome in 1972.

Followed by the Stockholm Conference that discussed the Human Environment and socioeconomic development. The debate with the Brundtland Commission in the 1980s discussing "Our Common Future" is affirmed.

The publication of the United Nations (UN) Report in 1987, added to the discourse the need to integrate into the socioeconomic planning of governments in general, the environment and the EA premises (Figure 1) while minimizing problems and the impacts arising from human activities, especially when, according to the report, planning becomes collaborative with nature when the idea of sustainable development becomes incorporated into the population's daily lives (BRASIL, 2003).

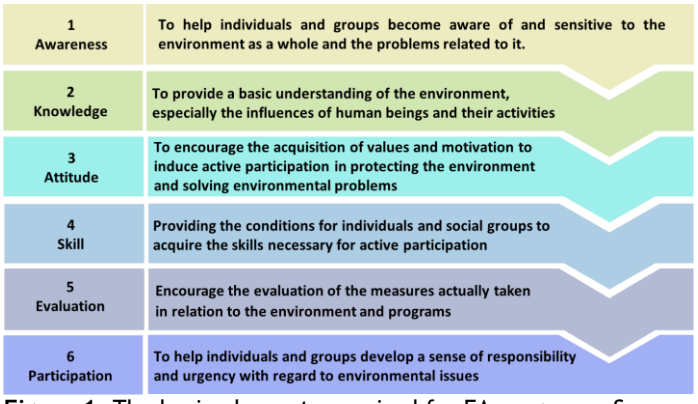

Figure 1. The basic elements required for EA programs. Source: Adapted from PNEA (BRASIL, 1999).

In the case of marine issues, the international community, in that same decade, agreed on standards for the conservation and rational exploitation of coastal regions, seas and oceans, continental shelves and large seabeds.

The United Nations Convention on the Law of the Sea – UNCLOS, in Chapter 17 of Agenda 21, is the protagonist of the theme "Ocean Protection; of All Types of Seas and Coastal Zones, and Protection, Rational Use and Development of their Living Resources", having put the UN Convention on Biological Diversity and other international treaties, both for signature and for seeking to give political effectiveness to proposals, with Brazil participating in most of these debates (PRATES; GONÇALVES; ROSA, 2012).

Over the decades, various segments of organized civil society and private entrepreneurship have made efforts to promote actions and generate knowledge about the marine environment and the need to preserve it, examples of these actions are: Aquariums and Zoos open to visitors and inspected by the European Association of Zoos and Aquariums (EAZA) and the World Association of Zoos and Aquariums (WAZA, 2005), being seen as one of the most effective wildlife educational spaces in the world.

An example of a marine educational space is also the Marine Scout movement, which exists in several countries and promotes awareness-raising activities and aquatic and seamanship practices to encourage young people and families to admire and desire to be in contact with the oceans.

The Blue Flag program is seen in this same practice, as it seeks to complete a protocol of a socio-environmental nature, within international standards, created by the organization Foundation for Environmental Education – FEE, dedicated to marine and coastal environmental education around the world.

The Marine Biodiversity Conservation Network (BIOMAR), brings together projects in favour of the preservation of migratory birds (Albatross), cetaceans (Humpback Whale and Rotator Dolphin), corals (Coral Vivo) and grouper fish (Brazilian Groupers) created to support projects that use Environmental Education as the main tool for protecting species and marine habitats.

Also seen is the Marine Biodiversity Recovery Program (REBIMAR), coordinated by the MarBrasil Association which has been developing a set of socio-environmental actions, based on the use of Artificial Reefs to help recover marine biodiversity, fishing stocks and conservation of coastal environments from the south coast of São Paulo to the north of Santa Catarina. As an example, as a project that opens up space for voluntary practices throughout Brazil, both the Clean Seas Campaign (UN Environment) and the Conscious Conduct Campaign in Reef and Beach Environments, promote information about the conservation of coastal environments and marine.

The issue of Environmental Education specifically aimed at Marine and Coastal discussions (EAMC), has been a small reflection when compared to all the production and results seen for the continental environment (PEDRINI, 2010).

The oceans are essential to life on Earth, as they regulate the climate, produce more than 50% of the oxygen we breathe, shelter immense biodiversity and provide food and fundamental resources for the global economy. (OCEANA BRASIL, 2021).

In this sense, the Pedagogical Political Project of the Brazilian Coastal and Marine Zone (PPPZCM) brings significance to the sustainable use and conservation of biodiversity, serving as an instrument for managing educational processes in the Brazilian Coastal and Marine Zone. The PPPZCM was built by the TerraMar Project and the GEF Mar Project in a participatory manner, from September/2019 to February/2021 (PPPZCM, 2021).

Decade of Ocean Science & Ocean Literacy

In the case of the “Decade of the Oceans”, as a proposal to emphasize this theme at a global level, promoting the importance of the oceans and actions to protect and preserve them, the idea was proposed for the first time during the Conference of United Nations on Environment and Development (UNCED), held in Rio de Janeiro in 1992, the so-called Earth Summit or Rio-92.

The idea of a decade dedicated to the oceans gained momentum during Rio-92 due to the growing concern shown by many about the health of the oceans and the need for global measures aimed at alleviating the challenges that arose related to waters and marine life. This culminated in the holding of the United Nations General Assembly, where Resolution 49/121 of 1994 was amended, appointing the International Decade of Oceans (DIO) to occur in the period from January 1, 1998, to December 31, 2008. This Decade of the Oceans has as its main objective to promote the sustainable management and development of the oceans, raising awareness about the critical importance of the oceans for global ecological balance, human health, the livelihood of coastal communities and marine biodiversity.

Since then, other initiatives have followed, with the United Nations General Assembly proclaiming the United Nations Decade of Ocean Sciences for Sustainable Development (2021-2030) in 2017. Thus, the Ocean Decade was renewed to contribute to the effective implementation of Sustainable Development Goal 14 (SDG 14) - "Life in Water", which aims to conserve and sustainably use the oceans, mares and marine resources.

Due to the need to demonstrate society's intrinsic relationship with the Ocean, in the 2000s, in the United States, the term “Ocean Literacy” as a movement to address knowledge and respect the influence of our actions in the Ocean, highlighting how the health of the ocean affects our lives. It is noteworthy that the term “Ocean” is used in the singular in all principles, precisely to reinforce the idea that we have a single body of salt water, the Ocean, with human influences on the Ocean, in any of its parts, affecting all populations in other regions, even if they are distant from each other (GHILARDI-LOPES et al., 2023).

This term, “Oceanic Culture”, was chosen as a translation from English, as the movement gained strength and expanded across Europe, and Ireland, reaching Brazil and other countries, through the United Nations Educational, Scientific and Cultural Organization (ONU, 2020). "Ocean Literacy" refers to an understanding of knowledge about the various issues related to the oceans or marine environment.

In the case of literacy, we seek to understand the importance of the oceans for life on Earth, as well as the processes, characteristics and challenges that occur in these vast aquatic ecosystems.

The so-called "Ocean Literacy" has seven principles (Figure 2) and encompasses several interdisciplinary topics. Having in its scope: (i) Scientific Concepts; (ii) Importance of the Oceans; (iii) Connections between Oceans and Other Ecosystems; (iv) Challenges and Threats; (v) Marine Sustainability; (vi) Awareness of the importance of sustainable management of marine resources and practices that promote the health of ocean ecosystems. "Ocean Literacy" should inspire conservation actions, sustainable development and a more responsible approach towards the oceans by humanity.

Figure 2. Ocean Literacy Principles. Source: Adapted from Santoro et al. (2020).

On this open front for promoting marine and coastal life, many educational initiatives, non-governmental organizations, and scientific programs work to increase ocean literacy. Encouraging people, in this case, to understand the individual relationship with the Ocean, the existing three-dimensional process of the early life environment, playing an important role in the ecology of species and with its urgent need for preservation by life in all its forms, even human life.

In Brazil, the first city to establish Oceanic Culture as a public policy (Municipal Law No. 3,935/2021) was Santos, where it provided for the insertion of knowledge about the oceans and preservation of marine life in different forms of pedagogical activities in the municipal education network.

In the state of Paraíba, Bill No. 3650/2022 was approved by the Legislative Assembly of Paraíba, which establishes the action to promote Oceanic Culture as mandatory in public institutions and the public and private education network in the state of Paraíba.

Although it has been repealed over time, initiatives like this should be encouraged and supported. Paraíba society, due to its easy access to coastal and marine ecosystems, has a strong relationship with natural resources. This has led to serious ecological and environmental imbalances in the marine environment over the years due to intense use beyond nature's recovery capacity. Protecting the marine environment is crucial for several reasons, as the oceans play a vital role in maintaining global ecological balance, the health of the planet, and sustaining human life. Therefore, it is necessary to confront issues in the field of public policies on EA applied to the Conservation of Marine Biodiversity in Paraíba, from the point of view of the experiences developed or monitored, and whether it is a priority as a government policy.

2 Material and Methods

This study is based on the definition of the National Coastal Management Plan (*Plano Nacional de Gerenciamento Costeiro* - PNGC), which represents the Coastal Zone as a geographic space for the interaction of air, sea and land, including its resources, renewable or not, covering a maritime strip on the one hand, and a terrestrial strip on the other (BRASIL, 2004). This presents itself as an area that undergoes considerable dynamism due to different influences (geological, climatic, fluvial, biological, oceanographic), being the place on the planet where external (cosmic) forces are most noticeable, such as the daily movement of the tides resulting from the positioning of the moon.

According to Thiollent (2022), it is socio-environmental research with a qualitative-quantitative and participatory approach. From a bibliographic and documentary examination, digital media, action research and socialization of information, Marine and Coastal Environmental Education initiatives applied to the Conservation of Marine and Coastal Biodiversity in Paraíba were identified. As the use case of action research, this took place in public visitation spaces, commemorative events through the allusive dates, and activities offered permanently and punctually by bodies linked to different spheres of the state government, private companies and organized civil society organizations. During the research, images (photos and videos) were recorded with cell phone cameras belonging to team members.

Environmental Education initiatives applied to the Conservation of Marine Biodiversity were classified into three aspects, considering representativeness, sphere of governance, technical aspects, conceptualization of biodiversity and some of the criteria adopted by Amaral and Jablonski (2005) and premises of the PNEA (BRASIL, 1999): (i) Social actor (institutional name); (ii) Representativeness (segment, sphere of governance); (iii) Project/Program or Specific Action.

Data collection took place from May 15th to August 15th, 2023. The data obtained - whether through a virtual search on the Google-Scholar platform or through technical field visits to apply action research - were systematized and treated using the Microsoft Office System 2007 package, in XML file formats, such as, docx, .xlsx and .pptx. The research carried out included critical and reflective analysis of the data presented.

Study Area

The Coastal Zone of Paraíba is approximately 140 km long, comprising 56 beaches, stretching from the Guajú River Estuary (to the north) to the Goiana River estuary (to the south), between the coordinates 6°31'08.00"S/ 34° 58'02.00"W and 7°34'43.13"S/ 34°49'54.81"W.

The coast of Paraíba is made up of 13 municipalities (Figure 3) that occupy an area of 2,640 km², with a population of around one million inhabitants (ARAÚJO; LAVOR; LIMA, 2017).

It has a hot and humid climate, with temperatures varying between 25ºC and 28ºC, with precipitation around 1500 mm and relative humidity of 80%. Rain is well distributed throughout the year thanks to the influence of the proximity of the sea and the action of the Atlantic Equatorial Air Mass, the Polar Front and the Southeast trade winds.

The Coastal Zone of Paraíba, from a geological point of view, is presented on tertiary and quaternary sedimentary terrains, located entirely in the Pernambuco-Paraíba Marginal Sedimentary Basin, the last portion of the South American Platform to separate from the African continent, during the opening of the Atlantic Ocean, with Ponta do Seixas (João Pessoa) recognized as the easternmost point in Brazil and America (FURRIER, 2007). In geomorphological terms, the coastal landscape is configured by the Low Coastal Plateau, Lowland Coastal and Marine Fluvial Plain compartments, which feature cliff formations, estuarine environments, sandbank vegetation, sandy beaches, coastal ridges, and reefs (ARAÚJO; LAVOR; LIMA, 2017).

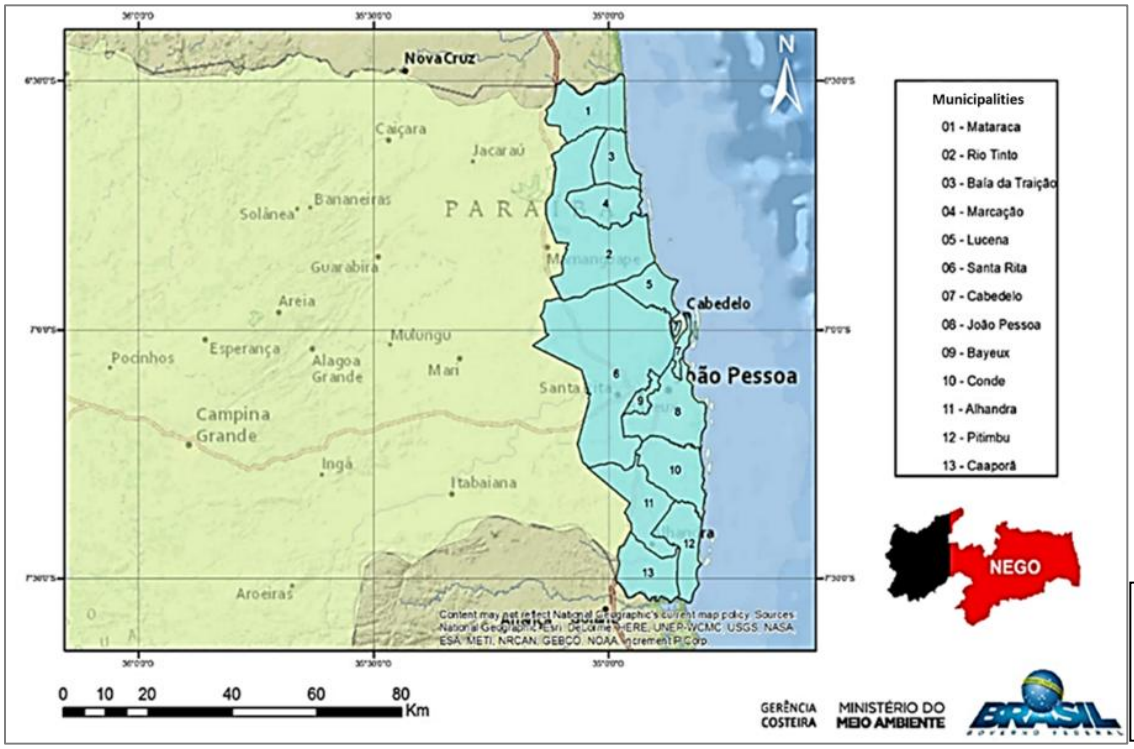

Figure 3. Coastal municipalities of Paraíba. Source: Adapted from the Coastal Management of the Ministry of the Environment (MMA, 2020).

The municipalities of Bayeux, Cabedelo, João Pessoa, Lucena, Marcação, Pitimbu, Rio Tinto, Alhandra, Baía Da Traição, Caaporã, Conde, Mataraca and Santa Rita are considered coastal because they face the sea or even if they do not directly face the sea. Sea, as they have an estuarine lagoon environment in their territories, being highly relevant coastal ecosystems (Decree nº 5.300/2004, GERCO/PB) (BRASIL, 2004). Due to its location - low latitude - the State's Coastal Zone is exposed to strong ultraviolet rays.

In these compartments, there are several species categorized on the Red List of the International Union for the Conservation of Nature and Natural Resources (IUCN) with some degree of threat (e.g.: marine manatees, sea turtles, corals, etc.).

In addition, it encompasses a great cultural heritage at the bottom of the sea, due to the several existing shipwrecks (SUDEMA, 2025).

For these reasons, over the years, 04 state Conservation Units (CU), 04 Federal Conservation Units and 01 Municipal marine and coastal Conservation Unit were established in Paraíba, essential for the preservation of species and ecosystems, encouraging sustainable use of environmental resources by society (ADAMS; PRESSEY; NAIDOO, 2010), according to the UC framework (Sustainable Use or Comprehensive Protection).

3 Results

As a historical context in this state, Paraíba society has a strong relationship with marine natural resources, whether due to easy access to coastal reefs or even the State's geomorphology, guaranteeing artisanal fishing as well as the use of this environment, rich in biodiversity, for leisure and recreation.

However, studies from the beginning of the last century already showed the degradation of Brazilian reefs, including in Paraíba, due to the extraction of corals for use in civil construction and even from old churches and forts. Instead of bricks, corals were used, as they were also widely used for the production of lime. Through Law No. 9,605/1998 (BRASIL, 1998), the capture and trade of marine invertebrates was prohibited. Another remarkable record that is part of the memory of the people of Paraíba, was the whale hunt, in the district of Costinha, municipality of Lucena, from 1904 to 1985, it is estimated that the Japanese slaughterhouse processed 19,800 whales, especially Mink and I know (MarSemFim, 2013). This hunting ended by Law 7.643/1987 (BRASIL, 1987).

Being "recent" examples, it is possible to observe the remains still in the history of Paraíba (Figure 4), which the oldest Paraíba residents remember, but which can be offered for reflections on the exploitation of natural resources as an inexhaustible source, verifying the need to educate, raise awareness and monitor so that we can effectively value history and preserve biodiversity.

In the survey carried out on the entities that work in the preservation and conservation of the marine and coastal environment of the State of Paraíba, 54 were identified, of which they are divided between the different spheres of government (federal, state and municipal), private companies and non-governmental organizations. - governmental (Figure 5).

Entities linked to marine and coastal causes

Among the 54 entities working with the coastal and marine cause, there are public-level organizations from different spheres of government: federal (12.9%), state (9.25%) and municipal (24%), private sector (20.3%), organized third sector (33%) and voluntary work, working directly and indirectly with initiatives in Paraíba.

As demonstrated above, the coastal and marine zone of the State of Paraíba, demonstrates a significant number of entities that have in their constitution the obligation to manage, others with the responsibility of academically debating the topic, and proposing, including scientific solutions. The action of volunteers seeking to contribute to the cause of preservation is seen through data production and interventionist practices of recovery, reproduction and monitoring.

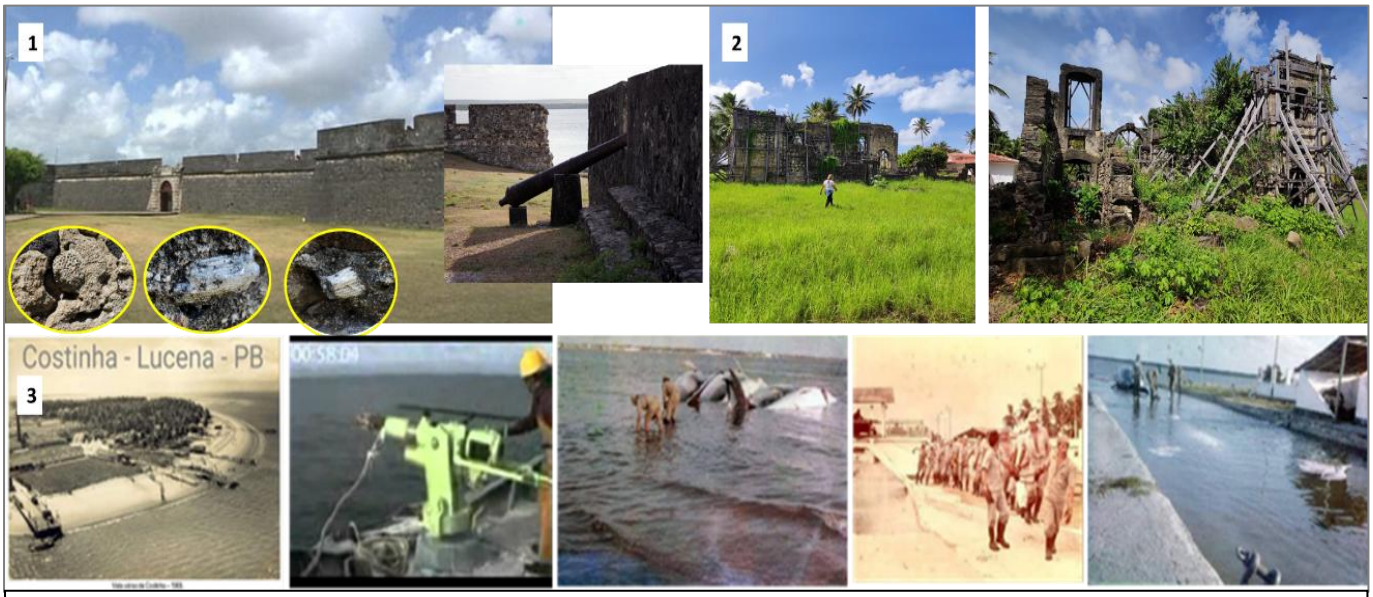

Figure 4. (1) Sequence of images of coral colonies observed on the walls of the Fortaleza de Santa Catarina and (2) in the Ruins of Almagre, both historical and cultural heritage sites, located in Cabedelo/PB. (3) Images of various management moments relating to whale hunting in Costinha, district of Lucena (Paraíba). Source: (1) and (2) Authors' collection. (3) https://www.facebook.com/photo/?fbid=107129621417308&set=pcb.107129844750619
https://www.youtube.com/watch?app=desktop&v=AZwKxaXZuaM

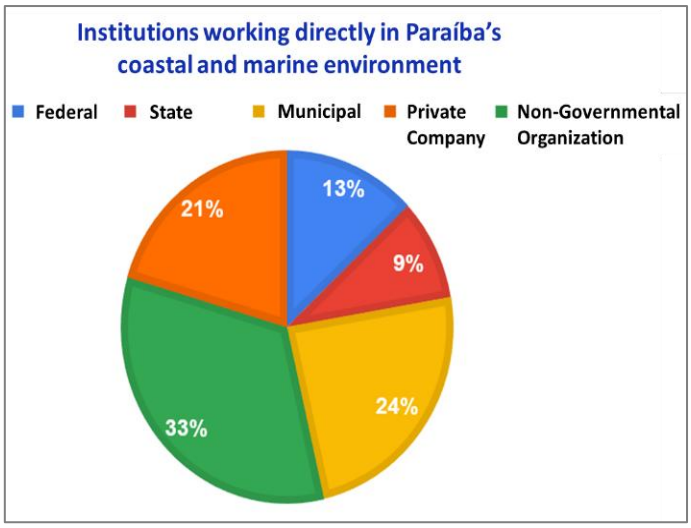

Figure 5. Entities operating in the coastal and marine environment in Paraíba. Source: Prepared by the authors, 2024.

Some companies sell marine and coastal nature, due to the need to make indirect use of the environment and find them with the minimum of negative impact. Noting that entities and actors are operating along the entire coast in this marine and coastal territorial strip of the State of Paraíba.

Government bodies play a fundamental role in promoting marine and coastal environmental education practices, accounting for around 50% of the workforce on the subject, and being present in all coastal municipalities. These public powers have the ability to implement policies, regulations and educational programs that aim to raise awareness among the population about the importance of preserving marine ecosystems.

This does not happen with Civil Society and Private Organizations, both more concentrated in the State capital and directly surrounding municipalities. By developing and supporting initiatives in this regard, the bodies contribute to increasing public awareness and encouraging more responsible attitudes concerning the natural resources of the Paraíba Ocean. Furthermore, marine environmental education practices promoted by agencies can help foster community engagement, encouraging people's active participation in protecting coastal and marine environments. This can result in significant benefits for the conservation of marine biodiversity – which may be in the context of Conservation Units – and for the sustainability of activities related to the environment and human life itself.

In summary, bodies that develop coastal and marine environmental education practices play a crucial role in forming a society that is more aware, informed and committed to the preservation of marine ecosystems.

Marine and Coastal Conservation Units

In the case of Conservation Units that permeate the coastal and marine zone, following what prioritizes the Law of the National System of Nature Conservation Units (SNUC), they aim to play an important role in protecting sensitive habitats. This being the case, coral reefs, sandbank vegetation, mangroves and estuaries, dedicated to these environments their own and direct management based on efficient supervision and licensing to promote the practice of what is stated in their official document of creation and use and occupation, called the Management Plan.

In Paraíba, the coastal and marine environment has 12 Conservation Units (Table 1), with 88,063.10 hectares in protected areas, between the governance spheres: federal, state and municipal, being Full Protection (allowing indirect use) and Sustainable Use (allowing direct use with guarantees of preservation of its natural attribute).

In terms of the degree of preservation, the 12 Conservation Units listed above (Table 1 and Figure 6) demonstrate that they have a greater amount of protected area in the Sustainable Use category, where housing or even use of the resource in its own right is permitted.

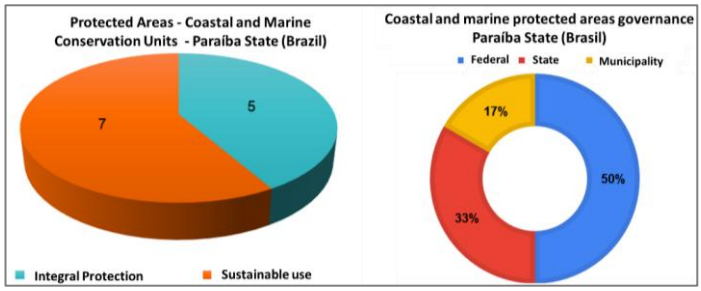

Figure 6. Categories and spheres of governance of UCs in the Coastal and Marine Zone of Paraíba. Source: Prepared by the authors, 2024.

These 12 existing Conservation Units demonstrate the interest and involvement of official bodies in promoting supervision, management and public sustainable use.

In this case, it appears that only 4 (four) of these Conservation Units have a Management Plan, with a physical headquarters on site, housing the manager and technical staff, and only 2 (two) Conservation Units (Flona de Cabedelo and RESEX Acau -Goiana has a headquarters. A third one stands out as having a headquarters, but which serves two UCs at the same time: APA da Barra do Rio Mamanguape and ARIE Manguezais da Foz do Rio Mamanguape. The State and Municipal Conservation Units, in this case, do not have their own headquarters and exclusive technical staff to manage them.

Table 1. Protected Areas - Coastal and Marine Conservation Units - Paraíba State (Brazil)Legend: US = Sustainable Use; PI = Full Protection; FD = Federal; ED = State; MN = Municipal; MA = Atlantic Forest; MR = Marine; *Note: Change in delimitation.

Categ.	Name	Area (ha)	Unit	Law	Cities	Biome
US	*Área de Relevante interesse Ecológico Manguezais da Foz do Rio Mamanguape*	5,721.07	FD	Decree Nº 91,890/ 1985	Marcação, Rio Tinto	MA
US	*Área de Proteção Ambiental Barra do Rio Mamanguape*	14,640.00	FD	Decree Nº S/N/ 1998	Baía da Traição, Lucena, Marcação, Rio Tinto	MA
PI	*Reserva Biológica Guaribas*	4,051.60	FD	Decree Nº 98,884/ 1990	Mamanguape, Rio Tinto	MA
US	*Floresta Nacional da Restinga de Cabedelo*	116.83	FD	Decree Nº S/N/ 2004	Cabedelo, João Pessoa	MA
US	*Área de Relevante Interesse Ecológico da Barra do Rio Camaratuba*	167.5	FD	Lei Nº 272/ 2008	Baía da Traição, Mataraca	MR
US	*Reserva Extrativista Acaú-Goiana*	6,676.63	FD	Decree Nº S/N/ 2007	Caaporã, Pitimbu, Goiana (PE)	MR
PI	*Parque Estadual Marinho de Areia Vermelha*	230.92	ED	Decree Nº 21,263/ 2000	Cabedelo	MR
PI	*Parque Estadual Trilhas*	514.8	ED	Decree Nº 35,325/ 2014	João Pessoa	MA
US	*Área de Proteção Ambiental Naufrágio Queimado*	42,269.00	ED	Decree Nº 38,931/ 2018	Cabedelo, João Pessoa	MR
US	*Área de Proteção Ambiental de Tambaba*	11,500.00	ED	Decree Nº 22,882/ 2002	Conde, Alhandra, Pitimbu	MA
PI	*Parque Ecológico Municipal da Barra do Rio Camaratuba*	210	MN	Decree Nº 26,296/ 2005	Mataraca	MA
PI	*Parque Municipal de Cabedelo*	50	MN	Law Nº 001/98	Cabedelo	MA

Source: Adapted from Brazil (2021).

Something important to highlight is that the management of one of these is shared with a non-governmental organization, in this case, the Aquatic Mammals Foundation.

The search for public policies is necessary and examples at the national level are the Orla Project, the Hydrographic Basin Committee, the Pedagogical Political Project of the Coastal and Marine Zone and more recently, at the state level, PREAMAR.

Waterfront Project

The so-called Waterfront Project is an Integrated Management Project for the seashore that appears to be a public initiative guided by the Ministry of the Environment – MMA and the Secretariat of Union Heritage – SPU. This action seeks to contribute, on a national scale, to the discipline of use and occupation of the national seafront. Being worked institutionally based on the planning and management of municipalities, articulated by State Environmental Bodies – OEMAs and Regional Heritage Management of the Union – GRPUs. The State of Paraíba has developed the Orla Project over the years following a call from the Superintendence of Environmental Administration – SUDEMA, responsible for implementing the National Coastal Management Program – PNGC. As the research was carried out on this date, a call was made to present the new program and coordinate the management group, by the Superintendency of the Union's Heritage in Paraíba – SPU/PB. Waterfront management is provided to municipalities.

River Basin Committee

The River Basin Committee has decision-making power and plays a fundamental role in the development of policies for water management in basins, especially in regions subject to critical events of water scarcity, floods or water quality that may put the multiple uses of water at risk. Water, as guaranteed by law.

PPPZCM

The Brazilian Coastal and Marine Zone Pedagogical Political Project (*Projeto Político Pedagógico para Zona Costeira e Marinha do Brasil* - PPPZCM) is an instrument for managing educational processes in the Brazilian Coastal and Marine Zone with a focus on the sustainable use and conservation of biodiversity. The PPPZCM was built in a participatory manner, between 2019 and 2021, by the TerraMar and GefMar Projects. The MonitoraEA PPPZCM Platform is the space for monitoring and evaluating PPPZCM projects and actions. The Platform connects with the National MonitoraEA System – developed for monitoring and evaluating Public Environmental Education Policies across the country. On this platform, several projects and actions are carried out in Paraíba.

Project "Mangue Vivo"

The Mangue Vivo Project is worth highlighting, an initiative by the technical team of the Restinga de Cabedelo National Forest (ICMBio servers) in partnership with professors/researchers from the Federal Institute of Paraíba (IFPB) with the contribution of the Federal University of Paraíba (UFPB).

It effectively began in 2017 and its territorial scope is the lower course of the Paraíba River, covering parts of the municipalities of Bayeux, Cabedelo, João Pessoa, Lucena and Santa Rita. The general objective was to understand the human populations that directly depend on the environmental quality of the estuary, the impacts on natural resources, points of environmental degradation and their land ownership reality to subsidize interventions such as the creation of conservation units. In this sense, throughout the course, it was possible to witness a public workshop organized by ICMBio, with the participation of the riverside community of the Paraíba River, aiming to propose the creation of a UC for Sustainable Use, possibly a RESEX, as a way of regulating occupation and the direct use of the area's natural resources, creating a mosaic system with Flona itself.

PREAMAR

In January 2023, the Partnership Agreement was signed between the Paraíba Development Company (*Companhia de Desenvolvimento da Paraíba* - CINEP) and the Federal Institute of Paraíba (*Instituto Federal da Paraíba* - IFPB), called Paraíba Strategic Marine Artificial Structures Program (*Programa Estratégico de Estruturas Artificiais Marítimas* - PREAMAR), which provides for the installation of artificial marine reefs and the ecological restoration of the State's corals. In order to organize fishing and tourism on the Paraíba coast, and assist in the regeneration and recovery of coral reefs, it was expanded in November 2023, following a request from the Federal Public Ministry, to address the issue of study and guidance on the effects of climate on coastal erosion throughout the State.

Other smaller programs and projects, but with comprehensive actions resulting in media and awareness-raising practices, are developed throughout the year, for example in January, the *Praia Limpa*-Clean Beach Project, promoted by SUDEMA over the years, but gaining a lot of evidence in the summer (www.sudema.pb.gov.br), in June, the Oceanic Week Paraíba (@semanaoceanica_pb), which aims to create a space for collaborative dialogue between municipalities, the private sector, organized civil society and academia. In September, River and Beach Cleaning Day – "Clean Up Day", promoted by *Instituto Limpa Brasil* (www.limpabrasil.org) and other entities, was replicated in different parts of the State. It's a global movement. It is worth highlighting the expansion of the SISFAUMAR platform (www.sisfaumar.com) which seeks to build a state database on fauna, flora and incidents in the coastal and marine zone of Paraíba.

The House of Science at the Federal University of Paraíba deserves to be highlighted, which is a pedagogical space for teaching, research and extension in science and the environment, which aims to encourage scientific literacy in formal and non-formal education.

The proposed activities aim to contribute to the integration of the different areas of Natural and Health Sciences, intending to involve the knowledge produced in research, teaching and extension, socializing it to education actors. In this way, the Paulo Young Invertebrate Collection (@cipyufpb), through the extension project Knowing the Marine Biodiversity of Paraíba (*Conhecendo a Biodiversidade Marinha da Paraíba*) offers the scheduling of educational visits for schools/educational institutions interested in taking their classes to see the collection.

4 Discussion

The occupation of the coastal region without planning, the cutting of riparian river forests, the degradation of mangroves carrying more and more sediment to the coast, suffocating coral formations, the collection of seaweed and the excessive fishing of crustaceans and fish without nature had replacement capacity, in addition to unordered and unsustainable tourism, and multiple forms of pollution, add to the list of threats to coastal and marine ecosystems. CIRM; GI-GERCO (2005) report that the expansion of resorts, large hotel developments, and areas designated for secondary residences threatens the preservation of coastal and marine ecosystems. Additionally, the unregulated occupation of coastal zones, particularly by the tourism sector, leads to an increase in the discharge of untreated wastewater, river sedimentation, and the accumulation of solid waste.

Due to the lack of environmental awareness, mitigating measures and effective management of protected marine areas created by government institutions, over the years, serious environmental imbalances have been triggered. Since committing to established agreements, Brazil has made progress in protecting its coastal and marine zones. In 2021, 27.8% of the country's marine and coastal area was under protection, distributed across 739 conservation units. Regarding the Marine Area, there are 190 conservation units covering 26.5% of this region, including 27.6% of the territorial sea and 26.4% of the Exclusive Economic Zone (BRASIL, 2023). In this sense, conservation and preservation programs must play an important role in educating and raising awareness among the population about the role of the ocean and coastal and marine ecosystems in our society.

Only through research, awareness campaigns, educational programs and dissemination activities, based on science and its methodologies, will it be possible to promote an awakening to environmental awareness and encourage both individual and collective actions to protect a clean healthy and resilient environment, productive, predictable, safe, transparent, inspiring and engaging, where a variety of habitats, such as coral reefs, mangroves and estuaries, are known and valued.

A study published by Costa et al. (2021) with elementary school students demonstrated that active and playful teaching methods are effective in promoting ocean literacy and environmental awareness. The authors highlight the need to integrate environmental education more systematically into the Brazilian school curriculum, possibly as a separate subject (COSTA et al., 2021).

Marine ecosystems are seen today as popular tourist destinations, attracting visitors from all over the world by generating curiosity, and leisure that is different from that commonly enjoyed on land, and it is necessary to promote sustainable tourism that encourages responsible practices with low environmental impact.

Oliveira; Silva; Vendel (2015) report that the experience of observing and exploring coral reefs, with their diverse forms of life, colours, and harmony, contributes to raising visitors' awareness. The main contribution of their study, conducted in reef environments, was to demonstrate that this experience enhances ecological awareness, promotes changes in environmental attitudes, and fosters a more critical perspective on the impacts caused by human actions, this is evident in perception responses, in which participants recognize their role in environmental degradation. This not only prevents destruction or deterioration caused by human activities but also provides diverse economic opportunities for local communities.

Oliveira; Silva; Vendel (2015) also suggest that environmental regulatory agencies effectively monitor the increasing number of visitors to reef environments so that, in the near future, it will be possible to implement visitation control measures to ensure the integrity of these areas. The initiatives mentioned above would help maintain the health of ecosystems, preserving ecological processes and interactions between species, providing essential data and information for adequate management, which includes monitoring the health of corals, observing threatened species and constant and continuous assessment of water quality. It is also necessary, and as a way to better understand nuances of marine life only seen and felt by traditional users, to involve local communities, including fishermen, coastal residents and indigenous people. By including these voices and their knowledge, it is possible to develop more effective and sustainable preservation strategies, through the active participation of these communities, which increases everyone's awareness, commitment, supervision and monitoring of the preservation of the marine and coastal environment. Promoting, with this, the solution of continuity in the knowledge of marine and coastal life.

In the case of Conservation Units (BRASIL, 2000) aimed at maintaining the health of marine ecosystems, they play a fundamental role in both protection and preservation, in addition to ensuring the connectivity of environments and their biodiversity.

Part of the marine ecosystems offer attractive environments for fishing and tourist visits, such as coral reefs, mangroves, seagrass meadows and estuaries, being particularly fragile and sensitive to human disturbances. As Conservation Units, these areas can be visited, however, with their management plan and direct management, they end up preventing degradation caused by human activities, such as predatory fishing, the exploitation of natural resources, disorderly tourism that exceeds the capacity of the environment and pollution in all its forms (BRASIL, 2001).

Scientific research on the ocean and its biogeographical basins must be encompassed by long-term studies, allowing direct and safe monitoring of species and ecosystems with data collection, and analysis of marine patterns and processes. They contribute, as a Conservation Unit with a management model defined by specific Law, to the advancement of scientific knowledge and provision of important information for the conservation and sustainable management of marine resources (PUREZA; PELLINI; PADUA, 2015).

In addition to ongoing management and supervision, it is the UCs' role to offer visitation opportunities, environmental interpretation, educational programs and community engagement activities, promoting people's connection with nature, and encouraging the adoption of sustainable practices.

5 Conclusions

Given the importance of the ecosystem and environmental services provided by marine nature to the planet and human society, as they provide oxygen, climate regulation, absorption of carbon dioxide and shelter for a great diversity of life, in addition to having many communities economically dependent on marine resources for subsistence and economy, and in this inventory and discussion concern, the need to take care of marine nature is highlighted as it is essential to guarantee a sustainable present and future for all.

It is important to discuss the threats that Marine Biodiversity faces today, as well as the place where they are used, focusing on climate issues, a fundamental point for the balance of life on Earth, and one of the least known or studied environments on the planet. It also suffers from plastic pollution, overfishing, damage to coral reefs, and acidification due to climate change.

The need to highlight the importance of reducing the use of plastic, promoting sustainable fishing choices, as well as supporting new creations of marine and coastal protected areas becomes evident. With awareness campaigns, volunteer programs, beach cleaning events and educational lectures, among others.

This may include practising sustainable diving, observing legislation and rules to protect marine life, properly disposing of waste and supporting marine and coastal conservation initiatives. Strategies that involve the application of Coastal and Marine Environmental Education and Oceanic Culture, with the promotion of citizen science for the conservation of marine biodiversity, have been strongly recommended in different segments of society.

In addition, it is inserted every day into the education system based on the assumptions of the 2030 Agenda by the United Nations, declared as the Decade of Ocean Science for Sustainable Development, as well as the Decade of Ecosystem Restoration (ONU, 2015).

Furthermore, it will be able to promote mobilisation in favour of the ocean, raising awareness and enabling citizens to become active defenders, so that they begin to demand effective actions from governments and business sectors to protect coastal ecosystems.

And, finally, it is believed that there is a very positive situation in favour of the Ocean, as in March 2023, finally, after years of discussion, the text of the Sea Treaty was approved (ONU, 2023). The document establishes a legal framework to extend environmental protection ranges to international waters.

This agreement will be open for signature by Member States for two years and will come into force after ratification by 60 countries, being a vital historical achievement to face threats and guarantee the sustainability of areas that go beyond those already assured by national jurisdiction, or that is, around two-thirds of the global ocean, or more than 70% of the Earth's surface, our Blue Planet.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Conceptualization, data collection and curation, visualization, writing – original draft: K.M. and R.S.F.; Study design and data collection analyses: D.S.B.O., M.C.P.F., T.E.C.; T.M.O.V.; A.S.V.; P.M.A.; Manuscript writing, M.A.F. and M.J.L.A.; Manuscript review and editing: J.P., P.A.O.; R.L.N.
All authors have read and agreed to the published version of the manuscript.

DECLARATION OF INTEREST

The authors disclose that they have no known competing financial interests or personal relationships that could have appeared to influence the study reported in this manuscript.

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