

## APPLICATION OF THE IAT AND ROVUC TOOLS FOR PUBLIC USE ANALYSIS IN MANGROVE ECOSYSTEMS: A CASE STUDY IN THE STATE OF RIO DE JANEIRO

### APLICAÇÃO DAS FERRAMENTAS IAT E ROVUC PARA ANÁLISE DO USO PÚBLICO EM MANGUEZAIS: ESTUDO DE CASO NO ESTADO DO RIO DE JANEIRO

### APLICACIÓN DE LAS HERRAMIENTAS IAT Y ROVUC PARA EL ANÁLISIS DEL USO PÚBLICO EN MANGLARES: ESTUDIO DE CASO EN EL ESTADO DE RÍO DE JANEIRO



<https://doi.org/10.56238/sevened2026.008-071>

Fernando Carrilho da Silva<sup>1</sup>, Julianne Alvim Milward-de-Azevedo<sup>2</sup>

#### ABSTRACT

The mangrove presents itself as an important coastal ecosystem that occurs in tropical and subtropical regions around the globe. In addition, it offers a range of ecosystem services essential for maintaining the quality of marine life and ensuring the subsistence of various traditional populations. In Brazil, 87% of this ecosystem is protected by Conservation Units (UCs). Visitation in these spaces represents an opportunity to strengthen social participation and the protection of the mangrove. However, it is necessary to plan and monitor public use activities to ensure the quality of visitation and environmental conservation. The present work aims to carry out a case study in the Guapi-Mirim Environmental Protection Area and in the Guanabara Ecological Station located in Guanabara Bay, in the state of Rio de Janeiro with the application of tools from the List of Visitation Opportunities (ROVUC) and the Tourist Attractiveness Index (IAT) to analyze the dynamics of public use. The research regarding the purposes was exploratory, descriptive and applied. And, as for the means of investigation, it was bibliographical, documentary, field and a case study. The results indicate the need to diversify activities. The importance of collaboration between public authorities and civil society to conserve the mangrove is emphasized.

**Keywords:** Protected Areas. Mangrove. Visitation. Rio de Janeiro. Brazil.

#### RESUMO

O manguezal se apresenta como um importante ecossistema costeiro que ocorre em regiões tropicais e subtropicais ao redor do globo. Além do mais, oferece uma gama de serviços ecossistêmicos essenciais para a manutenção da qualidade de vida marinha e garantia da subsistência de diversas populações tradicionais. No Brasil 87% desse ecossistema está protegido por Unidades de Conservação (UCs). A visitação nesses espaços representa uma oportunidade para fortalecer a participação social e a proteção do manguezal. No entanto, é

<sup>1</sup> Master's degree in Ecotourism and Conservation. Universidade Federal do Estado do Rio de Janeiro (UNIRIO). Universidade Federal Rural do Rio de Janeiro (UFRRJ). E-mail: carrilhofernando@outlook.com  
Orcid: <https://orcid.org/0009-0001-8910-787X> Lattes: <http://lattes.cnpq.br/8634565931530493>

<sup>2</sup> Dr. in Economics. Universidade Federal do Rio de Janeiro (UFRJ). Universidade Federal Rural do Rio de Janeiro (UFRRJ). E-mail: profa.juliannemilward@gmail.com Orcid: <https://orcid.org/0000-0001-9066-0843>  
Lattes: <http://lattes.cnpq.br/5447208174163206>

necessário que se planeje e monitore as atividades de uso público para garantir a qualidade da visitação e a conservação ambiental. O presente trabalho tem por objetivo realizar um estudo de caso na Área de Proteção Ambiental de Guapi-Mirim e na Estação Ecológica da Guanabara situadas na Baía de Guanabara, no estado do Rio de Janeiro com a aplicação de ferramentas do Rol de Oportunidades de Visitação (ROVUC) e o Índice de Atratividade Turística (IAT) para análise da dinâmica do uso público. A pesquisa quanto aos fins foi exploratória, descritiva e aplicada. E, quanto aos meios de investigação foi bibliográfico, documental, de campo e um estudo de caso. Os resultados indicam a necessidade de diversificar das atividades. Ressalta-se a importância da colaboração entre poder público e sociedade civil para conservar o manguezal.

**Palavras-chave:** Áreas Protegidas. Mangue. Visitação. Rio de Janeiro. Brasil.

## RESUMEN

El manglar es un importante ecosistema costero que se encuentra en regiones tropicales y subtropicales de todo el mundo. Además, ofrece una serie de servicios ecosistémicos esenciales para mantener la calidad de vida marina y garantizar la subsistencia de diversas poblaciones tradicionales. En Brasil, el 87 % de este ecosistema está protegido por Unidades de Conservación (UC). La visita a estos espacios representa una oportunidad para fortalecer la participación social y la protección del manglar. Sin embargo, es necesario planificar y supervisar las actividades de uso público para garantizar la calidad de la visita y la conservación del medio ambiente. El presente trabajo tiene como objetivo realizar un estudio de caso en el Área de Protección Ambiental de Guapi-Mirim y en la Estación Ecológica de Guanabara, situadas en la Bahía de Guanabara, en el estado de Río de Janeiro, con la aplicación de herramientas de la Lista de Oportunidades de Visita (ROVUC) y el Índice de Atractivo Turístico (IAT) para analizar la dinámica del uso público. La investigación fue exploratoria, descriptiva y aplicada. En cuanto a los medios de investigación, se utilizaron fuentes bibliográficas, documentales, de campo y un estudio de caso. Los resultados indican la necesidad de diversificar las actividades. Cabe destacar la importancia de la colaboración entre el poder público y la sociedad civil para conservar los manglares.

**Palabras clave:** Áreas Protegidas. Manglares. Visitación. Río de Janeiro. Brazil.

## 1 INTRODUCTION

The capitalist model and the speed of industrial urban production intensify the pressure on natural resources, which are essential for maintaining ecological balance and maintaining populations (Cortez; Ortigoza, 2009). This complex relationship between production models and environmental problems puts environmental conservation and, above all, the protection of ecosystems at risk (Santos *et al.*, 2024). It is in this sense that the creation of Protected Areas (PAs) as strategies for environmental conservation is observed (Diegues, 2000; Melgo, 2022).

These spaces are central elements for the protection of the environment, safeguarding biodiversity, endangered species, natural resources and their respective biomes (Medeiros, 2006). Conservation Units (CUs), in turn, are PAs in the public domain, with relevant natural characteristics, with defined objectives and limits, legally established by the Government in Brazil (BRASIL, 2000). The design of these spaces brings several benefits to the environment and population, such as maintaining quality of life and ecosystem services (MMA, 2022).

Guanabara Bay (BG), an important coastal ecosystem, located in the state of Rio de Janeiro, is of notorious importance for the growth and development of the city. However, urban and industrial development has negatively impacted their ecosystems, including the mangrove swamp (Dubeux, 1999; Soares *et al.*, 2003, ICMBio, 2018). Despite these challenges, BG remains an important source of funds, producing around 500 tons of fish per month. In the Guapi-Mirim Environmental Protection Area (APA),<sup>3</sup> about two million Uçá crabs are collected annually, reinforcing the urgency of conserving these habitats (Alencar, 2024).

It is in this context that the work is presented. The main objective is to analyze the dynamics of public use, through the application of the tools of the List of Visitation Opportunities (ROVUC) and the Tourist Attractiveness Index (IAT) to analyze the public use of the Guapi-Mirim APA and the Guanabara Ecological Station located in BG, in the state of Rio de Janeiro.

## 2 THEORETICAL APPROACH

### 2.1 IMPORTANCE OF MANGROVES

Mangroves are coastal ecosystems, at the interface between land and sea, occurring in tropical and subtropical regions of the world, between latitudes 30°N and 30°S (FAO, 2023; Giri *et al.*, 2011). Marked by the intertidal regime and with an unconsolidated substrate (Leal;

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<sup>3</sup> The name of the Guapi-Mirim APA was given in honor of the Guapimirim River, a name with Tupi-Guapi origin: source or headwater of a river and Mirim: small thing (ICMBio, 2001).

Spalding, 2024). These regions contribute to carbon sequestration and protection against extreme weather events (Leal; Spalding, 2024; Alongi, 2014).

The term mangrove refers to the plant species that make up these spaces, which have adapted over thousands of years to survive in environments of high salinity, low oxygen between roots and flooded, at times, by the tide (Soares *et al.*, 2003; ICMBio, 2018; Mandal; Bar, 2018).

These adaptations are related to mechanisms such as aerial roots (Rhizophores<sup>4</sup>), which assist in respiration and anchorage in the waterlogged substrate, the ability to deal with salinity by eliminating it through roots and leaves, dispersal through propagules - viviparous seeds<sup>5</sup> - and nutrient retention mechanisms (FAO, 2023).

Mangroves are vital ecosystems for protecting the environment, tackling the climate crisis, and promoting environmental justice. This is because these spaces offer essential ecosystem services. These services can be: Provision (food production, genetic resources, wood production); Regulation (climate and microclimate regulation, coastal protection, carbon sequestration, ecological niche formation), Support (nutrient cycling, soil formation, biomass export) and Culture (ecotourism, medicine and religion) (ICMBio, 2018).

Mangroves support 800 trillion juvenile fish, shrimp, bivalves, and adult crabs per year around the globe. This exposes the economic importance and guarantee of food security for various populations (Leal; Spalding, 2024).

According to the Global Mangrove Alliance<sup>6</sup>, the extent of these ecosystems in the world was estimated at 141,957 km<sup>2</sup>, 135, 882 km<sup>2</sup> in 2016 and 147,256 km<sup>2</sup> in 2024. (Leal; Spalding, 2024). This extension corresponds to 1% of the world's tropical forests (FAO, 2023). They occur in at least 128 countries and territories (Table 1), with a predominance in Southeast Asia (50,000 km<sup>2</sup>), followed by West and Central Africa (22,000 km<sup>2</sup>) (Leal; Spalding, 2024).

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<sup>4</sup> A type of stem that grows toward the ground, with positive geotropism. It forms adventitious roots and allows the aerial respiration of typical mangrove vegetables (ICMBio, 2018).

<sup>5</sup> They are characterized by the germination of the embryo next to the mother plant, forming a propagule ready for dispersal (FAO, 2023).

<sup>6</sup> The Global Mangrove Alliance is an organization focused on protecting the ecosystem, gathering tax incentives, formulating and coordinating partnerships with institutions from various sectors. It is currently coordinated by members *Conservation International, The International Union for the Conservation of Nature, The Nature Conservancy, Wetlands International, World Wildlife Fund, SaciWATERS and Audubon Americas.*

**Table 1***Extension of mangroves in the world*

Region	Sum of areas (km <sup>2</sup> )	Overall percentage (%)
Southeast Asia	49.500	33.6
West and Central Africa	22.802	15.5
North, Central America and the Caribbean	21.270	14.4
South America	19.469	13.2
Australia and New Zealand	10.348	7.0
South Asia	9.749	6.6
East and South Africa	7.749	5.3
Pacific Islands	5.790	3.9
Middle East	358	0.2
East Asia	221	0.2
Total	147.256	100

Source: Leal; Spalding, 2024.

In Brazil, mangroves occur from Amapá - Oiapoque, 4°26'N - to Santa Catarina - Laguna, 28°30'S (Coelho *et al.*, 2025) and has an approximate extension of 14,000 km<sup>2</sup>, with the highest concentrations in the states of Maranhão (36%), Pará (28%) and Amapá (16%), totaling 80% of the mangroves in the national territory and the largest continuous strip of the ecosystem under legal protection in the world. In addition, 120 national PAs have mangroves inside, ensuring greater protection for about 87% of the ecosystem in Brazil (ICMBio, 2018).

However, since the beginning of the twentieth century, about 25% of Brazilian mangroves have been destroyed (ICMBio, 2018). Threats such as urban expansion on the coast, agriculture, aquaculture, fishing industry, logging, and climate change put the protection of these ecosystems and their ecological and geomorphological function at risk (Bunting *et al.*, 2018).

In the national territory, the experience in the mangrove represents part of the survival, culture and medicine of indigenous peoples, artisanal fishermen, shellfish gatherers, caiçaras and quilombolas. Therefore, protecting mangroves constitutes an advance in the resistance struggle for environmental, social, and climate justice (Sofiatti, 2023; Moraes, 2022). To this end, legal instruments such as the Federal Constitution of 1988 – which defines the coastal zone as national heritage in its article 225 –, the Forest Code of 2012 (Law No. 12,651/2012), which classifies mangroves as Permanent Preservation Areas (APP) –, and the National System of Conservation Units (SNUC) (Law No. 9,985/2000), which has as one of its objectives to contribute to the conservation of natural ecosystems –, constitute some of the main legal frameworks for environmental protection in the country (Brasil, 1988; Brazil, 2012).

The PAs are strategic spaces in the defense of Brazilian mangroves (Coelho *et al.*, 2025). The most recurrent categories are related to Sustainable Use Units, which allow the indirect use of natural resources, such as the Extractive Reserve (RESEX) and the Environmental Protection Area (APA). This characteristic is relevant given the importance of these spaces for the social, cultural, and economic development of traditional populations in one of the richest environments on the globe (ICMBio, 2018).

However, there are challenges regarding the management and application of protection laws in these spaces (Coelho *et al.*, 2025; ICMBio, 2018). These challenges are related to the lack of tax incentives, inspection, monitoring, and land conflicts (ICMBio, 2018). The conservation of mangroves, however, is decisive for facing the climate crisis and protecting populations in a state of vulnerability (Brasil, 2025).

In this context, initiatives such as the National Program for the Conservation and Sustainable Use of Mangroves in Brazil (ProManguezal) and Brazil's accession to the *Global Mangrove Breakthrough* add efforts in the conservation and restoration of this important coastal ecosystem by 2030 (Brasil, 2025).

Effective environmental management of PAs that have mangroves in their interior, associated with the participation of traditional peoples and communities, tend to reduce the loss of mangrove cover and help ecological and social resilience. However, the effectiveness of the management of protected spaces is not directly linked to the simple fact of their creation, but to ensure active management, the continuity of monitoring and inspection actions, and the existence of stable funding (ICMBio, 2018).

It is in this sense that protecting these spaces goes beyond the recognition of their economic and environmental importance, but also an ethical commitment to the climate and the ways of life historically built in these territories (Lopes *et al.*, 2025; Corrêa *et al.*, 2024; Mariano *et al.*, 2025).

## 2.2 IMPORTANCE OF PUBLIC USE FOR THE CONSERVATION OF PROTECTED AREAS

Public use activities in PAs generate individual, economic, environmental and social benefits, by reconciling conservation with visitation (Vallejo, 2013). Public use becomes an ally in the preservation of biodiversity and ecosystem services (Crema; Faria, 2020). Among the factors that influence the visitor's choice are contact with nature, interest in meeting traditional peoples, the search for adventures and extreme sports, and the preference for quiet and welcoming environments for families, especially children (Omena, 2022).

Visitation in PAs is an essential tool for the conservation of these spaces. When well planned, activities for public use stimulate visitors' awareness of the importance of territorial

protection and biodiversity (Vallejo, 2013; Pedrini, 2019; Crema; Faria, 2020). From a tourism perspective, ecotourism emerges as a sustainable practice that has been gaining strength in Brazil and in the world, becoming a fundamental ally in the preservation of PAs (MMA, 2010; Brod; Milward-de-Azevedo, 2022 *apud* Carrilho-da-Silva; Milward-de-Azevedo, 2023).

### 2.3 TOOLS FOR PUBLIC USE PLANNING

The organization of visitation in PAs, combined with monitoring, inspection and management, seeks to maximize positive environmental impacts and inhibit illicit activities. Proper planning is essential for visitors to have a satisfying experience that aligns with conservation objectives. In this context, tools such as the Tourist Attractiveness Index (IAT) and the List of Visitation Opportunities in Conservation Units (ROVUC) play a crucial role. They assist in the creation and review of the management plans of the PAs, providing a better understanding of the tourist context and promoting sustainable visitation (Crema; Faria, 2020).

#### 2.2.1 List of Visitation Opportunities in Conservation Units (ROVUC)

The List of Visitation Opportunities in Conservation Units (ROVUC), approved by Ordinance No. 1,148/2018 of the Federal Government (ICMBio), guides the planning of visitation in PAs. It defines five classes of opportunities based on biophysical, sociocultural and management attributes, covering both the internal environment of the UC and external areas and surrounding attractions (Crema; Faria, 2020).

ROVUC contributes to the planning of public use, evaluation of investments, definition of zoning and identification of impacts on biodiversity. In addition, its implementation requires the participation of social actors, including residents, tourists, and scientists, which enriches its applicability. This tool broadens the understanding of tourism opportunities in PAs, favoring conservation strategies and improving visitation planning (Crema; Faria, 2020).

#### 2.2.2 Tourist Attractiveness Index (IAT)

The Tourist Attractiveness Index (TAI) has become essential for the analysis of the internal and external environment of PAs, evaluating biophysical, social, and management attributes and correlating them with factors such as scenic attractiveness, infrastructure, and population density.

The application of the tool represents an effective management strategy, capable of understanding the dynamics of visitation, directing investments, and contributing to the sustainability of visitation and environmental conservation (Souza, 2016). The main objective of the tool is to establish parameters to monitor and plan visitation opportunities (Souza *et*

*al.*, 2017).

The IAT groups the PAs according to their tourist vocation through three stages: (1) analysis of the internal physical attributes – considering infrastructure, scenic attractiveness and volume of visits; (2) analysis of external physical attributes – evaluating regional attractions, public access and socioeconomic context through data from IBGE, *TripAdvisor* and *Google Maps*; (3) classification of tourist attractiveness classes – segmenting the PAs into five categories primitive, semi-primitive, extensive, intensive and highly intensive, according to their degree of accessibility and development.

### 3 MATERIAL AND METHODS

#### 3.1 TYPOLOGY OF THE STUDY

The elaboration of this research carried out from March 2023 to April 2025, was characterized, as to the purposes, as exploratory, descriptive and applied. The first characterizations are related to the small number of studies that apply the tools for public use and also to their investigative and descriptive character of the visitation given in the PAs, as well as aspects related to visitors. And, finally, it was applied, as it sought to generate subsidies for the resolution of real problems of visitation (Vergara, 2000).

Regarding the identification of the means of investigation, it was bibliographical, documentary, field and a case study. Bibliographic, therefore, it gathered data from scientific platforms (*Scholar*, *Google*, *Scielo* and *Researchgate*) and documentary, given the use of institutional files of the Federal Government made available at electronic addresses (IBAMA, ICMBio, MMA, among others). The field research is characterized by the use of direct observation – written from the experiences in the proposed place – and a case study, given that the research was carried out in the empirical space in which it was proposed to study (Vergara, 2000).

#### 3.2 IAT AND ROVUC TOOLS

For the application of the IAT and ROVUC tools, direct observation and dialogue with local social actors, including the manager and civil servants, were employed. These professionals, when experiencing the activities of public use in the UC, play an essential role in the preservation of these spaces.

The IAT tool evaluated the internal and external parameters of the UC. In the internal environment, it considered biophysical (natural/cultural variety and scenic attractiveness), social (diversity of activities and number of meetings) and management (infrastructure and services) attributes (Souza *et al.*, 2017).

In the external environment, it analyzed biophysical (regional attractions and public access), social (socioeconomic context and population density) and management (hospitality establishment) attributes (Souza *et al.*, 2017).

Each indicator received a score from 1 to 5, and the average was calculated by the sum of the scores divided by the number of indicators. The values of the three groups of attributes (biophysical, social and management) were summed and divided by three, resulting in the overall score of the two environments. The final score was obtained by adding the general internal and external values and dividing them by two. This result allows us to classify the tourist attractiveness of the CU at the following levels: primitive (high degree of naturalness), semi-primitive (high degree of naturalness), extensive (sustainable use of resources), intensive (variety of activities) and highly intensive (Brazilian icon PAs) (Souza *et al.*, 2017).

The application of the ROVUC tool followed the steps described by Crema and Faria (2020) in the UC. First, the general characterization was performed (stage 1). Then, the attractions and visitation areas were detailed, the management zones were identified and the characteristics of the visitors were analyzed (stage 2). Finally, the visitation areas were defined and the spatialization of the experience classes was elaborated on the map of the PAs (stages 3 and 4).

### 3.3 CHARACTERIZATION OF THE STUDY AREA

#### 3.3.1 Geographical Location

The Guapi-Mirim APA (Figure 1), created by Decree No. 90,225, of September 25, 1984, as a result of an environmental movement against the destruction of Brazilian mangroves, is located in the Recôncavo da Baía de Guanabara, in the state of Rio de Janeiro. An area also known as 'Fundo de Baía', with geographic coordinates between 22° 39'30" and 22° 46'50" south latitude and 42° 57'00" and 43° 06'40" west longitude, is part of the Guanabara Bay Hydrographic Region, located at the mouth of the Iriri, Roncador, Guapimirim and Imboáçu rivers (ICMBio, 2001).

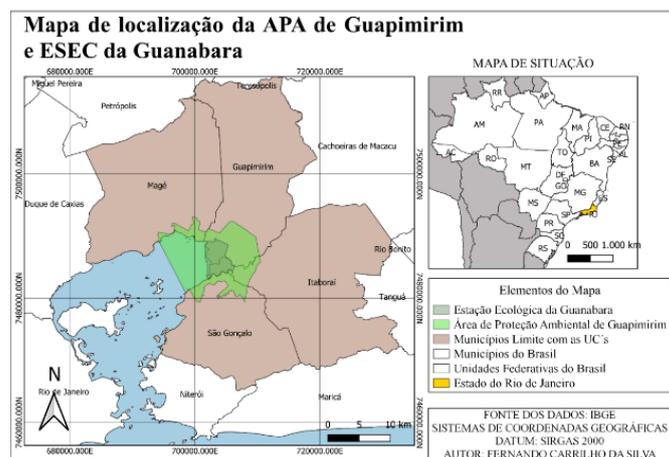
The territorial extension of the Guapi-Mirim APA is 138.25 km<sup>2</sup> - mangroves (44.7%), land (19.6%) and water section (35.7%). It is part of the municipalities of Guapimirim, Magé, Itaboraí and São Gonçalo, in the Metropolitan Region of Rio de Janeiro (ICMBio, 2001).

The ESEC of Guanabara, created by Decree s/n of February 15, 2006, is the core area of the Guapi-Mirim APA, with geographic coordinates between latitude 22°41'16.70"S and 22°44'44.412"S and longitude 43°1'23.022"W and 43°1'51.672"W. It has a territorial extension of 19.35 km<sup>2</sup>, and a perimeter of 21.5 km. This important UC, located in the Atlantic

Forest Biome, aims to preserve the last continuous stretches of medium-sized mangroves in Guanabara Bay. It covers the municipalities of Guapimirim (58%) and Itaboraí (42%), both located in the city of Rio de Janeiro, RJ (ICMBio, 2012).

## Figure 1

### *Location of the Guapi-Mirim Environmental Protection Area/RJ*



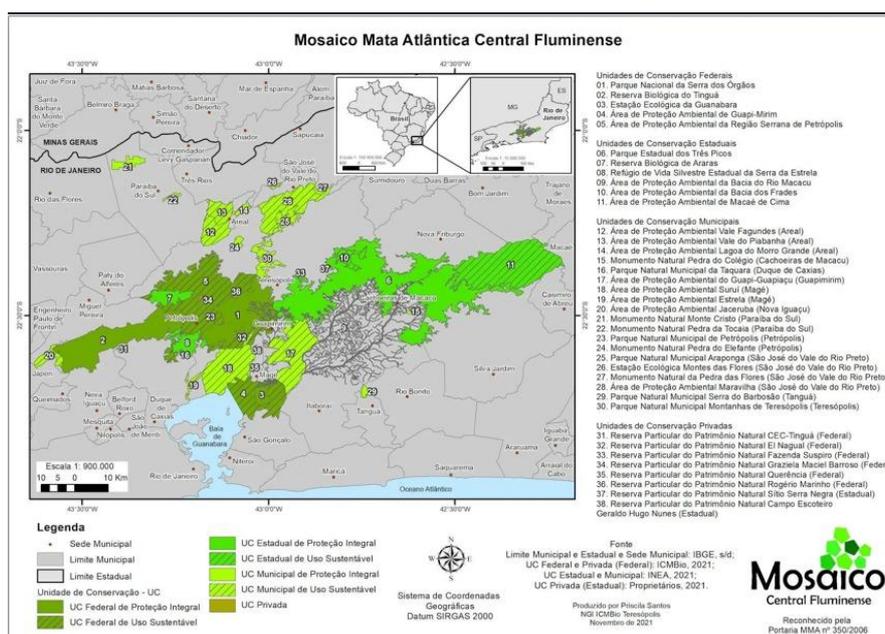
Source: Prepared by the authors, 2025.

The Guapi-Mirim APA is the first UC in Brazil dedicated to the protection of mangroves. Its implementation is deeply linked to stories of struggle and popular mobilization. The UC promotes the conservation and restoration of mangroves in the BG Recôncavo, the protection of biodiversity (microorganisms, mollusks, crustaceans, mammals, fish, among others), and ensures the subsistence of local populations – artisanal fishermen and crab collectors – by applying adequate environmental management for the maintenance of various activities in stretches of the estuary (ICMBio, 2001).

Finally, the Central Fluminense Mosaic (Figure 2), created in 2006, covers, among 29 other PAs, the APA of Guapi-Mirim and the ESEC of Guanabara. The main objective of the Mosaic is the integrated management of these units, located in the Atlantic Forest Biome. In addition, the initiative promotes the conservation of biodiversity, connectivity between forest fragments forming important ecological corridors and social participation in environmental protection (FUNBIO, n.d.).

**Figure 2**

*Map of the Central Fluminense Mosaic*



Source: FUNBIO, s.d.

## 4 RESULTS AND DISCUSSION

### 4.1 PUBLIC USE OF THE GUAPI-MIRIM APA / RJ

It was found that the Guapi-Mirim APA enables the conservation and sustainable use of natural resources. The application of the ROVUC tool in the UC occurred in four stages.

In the first stage, given by the general characterization of public use, it is clear that the UC encompasses rivers and mangroves in Guanabara Bay, recognized for their biodiversity and tourist potential. Located between Guapimirim, Magé, Itaboraí and São Gonçalo, it has tourist infrastructure and access via the BR-493 Highway. In the socio-cultural aspect, artisanal fishing and Community-Based Tourism, aimed at small guided groups, stand out. In management, there is a consolidated plan, vessel control and visitor support infrastructure.

In the second stage, given by the detailing of the attractions and considerations about visitors, it is noted that the spaces of the UC include a visitor center, auditorium and cafeteria, where safety measures and information about biodiversity are addressed. Visitation to the mangrove takes place through boat tours, with environmental education and interpretation activities. Access is monitored by the cooperative's boatmen and ICMBio employees, prioritizing ecotourists, families, schools and researchers.

In the third and fourth stages, given by the classification of the visitation areas, two visitation areas were identified: (1) the terrestrial portion, which represents 50% of the opportunities, was categorized as semi-natural, due to the degree of intervention; (2) marine zones, including mangrove rivers and biodiversity observation, categorized as natural,

because they have high preservation, but with some interaction with residents and minimal environmental impacts.

#### 4.2 TOURIST ATTRACTIVENESS INDEX OF THE APA OF GUAPI-MIRIM/ RJ

The application of the IAT tool resulted in the elaboration of two tables, with attention to the spatialization of classes both in the internal and external environment of the UC.

Table 2 shows the spatialization of the classes of the internal environment of the CU, in which the biophysical, social and management attributes are glimpsed. In addition to the exposure of the source, there is the exposure of the calculation of these attributes.

**Table 2**

*Spatialization of the classes of the internal environment of the APA of Guapi-Mirim/RJ*

Indoor Environment				
Biophysical Attributes		Notes	Average	Source
Natural/cultural variety	Forest, mangrove, biodiversity, Guanabara Bay	3,5	3,6	Field research
Scenic attractiveness	Google Scholar results: 1,560. Most sought-after attractiveness: 3 thousand.	3,8		Google Search and Google Scholar
Social Attributes		Notes	Average	Source
Diversity of activities	Fishing, contemplation, boating, research, education	3,8	3,4	Field research
Number of encounters	UC area in km <sup>2</sup> / number of visitors in 2023: $138.25/ 549 = 0.251$	3,0		ICMBio (2001)
Management Attributes		Notes	Average	Source
Infrastructure	Parking, visitor center, boats, accommodation	3,5	2,7	Field research
Services	Technical visit, sightseeing tour	2,0		Field research

Source: Prepared by the authors, 2025.

The scores were assigned based on the field visitation and the methodology described by Souza *et al.*, (2017). The overall score of the indoor environment was calculated by adding the mean of the attribute scores and dividing by three, resulting in 3.3. This value was used in the next stages of the analysis to compose the final score.

Table 3 shows the spatialization of the classes of the external environment, in the same way as the internal environment of the CU, with the exposure of biophysical, social and management attributes. In addition to the exposure of the source, there is the exposure of the calculation of these attributes.

**Table 3**

*Spatialization of the classes of the external environment of the APA of Guapi-Mirim/RJ*

External Environment				
Biophysical Attributes		Notes	Average	Source
Regional attractions	Tourist attraction in the region:15	3,5	3,6	TripAdvisor
Public access	Travel time from the nearest airport: 1 hour.	3,8		Google Maps
Social Attributes		Notes	Average	Source
Socioeconomic context	Average of the Human Development Index (HDI) of the municipalities belonging to the PAs studied	2,5	2,5	IBGE
Population density	Average number of people living in the municipalities belonging to the PAs	2,5		IBGE
Management Attributes		Notes	Average	Source
Hospitality Establishment	accommodation and food establishments in the municipality: 126	3	3	TripAdvisor

Source: Prepared by the authors, 2025.

From the calculation of the sum between the final averages of each attribute divided by three, the final score of attractiveness in the external environment was composed: 3.0. The final tourist attractiveness of the Guapi-Mirim APA was: 3.1. And, according to Souza *et al.*(2017), was classified as a CU with an attractiveness class considered extensive.

#### 4.3 PUBLIC USE OF THE ESEC OF GUANABARA

It was found that the Guapi-Mirim APA enables the conservation and sustainable use of natural resources. The application of the ROVUC tool in the UC occurred in four stages.

In the first stage, referring to the general characterization of public use, it is observed that the UC is composed of a set of rivers and mangrove forests in a high state of conservation in BG, recognized for their potential for environmental education and interpretation activities. The protected area covers the municipalities of Guapimirim and Itaboraí, and its biological diversity is the main attraction for visitors, although disembarkation is not allowed. Its access is via the BR-493 highway with entrance to the headquarters of the APA Guapi-Mirim.

In the sociocultural aspect, the UC has historical and cultural heritage – fishing corrals – and medium-sized continuous mangrove forest fragments, considered the best preserved in the BG. In addition, there are scientific research activities and visitation with a focus on environmental education. In management, there is infrastructure to support visitors – visitor center, guardhouses, parking, among others. Technical visits are provided by appointment, guided by AP employees.

In the second stage, the visitor support features are similar to the previous CU. This is because the ESEC of Guanabara is inserted in the space of the APA Guapi-Mirim. The beginning of the visitation is given by safety guidelines, and environmental education activities in the available infrastructures. The Mangrove space – a new structure to support visitation – works as a foundation in the exhibition of photos and materials. Visitation takes place from boats, with small groups of scientists, students and ecotourists.

In the third and fourth stages, referring to the classification of the visitation areas, a single area was identified: the portion of mangrove in the best state of conservation in the BG, classified as natural due to the medium degree of intervention, the low human presence and the predominance of biodiversity observation.

#### 4.4 GUANABARA ESEC TOURIST ATTRACTIVENESS INDEX

The application of the tool in the development of the *et al.*, (2017) at UC, resulted in the elaboration of two tables, with special attention to the spatialization of the experience classes in the internal and external environments.

Next, there is the application of the tool to the internal environment (Table 4).

**Table 4**

*Spatialization of the classes of the internal environment of the ESEC of Guanabara/RJ*

Indoor Environment				
Biophysical Attributes		Notes	Average	Source
Natural/cultural variety	Forest, mangrove, mangrove restoration spaces, biodiversity, Guanabara Bay	2	2,5	Field research
Scenic attractiveness	Google Scholar results: 17K. Most popular attraction: boat trip, 3 thousand.	3		Google Search and Google Scholar
Social Attributes		Notes	Average	Source
Diversity of activities	contemplation, boating, research, education	2	1.75	Field research
Number of encounters	UC area in km <sup>2</sup> / number of visitors in 2023: 20 km <sup>2</sup> /549 = 0.036	1.5		ICMBio (2001)
Management Attributes		Notes	Average	Source
Infrastructure	Boats for visitation and research	1.5	1.75	Field research
Services	Technical visit, sightseeing tour	2		Field research

Source: Authors' collection, 2025.

From the sum of the mean score, an internal score of 2 was obtained. This value is maintained for the calculation of the final attractiveness, which will be determined based on the evaluation of the external environment (Table 5), presented below.

**Table 5**

*Spatialization of the experience classes of the external environment of the ESEC of Guanabara/RJ*

External Environment				
Biophysical Attributes		Notes	Average	Source
Regional attractions	Tourist attraction in the region:15	3.5	3.6	TripAdvisor
Public access	Travel time from the nearest airport: 1 hour.	3.8		Google Maps
Social Attributes		Notes	Average	Source
Socioeconomic context	Average of the Human Development Index (HDI) of the municipalities belonging to the PAs studied	2.5	2.5	IBGE
Population density	Average number of people living in the municipalities belonging to the PAs	2.5		IBGE
Management Attributes		Notes	Average	Source
Hospitality Establishment	accommodation and food establishments in the municipality: 126	3	3	TripAdvisor

Source: Authors' collection, 2025.

The score of the external environment was equal to 3.0. From the sum of the internal (2.0) and external (3.0) indexes divided by 2 (environments) it was possible to reach the final index equal to 2.5. It is observed that the UC has the same classification as the APA Guapi-Mirim: Extensive. The CUs are similar in many characteristics of the internal and external environment, although they have different conservation categories. At the ESEC of Guanabara, some activities are restricted, such as the indirect use of natural resources, prohibition of fishing, disembarkation and visitation without permission. Characteristics provided for in the SNUC (ICMBio, 2001).

## 5 CONCLUSION

The present study highlights the importance of mangroves as essential ecosystems for biodiversity and the subsistence of traditional populations. The Guapi-Mirim APA and the

Guanabara ESEC, in Guanabara Bay, were analyzed using the ROVUC and IAT tools, allowing us to understand the dynamics of the public use of protected spaces.

Planning visitation becomes essential to reconcile the positive experience of the visitor with environmental conservation. In this context, the application of ROVUC and IAT in the PAs contributes to the understanding of the dynamics of visitation and to the definition of investment and management parameters.

The application of ROVUC in the PAs highlighted the need for diversification of tourism activities. Although the visitation experience is considered satisfactory, it takes place almost exclusively on boats, which limits public use. The recent creation of the Mangrove Space is a relevant strategy for this diversification, by providing activities prior to the boat trip and expanding the possibilities of environmental interpretation.

It is concluded that it is essential that the Federal Government, in partnership with ICMBio, the Management Council of the UCs and other sectors involved, invest in structures for the management of visitation in the spaces analyzed. In addition, the elaboration of the tool represents a starting point for the construction of technical documents that do not yet exist, such as the Public Use Plan. Such actions have the potential to strengthen the protection of the mangroves present in these protected areas, improve the quality of life of local populations and ensure the maintenance of ecosystem services.

The application of the IAT tool in the Guapi-Mirim APA resulted in a final tourist attractiveness of 3.1, classified as extensive. In the internal environment, potential was identified for diversification of visitation, with the proposal to implement a suspended trail or a viewpoint to observe the mangrove, aiming to expand the activities offered and attract a greater number of visitors. In the external environment, there was a need to improve signaling, especially on the highways and in the surrounding municipalities, in order to highlight the presence of the UC. In addition, when accessing the protected area, it is essential to invest in speed reduction mechanisms, ensuring greater safety for visitors.

At the ESEC of Guanabara, the application of the IAT resulted in a final tourist attractiveness index of 2.5, classifying it as extensive. As it is a Full Protection Unit, the diversification of activities, although possible, must consider the guidelines established by the SNUC. Investments in environmental education and interpretation programs, developed in partnership with municipal governments, are strategic actions to strengthen public use.

The external environment has characteristics similar to those observed in the Guapi-Mirim APA. The internal environment is predominantly composed of aquatic areas, complemented by terrestrial structures located at the headquarters of the Guapi-Mirim APA.

The activities offered are perceived as satisfactory by visitors, especially due to the expressive scenic beauty of the mangrove and its biodiversity.

It is in this sense that the results indicate the need to diversify visitation activities, ensuring that tourist exploration occurs in a balanced way and respects the principles of conservation. In addition, the importance of collaboration between the government and civil society is highlighted, promoting preservation actions and strengthening environmental awareness.

The integration of effective public policies and joint efforts between management, science and the community is essential to ensure the protection of mangroves and improve the visitor experience. In this way, the need for continuous and participatory planning is reinforced, which ensures the sustainability of this vital ecosystem for Guanabara Bay.

## ACKNOWLEDGMENTS

We would like to thank the Center for Studies in Management of Conservation Units (NEGUC) of the Federal Rural University of Rio de Janeiro (UFRRJ) and the Graduate Program in Ecotourism and Conservation (PPGEC) of the Federal University of the State of Rio de Janeiro (UNIRIO) for their support in the development of this research.

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