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Green areas in the West Zone of Rio de Janeiro: the environmental heritage of Atlantic Forest

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A B S T R A C T

This article gathers information, characteristics, photos, and data from scientific research on the green areas of the West Zone's environmental heritage. The city of Rio de Janeiro is divided into Planning Areas (PA). PA-5 (West Zone) in the region with the highest population concentration in the State of Rio de Janeiro, containing about 50% of vegetation cover of the Atlantic Forest biome, with forest, sandbank, and mangrove ecosystems; presents remarkable scenic beauty in a set of factors such as massifs, beaches, waterfalls, and rivers. West Zone was a backdrop for pre-colonial historical events, from colonial to urbanization and industrialization that caused green areas changes. The areas protected by environmental law in PA-5 are the Pedra Branca State Park, the Gericinó-Mendanha State Park, and the Mendanha Municipal Natural Park, and areas of sandbanks and mangroves that surround Sepetiba Bay and Marambaia, within the Guaratiba Biological Reserve and the Private Reserve of Natural Heritage Ana Gonzaga, in addition to the areas mentioned above. The Camboatá Forest, in Deodoro, was also considered in this exhibition. This work's objective was to do a survey and synthesize the information about the green areas of the West Zone from bibliographic data and on-site experience and illustrate the natural landscapes with photos. The proposal contributed to the divulgation of green areas in the West Zone, promoting the importance of environmental conservation.

Keywords: Atlantic Forest, Pedra Branca, Mendanha, Camboatá, Conservation Unit, West Zone.

Áreas verdes na Zona Oeste do Rio de Janeiro: patrimônio ambiental de Mata Atlântica

R E S U M O

Este artigo reúne informações, características, fotos e dados de pesquisas científicas sobre as áreas verdes do patrimônio ambiental da Zona Oeste. A cidade do Rio de Janeiro é dividida em Áreas de Planejamento (AP). A AP-5 (Zona Oeste) é a região com maior concentração populacional do Estado do Rio de Janeiro, com cerca de 50% de cobertura vegetal de bioma Mata Atlântica, com ecossistemas de floresta, restinga e manguezal; apresenta notável beleza cênica em um conjunto de fatores como maciços, praias, cachoeiras e rios. A Zona Oeste foi cenário para eventos históricos pré-coloniais, coloniais até a urbanização e industrialização que ocasionou alteração das áreas verdes. As áreas protegidas por lei ambiental na AP-5 são o Parque Estadual da Pedra Branca (PEPB), o Parque Estadual do Mendanha/Gericinó e Parque Natural Municipal do Mendanha, e áreas de restingas e manguezais que circundam a Baía de Sepetiba e Marambaia, dentro da Reserva Biológica de Guaratiba (REBIO) e a RPPN (Reserva Particular do Patrimônio Natural) Ana Gonzaga, além de áreas sobrepostas as citadas. A Floresta de Camboatá, em Deodoro, também foi considerada nesta exposição. O objetivo deste trabalho foi fazer um levantamento e sintetizar as informações sobre as áreas verdes da Zona Oeste a partir de dados bibliográficos e vivência in loco, além de ilustrar com fotos as paisagens naturais. A proposta contribuiu para divulgação das áreas verdes da Zona Oeste, fomentando a importância de conservação ambiental.

Palavras-Chaves: Mata Atlântica, Pedra Branca, Mendanha, Camboatá, Unidade de Conservação, Zona Oeste.

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1. Introduction

Rio de Janeiro (Brazil) is the second most populated city (estimated at 6.7 million inhabitants), according to the IBGE demographic census (2020). The city has 58 Conservation Units, which correspond to 23,581 hectares of the city's 122,456 hectares of vegetation coverage (Rio de Janeiro, 2020). Located in the Southeast region, the city of Rio de Janeiro is well known for the natural beauty, biological diversity of the Atlantic Forest areas, and the contrasting landscape between beaches and rocky massifs, attracting eclectic and international tourism. The contrast between the mountains and the sea of the carioca landscape permeated with history and culture was considered a world heritage site (UNESCO, 2012).

Five geographic areas compose Rio de Janeiro (Urban areas) (1,200,329 km²) defined by Planning Areas - PA. According to Complementary Law No. 111 of February 1, 2011, the PA-5 is the largest and concentrates high population indices (26.6% of the city's population) (IBGE, 2020) and is in the extreme west of the municipality, having a territorial extension of 592.33 km^2, corresponding to almost half of the city's territory (48.4%). The PA-5 contains the administrative areas: Bangu, Realengo, Campo Grande, Guaratiba, and Santa Cruz (Rio de Janeiro, 2020).

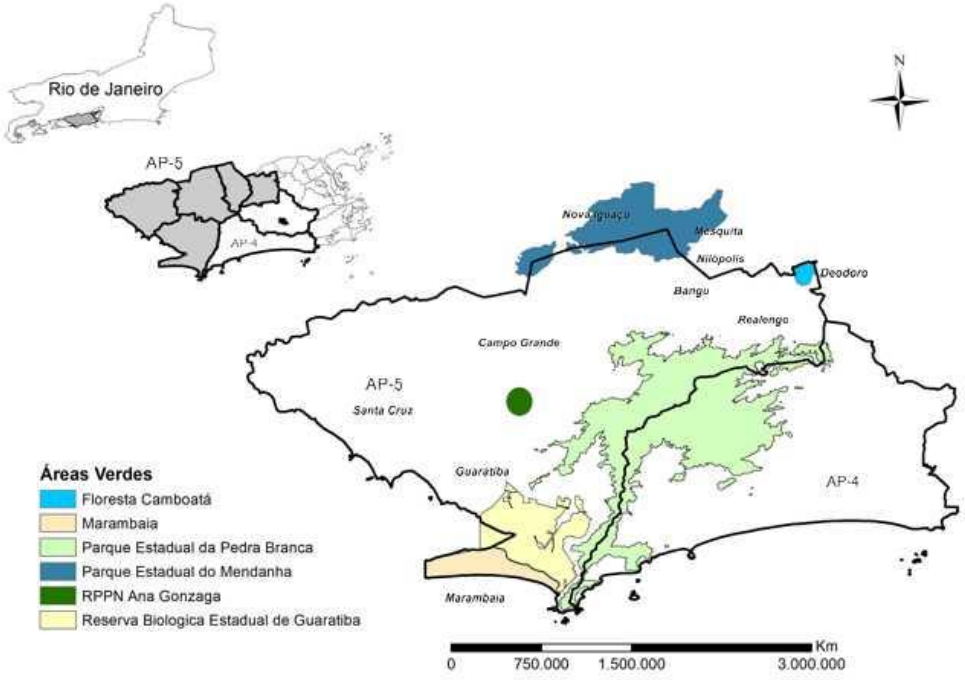
Until the middle of the 19th century, the West Zone of Rio de Janeiro was a rural area, with many farms that went through the cycles of sugar cane (mills), coffee, and orange plantations. The mills use sugarcane, and the deforestation of the Atlantic Forest occurs due to monoculture areas (Oliveira; Fernandez, 2020). From 1960 on, the urbanization process began, which partially eliminated the West Zone's agricultural vocation and perpetuated natural ecosystems' environmental degradation due to irregular occupation of slopes, which brought infrastructure and safety problems, deforestation, and environmental quality damage (Oliveira, 2017).

In Campo Grande and Santa Cruz's neighborhoods install larges industrials complexes between 1960 and 1970. Although they stimulate the economy, they interfere with environmental health because they pollute the air, water, and soils of the Atlantic Forest ecosystems with different types of waste and residues mainly associated with the metallurgical activity (SEMADS, 2001; PACS, 2015; Oliveira, 2017; Victório et al., 2020; Victório, Silva and Simas, 2021).

The green areas of PA-5 have a few visitations, although they present the ecotouristic potential for their natural scenic beauty. The West Zone is a distance longer from the center of the city (60 Km) and the neighborhoods concentrating on the main tourist attractions and hotels - South Zone (70 Km). In the South limit of PA-5, there is the Sepetiba and Guaratiba coast, with mangroves and beaches that present shallow and calm sea due to the ocean's isolation. Two distinct mountainous massifs stand out to the North and East: the Gerecinó-Mendanha and Pedra Branca massifs (Figure 1). These geographical references indicate the main green areas protected by law in the West Zone.

Camboatá Forest is in the Deodoro (PA-5) neighborhood, a fragment of the Atlantic Forest (which has recently been the target of controversy due to the project to build the Rio de Janeiro International Racetrack Formula 1 competitions) (Nascimento, 2015). Studies conducted by the Botanical Garden Institute show the importance of the biological diversity of Camboatá, an oasis that promotes a reduction in the average temperature of the region, accumulates water in pluvial and seasonal lakes (Gribel et al., 2013). Except for Camboatá, the green areas listed in this article are protected by Law No. 9,985, which establishes the National System of Nature Conservation Units (SNUC). According to Iwana, Lima, and Pellin (2014), although protected by law, they have often been threatened. Therefore, there is an increase in deforestation and illegal burnings, real estate construction, urban disorder, high production of domestic waste and sewage. However, there are positive prospects as reforestation projects have favored the recovery of Atlantic Forest ecosystems in Rio de Janeiro.

Figure 1. Green areas of the West Zone (*AP-5*/PA-5) of Rio de Janeiro. The area of Mendanha State Park shares with the municipalities of Nova Iguaçu and Mesquita. The figure also shows the Camboatá Forest (in Deodoro) as a connection point between the Rio de Janeiro massif complexes: Gericinó-Mendanha, Pedra Branca and Tijuca (Tijuca National Park).



The West Zone has an extension of 9,620 ha corresponding to almost 50% of the conserved areas in Rio de Janeiro's municipality, occupying Atlantic Forest biome vegetation with forest, “restingas," and mangroves ecosystems (SMAC, 2020a). Estimates that there are around 20 thousand plant species in the Atlantic Forest, including several endemic and endangered species. This wealth is more significant than in North America (17 thousand) and Europe, with 12.5 thousand plant species, which makes the Atlantic Forest relevant and prioritizes it about measures for the conservation of global biodiversity (Varjabedian, 2010), being considered a National Heritage by the Federal Constitution (Art. 225, Brazilian Federal Law n.11.428/06).

This work's objective was to collect and synthesize information about West Zone's green areas and their scientific records and illustrate the natural landscapes with photos. The proposal presented contributed to the dissemination of these green areas, fostering the importance of conservation. This article results from the experience in these areas in eclectic groups with bibliographic research in a series of digital articles published periodically, between 2016 and 2019, about the West Zone's green areas in the website of research institution - UEZO (2020).

2. Methodology

Green study areas of the West Zone (PA-5), Rio de Janeiro occupies 592.33 Km^2 (IBGE, 2000). The article analyses the scenic beauty and attractive local characteristics: biological, historical, and conservation, considering the conservation units and their biological and ecological aspects, history and culture, environmental importance.

The review conduction is from the collection of data in scientific and journalistic articles available and accessible online. For a random search, uses the keywords: *"Unidade de Conservação" (Conservation Units) , "Zona Oeste" (West Zone), Mendanha, Gericinó, Pedra Branca, Guaratiba, Baía de Sepetiba, Camboatá, "restinga", and "manguezal"*. After reading the material, the relevance discards the materials that had no relation with the proposed approach. The scarcity of information and work on the West Zone's green areas also prompted the master's thesis of one of the authors on the subject. Therefore, this article is a cutout of the data obtained and presented in the author's final dissertation for the Postgraduate Program in Environmental Science and Technology (EST) - UEZO.

The data brings together experiences in locus with various groups. Executes the field visits in groups of guides, student-teachers, and people in general, except for Marambaia and the Camboatá Forest that are not open to the public (this an area only for military training or research). The authors conductions the route on foot, and each route in the West Zone's green areas is for contemplating the biological, environmental, historical, and cultural elements.

The surveys on scientific research in green areas use Scielo, Science Direct, and Web of Science (considering the period 2015 to 2020). Pedra Branca, Mendanha, Guaratiba, Camboatá, Marambaia, Piraquara, and Rio de Janeiro, and West Zone are the research keywords. The research includes older records in case of data shortage.

3. Results and Discussion

In the 16th century, the Portuguese colonizers Brazil and occupied green areas when they sighted Brazil's Atlantic coast (12% of Brazil's territory). The growing deforestation for the economical use of brazilwood (*ibirapitanga* in Tupi - indigenous language, *Paubrasilia echinata* (Lam.) Gagnon, H.C.Lima & G.P.Lewis, *syn Caesalpinia echinata* Lam.), extracting for the Portuguese crown economic uses (the red dyeing resin and the very resistant woods).

Other European countries as France, Holland, and England explore pau-brazil in Brazilian territory. The brazilwood is an icon of the Atlantic Forest and historically threatened (Agostini et al., 2013). This first record of intense deforestation continues throughout history and the economic cycles: gold and diamond mining, cattle ranching, sugarcane, and coffee monocultures (Dean, 1995).

The Rio de Janeiro population growth and urbanization, replacing the forest with housing, commercial areas, and industries reducing the Atlantic Forest's vegetation cover, mainly in difficult access areas - high and steep (Dean, 1995; Varjabedian, 2010; Agostini et al., 2013).

The green areas in this article are primary and secondary fragments of Atlantic Forest that in total (from South to Northeast of the Atlantic coast) have been reduced to 7% of Brazilian territory, where ecosystems are threatened with extinction and have a loss of biological diversity (Varjabedian, 2010; MMA, 2010; Agostini et al., 2013).

Among the preserved green areas in the West Zone, we find the PBSP (Pedra Branca State Park), the Mendanha/Gericinó State Park, the Mendanha Municipal Natural Park, restingas and mangroves areas such as Sepetiba Bay (Guaratiba Biological Reserve), and Marambaia (under the tutelage of the Brazilian Armed Forces), and the PNHR (Private Natural Heritage Reserve) Ana Gonzaga. The concentration area is Realengo, Bangu, Campo Grande, Sepetiba, and Guaratiba (PA-5).

The green areas are public and are under the Municipal, State, and Federal spheres. Table 1 (see last page) gathers the characteristics of the green spaces of the West Zone.

3.1. Pedra Branca State Park (PBSP)

The Pedra Branca State Park (PBSP) is between PA-5 and PA-4 (Figure 1), one of the most frequented

areas of PA-5. It has many routes that mix beaches and mountains, being relevant for ecotourism, leisure, and physical activities (Costa, Triane, and Costa, 2008; Ribeiro, 2016; Cabral, Oliveira Solórzano, 2020). The Park's name references the massif it protects - ”Pedra Branca”, white limestone formation (INEA, 2013).

The PBSP is one of Brazil's Atlantic Forest's biodiversity core (State Law no. 2.377 of June 28, 1974, as Conservation Unit of integral protection). The area covers about 16% of Rio de Janeiro's municipality, with 12,398 ha (Figure 1). It receives the largest Conservation Unit in the municipality (SMA, 2009) and largest urban forest globally (Victório; Tadeu, 2019). Among the aims of this UC can be listed: 1. Preservation of the remaining forest and biological diversity - native and endemic plant species, and consequently the water sources, and other species; 2. Protection of natural landscapes and little altered considered of remarkable scenic beauty; 3. Protection and revitalization of historical buildings, ruins, and archaeological sites, as well as a socio-cultural heritage; 4. Promotion of opportunities for outdoor recreation and socio-educational, cultural, and environmental actions. (Fernandez, 2011; Ribeiro; Ribeiro, 2016; Vilani; Coelho, 2017; INEA, 2018). The application of interpretative routes as an active methodology of education in areas of PBSP in the promotion of Environmental Education (Victório; Tadeu, 2019). Superimposed on the PBSP has the three Conservation Units: the APA (or EPA - Environmental Protection Area) da Pedra Branca (Municipal Law No. 1.206 of March 28, 1988); the Prainha Municipal Natural Park (Municipal Law No. 1.534 of January 11, 1990); and the Grumari Municipal Natural Park (Municipal Decree No. 20.149 of July 2, 2001).

The PBSP is divided into four sectors, as shown in Table 2: 1. Wild Beach Sector (Praias Selvagens): Wild Beach Circuit (Praia do Perigoso, Meio, Funda and Inferno), Pedra do Telégrafo (Telegraph Hill) trail and Guaratiba x Grumari crossing; this PBSP sector overlaps with the Grumari Municipal Natural Park (PNM de Grumari) formed by landscape beaches, restinga vegetation, forest on the slopes, flooded areas and wetlands, and mangrove swamps at the mouth of “Rio do Mundo”; 2. Ilha de Guaratiba Sector: Morgado Trail; 3. Rio da Prata Sector: Caixa d'àgua Circuit and Jequitibá Trail; 4. Piraquara Sector: Piraquara Center Headquarters, via Cachoeira do Barata and Aqueduct, Circuito Jesus vem and Pedra do Osso, and Morro do Lameirão (Figure 2, Table 2) (INEA, 2013, SMAC, 2020b). All present sectors reveal the forest and restinga ecosystems routes.

The visits are to ”Praias selvagens” Circuit and the Piraquara. The highlight goes to the "Transcarioca Corridor" (route), whose implementation began in 2011, and several Conservation Unitis are connecting (but about 60% pass through the PBSP). Moreover, the "*Transcarioca*" trail connects, on a long walk, for about 180 km, the neighborhood of Barra de Guaratiba to Urca in the South Zone (Municipal Natural Monument of the Sugar Loaf and Urca hills – “Monumento Natural Municipal dos Morros do Pão de Açúcar e da Urca”) (INEA, 2013).

Table 2. Overview of the Pedra Branca State Park (PBSP) sectors located within PA-5 and the most frequented green areas.

Sector	Neighborhood	Location (GPS)	General state of conservation of the trails/route	Description
Ilha de Guaratiba (Guaratiba Island)	Guaratiba (Ilha de Guaratiba)	Latitude, 22º58´36,061``N Longitude, 43º30´32,768``E	These are trails used for crossings, mostly by motorcycles, jeeps, and bicycles. Although little frequented, they are very susceptible to erosion, by motorized vehicle traffic	Mangrove ecosystem. It is the least known and least visited sector.

Praias selvagens (wild beaches)	Guaratiba (Barra de Guaratiba)	Latitude, 23º3`48,824``N Longitude, 43º34`3,154``E	They are the most sought-after trails of PA-5. For lack of more effective inspection and greater access control, high erosion in the trails and depredatory action of some visitors (such as garbage and graffiti) can be seen	Ecosystem of restinga, with a high degree of isolation from the urban area, however, it is the most visited sector.
Rio da Prata	Campo Grande	Latitude, 22º53`50,166``N Longitude, 43º34`34,335``E	Well preserved trails, although they need better signage. The intense presence of cultivars among native plants is noticeable.	Forest ecosystems, with strong agroforestry and extractive activity.
Piraquara	Realengo	Latitude, 22º53`56,427``N Longitude, 43º27`46,767``E	It is well preserved, but it suffers constant burning, even if it is fought and restrained by local public agents.	Forest Ecosystems, near the urban area.

Data by consulting the INEA website and visiting the areas.

In the PBSP, there is a high floristic diversity with the predominance of native plants of the Fabaceae and Myrtaceae families. The highlight is bromeliad species endemic to the Park - *Neoregelia camorimiana* E.Pereira & I.A.Penna (Bromeliaceae) (INEA, 2018). The dispersion of Fabaceae seeds occurs by gravity, animals, and wind, while among Myrtaceae, the distribution is zoochoric, being fundamental to the faunistic diversity, in this case, mainly of birds (Gressler, Pizo and Morellato, 2006; INEA, 2018). There are plants at risk of extinction regarding the flora, such as *Anthurium luschnathianum* Kunth (anthurium), *Heliconia angusta* Vell. (bico-de-guará) and *Melanopsidium nigrum* Colla (corona-de-sapo) according to the PBSP management by INEA Resolution No. 74 of July 2013 (INEA, 2018).

The vegetation coverage and biodiversity of the PBSP are subject to tremendous anthropic pressure from its surroundings (Sathler, 2009; Iwama, Lima and Pellin, 2014), mainly due to burning and deforestation, suppression of native plants, and substitution by exotic or invasive species, in addition to degradation by domestic and industrial pollutants. Reports point to the mining activity to remove ornamental granite (Beiroz, 2015). The environmental degradation began with colonization and the Pedra Branca massif slopes' colonization to obtain natural resources and open spaces for crops such as coffee and sugar cane and later for livestock. There were regions such as the current Tijuca Forest that were extensively deforested in substitution of monocultures such as coffee plantations, causing water availability problems (Freitas, Neves and Chernicharo, 2006). Because of this, in 1861, by D. Pedro II, Major of the National Guard Manoel Gomes Archer heads the reforestation of the Tijuca Forest during 13 years, and many plant seedlings were transferred from the PBSP still well preserved (Maya, 1966).

The PBSP has a historical heritage that goes back to the period of colonization and slavery in Brazil. The first records of the occupation of the massif date from 1594. The large farms such as Fazenda Pau-da-Fome (former “Engenho do Rio Grande”) had many slaves (black and indigenous) (Santos, 2014), and with the flight of black slaves, the “quilombos” forming in the Massif of Pedra Branca. The Quilombo Trail goes back to when slaves used this path to escape or, after the “Alforria” (Manumission) (19th century), as a passage. The Quilombo Trail area is to the east of the Pedra Branca Massif and holds evidence of the life of “quilombolas” in the region (Costa, Triane, and Costa, 2008) with; there are registers three quilombos in the

PEPB area, according to Law 9.985 of 2000 (Rodríguez Cáceres, 2017; Victório; Tadeu, 2019).

Between the XIX and XX centuries, the deforestation of Pedra Branca's forest is continuous without replanting for the use of wood in the charcoal factories (Corrêa, 1936; Cabral, Oliveira, and Solórzano, 2020). Oliveira and Fraga (2012) report more than 1,000 charcoal plants in the PBSP, currently inoperative and covered by secondary vegetation. Other reports cite 104 ruins and 1,170 charcoal plants in the Pedra Branca Massif (Oliveira, 2018; Cabral, Oliveira, and Solórzano, 2020). At the beginning of the 20th century, in his ethnographic study, Magalhães Corrêa described the inhabitants of the rural areas of the massif: banana growers, hunters, charcoal burners, heads of cattle, basket workers, caterpillars, potters, fishermen, cloggers, and street vendors whom he called "sertanejos." Magalhães Corrêa explains the degradation of the Atlantic Forest ecosystems by the residents due to the extraction of natural resources to manufacture various products (Franco; Drummond, 2005; Oliveira; Fernandez, 2020).

The producers are descendants of the community of *Quilombo Dona Bilina*, live in the PBSP area, and sell their organic products (for example, banana, “chuchu”, avocado and orange, manioc, vegetables, and medicinal plants) by the Association of Organic Farmers of Pedra Branca (Agroprata) (Barbosa; Ramos, 2015; Dias, 2017; Santos, 2018; Victório; Tadeu, 2019). It also has a strong market for tropical ornamental plants such as the rhizomatosas of the Zingiberaceae family.

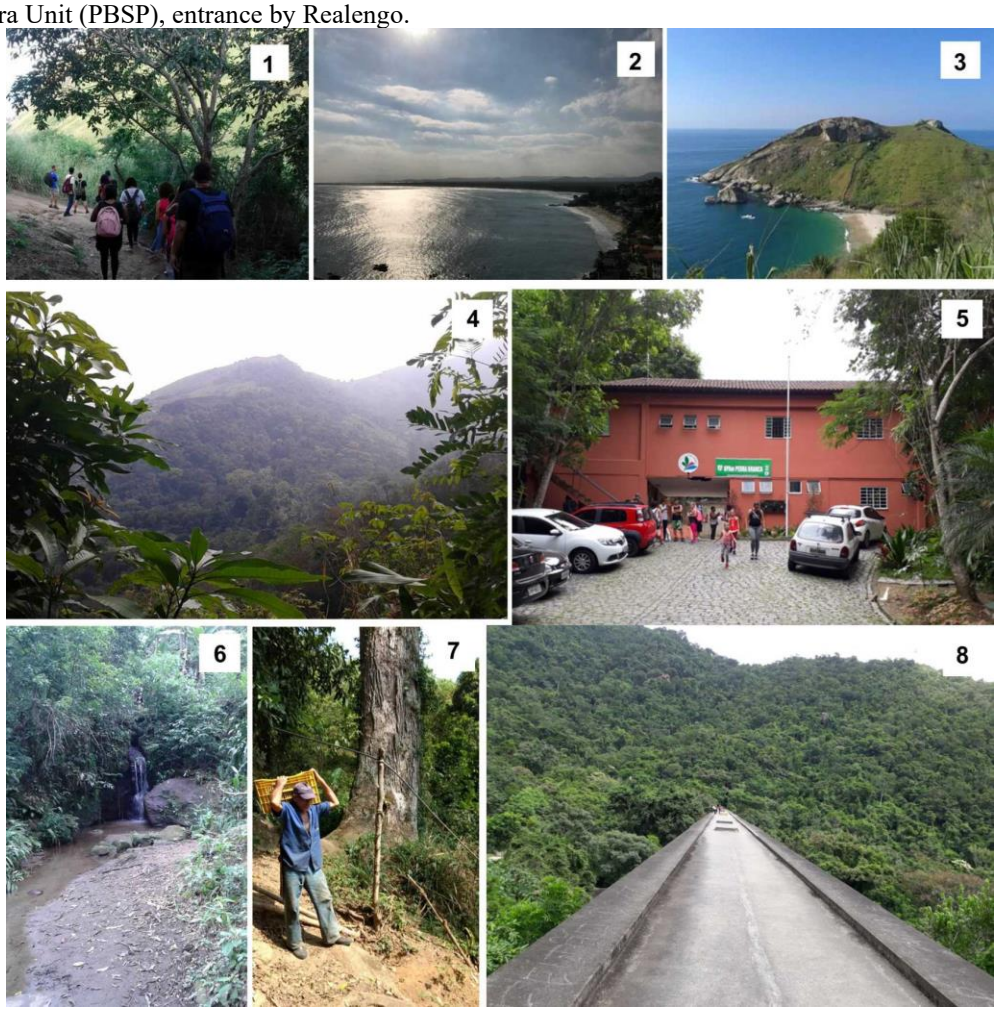
In the area that today comprises the PBSP, a robust agricultural culture had to adapt after the Conservation Unit`s law in 1974. In the year 2000, a resumption of farming practices in the Pedra Branca Massif with agro-ecological and "organic" techniques (Fernandes, 2016). One of the most relevant areas in the scenario of plant production in Rio de Janeiro in the Rio da Prata in Campo Grande is its territory within the PBSP.

The producers are descendants of the community of *Quilombo Dona Bilina*, live in the PBSP area, and sell their organic products by the Association of Organic Farmers of Pedra Branca (Agroprata). The organic product sells banana, avocado and orange, manioc, vegetables, medicinal plants, and herbal medicine, for example, tropical ornamental plants rhizomatosas the Zingiberaceae family also are selling (Barbosa; Ramos, 2015; Dias, 2017; Santos, 2018; Victório; Tadeu, 2019).

Ethnobotanical studies appoint native and endemic fruit plants of the Myrtaceae family: “jaboticaba” (*Myrciaria cauliflora* (Mart.) Kausel), “grumixama” (*Eugenia brasiliensis* Lam.), “cabeluda” (*Myrciaria glazioviana* (Kiaersk.) G. Barroso & Sobral), “cambucá” (*Plinia edulis* (O. Berg.) Nied) and “araçá” (*Psidium cattleianum* Sabine), as part of the diet of the community of the Pedra Branca Massif, being an essential geographical indication in the sustainable acquisition of the fruits of these species. Also, the fruits nourish several animals, such as birds. Furthermore, the most relevant and economic crops are banana (*Musa x paradisiaca*), cassava (*Manihot esculenta* Crantz), and yam (*Colocasia esculenta* (L.) Schott) (Oliveira; Fernandez, 2020). There are indications of native medicinal plants such as “Chapéu-de-couro” (*Echinodorus grandiflorus* (Cham. & Schltdl.) Micheli) component of the Brazilian drink Mineirinho® and one of the popular types of the local tea (*Euphorbia prostrata* Aiton) (Oliveira; Fernandez, 2020).

The PBSP has many rivers, lakes, waterfalls, and dams built to capture and supply water. This urban forest is a water source for Rio de Janeiro (Oliveira; Annelise, 2020). Inaugurate in 1966, the Veiga Brito Aqueduct, to water supply 7.5 million people in Rio de Janeiro, visible in part at the Piraquara Unit (Realengo) (CEDAE, 2018). INEA records show that there is countless research done at the PBSP addressing different areas: Botany, Zoology, History, Geography, Environmental Pollution, Ecotourism, Reforestation, Climatology, Ecology, Flowering and Pollination Biology, for example.

Figure 2. Sectors of the Pedra Branca State Park (PBSP) in PA-5 (*AP-5*). 1. students of the Post-medium course being conducted on a trail to the wild beaches of Barra de Guaratiba. View from the Morro do Telégrafo (Telegraph Hill), from the Barra de Guaratiba shore, with Restinga da Marambaia in the background. 3. in the foreground one of the wild beaches (Praia do perigoso) and in the environment the Pedra da Tartaruga. 4. view of the PBSP from the Rio da Prata trail. 5. administration of the Piraquara with Environmental Policing Unit and Base of the park ranger service. 6. Rio da Prata Waterfall, in the Rio da Prata sector, Campo Grande. A farmer living isolated in the Rio da Prata. 8. view of the aqueduct of the Piraquara Unit (PBSP), entrance by Realengo.



3.2. Mendanha-Gericinó

The Mendanha State Park (SP) (creates by state Decree No. 44,342 of August 22, 2013) is the municipalities of Rio de Janeiro, Nova Iguaçu, and Mesquita (Figure 1). It is a statewide Conservation Unit of integral protection creation that provides that the third rock mass of the metropolitan region (Gericinó-Mendanha), which has 105 Km^2 covered by forest, is under integral protection (INEA, 2020). The residual massifs of Pedra Branca and Gericinó-Mendanha with the Tijuca massif make up the central relief units of Rio de Janeiro (Costa; Moura, 2003; Costa, 2006).

According to the INEA website (2020), the Conservation Unit creation protects natural geo-hydrological systems, biodiversity, volcanic geological structures, and numerous watercourses (INEA, 2018). About the

volcano, although the INEA website (2020) shows the protection of the volcano in the Mendanha massif, reports to Vieira studies (2005). Motoki (2007) diverges, saying that the volcano is unviable, proposing that the geological structure observed results from fillings of conduits and vulcanic fissures.

Unlike State Park of Mendanha, the EPA - Environmental Protection Area Gericinó-Mendanha is a Conservation Unit of sustainable use (creates by State Decree No. 38,183/2005), and its extension covers the municipalities of Rio de Janeiro, Nova Iguaçu, and Nilópolis (INEA, 2018). The State Park do Mendanha presents an overlapping of UCs (Conservations Units). The Mendanha Municipal Natural Park (Figure 3) has a very well-structured headquarters, from the reform of the farm structures in the region (Figure 3.2) and exists on State Park do Mendanha area.

The Mendanha Municipal Natural Park forest is in the secondary successional stage. Among the native plants of the Atlantic Forest, there are species of the Fabaceae family (Leguminosae) as the illustrious representative “pau-brasil” (*Paubrasilia echinata* (Lam.) Gagnon, H.C.Lima & G.P.Lewis, *syn: Caesalpinia echinata* Lam.) and the “jatobá” (*Hymenaea courbaril* L); “jequitibás” as the *Cariniana legalis* species (Mart.) Kuntze; and the endemic “sapucaia” (*Lecythis pisonis* Cambess.) of the Lecythidaceae family; besides many “begonias” and bromeliads orchids (INEA, 2018). In the past, the deforestation of areas of Mendanha happens for sugar cane and coffee plantations-supply the mills. Urbanization contributes to deforestation by the arrival of the train to the Bangu neighborhood in 1890 (Cruz, 2017).

In 1893, establish the Companhia Progresso Industrial Brasil in front of the Bangu Railway Station, known as Fábrica Bangu (or Bangu Fabrics Factory). The factory contributes to the Bangu urbanization process and, consequently, reduces agricultural areas; other fabrics and the manufacturing movement for three decades support its economy (Sá, 2014; Cruz, 2017).

The factory acquired large farms such as Espírito Santo and Mata-Fome to build villages for technicians and workers, which began the emergence of the populous neighborhood of Bangu. For the confection of textiles, the water from the Bangu River requires steps. One of the stages is the washing of the textiles after dyeing, resulting in the Bangu River's pollution with different colors. For this reason, the popular term for the river is "River of dyes" (Sá, 2014).

The “Serra do Medanha” conservation areas are currently subject to anthropic pressures: deforestation and consequent irregular occupation, slumming processes, and precarious environmental sanitation in the surrounding areas. According to reports, the plant had a large green area in “Serra do Mendanha”, which integrates into Conservation Unit of Mendanha as environmental compensation (Cruz, 2017; Rio de Janeiro Aqui, 2020; Jornal Zona Oeste, 2020).

Figure 3. Photographic records of the Municipal Park of Serra do Mendanha: 1. The Municipal Park of Serra Mendanha. 2. headquarters of the Municipal Natural Park (PNM) of Mendanha. 3. swimming pool at the base of PNM do Mendanha. The acronym CPIB (Cia Progresso Industrial de Bangu). 4) PNM do Mendanha: one of the natural pools formed by the Park's waterfalls, its main attraction. 5) Mendanha Waterfall in Mendanha State Park is used as leisure by the local population. 6) View of Mendanha State Park, from Gericinó Municipal Natural Park, in Nilópolis.

3.3. Guaratiba Biological Reserve

The Guaratiba Biological Reserve (Figure 4) is in Guaratiba (XXVI Administrative Region of Rio de Janeiro) and composes Pedra de Guaratiba, Barra de Guaratiba, and Guaratiba Island. Creates by decree No. 7,549, of November 20, 1974, for protection to mangrove ecosystems and archaeological sites as the first protected area in Guaratiba and Sepetiba Bay (INEA, 2020). Geological studies made by Beckheuser in 1918, followed by anthropological studies of Roquete-Pinto (1925), revealed the characteristics of shell midden (first population) of the region (Kneipl et al., 1987; IAB, 2018). The Guaratiba Reserve underwent several review processes of its limits (State Decree No. 5,415 of March 31, 1982; State Law No. 5,842 of December 3, 2010) when reclassifies the Conservation Unit to full protection (UCPI) - Biological Reserve (REBIO) State of Guaratiba, (Law No. 9,985/2000).

With approximately 3,360 ha, the Guaratiba Biological Reserve protects significant mangrove forest remnants in Rio de Janeiro's metropolitan region. Mangroves are Permanent Protection Areas (PPA) according to the Brazilian Forest Code of 1965 (Law n. 4,771) and present great environmental, economic, and social value for offering countless ecological services, among which the maintenance of biological diversity (Sugiyama, 1995; Fernandes, 2012). These ecosystems are vulnerable to the effects of the uncontrolled population growth typical of Brazil's large cities and economic development. (Alves, 2001). Many birds and fish feed, grow, reproduce (spawning and nursery), and protect themselves against predators (Sugiyama, 1995; Fernandes, 2012). In Guaratiba, archaeological sites like the shell midden or shell mound are near the mangroves (Alves, 2001).

According to the tidal regime, mangrove areas are dynamic due to physical-chemical and biological variation, subject to brackish water with high salinity, low availability of oxygen, and unconsolidated substrate (Sugiyama, 1995; SEMADS, 2001). The presence of crabs, especially the uçá crab (*Ucides cordatus*), helps to recycle organic in abundance and by digging holes in the soil and revolve the nutrients to the substrate. As an economic activity, crab collection is a common practice that reverts in income for the populations that live in the neighborhood (Fernandes, 2012). Sepetiba Bay (±450 km²) extends through the West Zone of Rio and the cities of Itaguaí and Mangaratiba. It is essential for the fishing economy since it is a favorable environment for fish, mollusks, and crustaceans. The recurrent plant species in the Sepetiba mangroves are *Rhizophora mangle* L., *Avicennia shaueriana* Stapf & Leechman, and *Laguncularia racemosa* (L.) C. F. Gaertn. which guarantees the contribution of organic matter from mangroves and the high primary productivity of these ecosystems (Sugiyama, 1995; Fernandes, 2012; ICMBio, 2018).

The Sepetiba Bay and is around suffering from the pollution of domestic and industrial effluents. Among the waste, heavy metals, fertilizers, polycyclic aromatic hydrocarbons, plastics, and derivatives are examples of pollution (Santos, 2012; Fernandes, 2012; Ribeiro et al., 2013; PACS, 2015; Victório et al., 2020; Pontes et al., 2020; Victório, Silva and Simas, 2021). There is an intense environmental impact due to the industrial complexes near Sepetiba Bay, such as ports and metallurgical, petrochemical and textile industries (SEMA, 1998). Finding other solid wastes in mangrove areas between tree roots and stems. The urbanization in mangrove areas and construction of housings and industries deforestation and reduce ecosystems and affect biodiversity and the lives of communities that survive from artisanal fishing. The artisanal fisheries in Sepetiba Bay are the heritage of the “Tupis-Guaranis” indigenous communities along the coast. Currently, the practice is made by different capture tactics using the artisanal fishing nets: "bate-poita," "caceio," "espera” (Lopes, 2013).

In different areas of the West Zone, the Conservation Units overlaps. For example, Sepetiba Bay's Waterfront EPA (Environmental Protection Area) gathers the green regions of Marambaia, Brisas EPA, and REBIO Guaratiba along the coastal strip. Its journey begins in Barra de Guaratiba and ends at Itaguaí River (municipality of Itaguaí) (SMAC, 2020b). The EPA das Brisas (Law No. 1,918 of October 5, 1992) protects the coast of Sepetiba Bay - from the neighborhood of Guaratiba to the Pedra de Guaratiba. This green area has essential ecological, historical, and archaeological value following the own conservation characteristics of REBIO Guaratiba.

Scientific research has been conducted in the area, with different themes to reveal the environmental, biological, and economic importance of the region's mangrove ecosystems (Martins et al., 2017; Victório et al., 2020) (Table 3). Moreover, thus protect ecosystems from real estate speculation and the negative impacts of pollution and other actions of environmental degradation. A consultation on INEA's website, which authorizes research in this Conservation Unit, has records since 1977 - about microphytoplankton in the Ponta de Guaratiba to Cabo Frio region (Filho et al., 1977). The studies at REBIO are about Sepetiba Bay, the mangroves, the restingas Fluminense, and the biodiversity.

3.4. Marambaia

The Marambaia restinga is a narrow strip of land of about 42 km between Sepetiba Bay and the sea among the municipalities of Rio de Janeiro, Itaguaí, and Magaratiba. In Rio de Janeiro, it is a fragment of the Atlantic Forest heritage of the Brazilian Army, where the Army Evaluation Center, "Marambaia's Proving Ground" (Figure 1). Historical reports point to Marambaia Island as a place of illegal landing of slaves to Brazil in 1831. The community that lives in the region has its economic activity, mainly fishing and seafood and the quilombolas (Pereira et al., 2015).

The region is beautiful, and the entrance is only possible under military authorization. In this area, we find restinga ecosystems with halophytic, psamophilic-reptant vegetation, and many Myrtaceae plant species such as *Neomitranthes obscura* (DC.) N. Silveira and *Eugenia copacabanensis* Kiaersk, endemic to Southeastern Brazil, and *Myrrhinium atroporpureum* Schott (Souza et al., 2007; Arruda; Victório, 2011; Victório et al., 2018). Studies about polar and apolar extracts of Myrtaceae leaves revealing different biological activities: larvicide and antimicrobial (Succar et al., 2019; Carneiro et al., 2021).

In Marambaia, it is possible to access a mangrove area facing Sepetiba Bay. The restinga and the mangrove area of Marambaia are part of the EPA of the Sepetiba Bay's shoreline. Although it is an area with access restrictions as it is a military area, it accepts the research requests (Arruda; Victório, 2011; Victório et al., 2011; Silva et al., 2013; Maia; Silva, 2016; Victório et al., 2018). As with most restingas areas, there is estate pressure (Rocha et al., 2007). According to a scientific survey, educational institutions develop projects in the region (Table 3); from the Scielo database, five scientific articles in the Marambaia restinga in 2016, 2017, one, and in 2019, two.

Figure 4. Photographic records of the Guaratiba Biological Reserve: 1. Restinga da Marambaia from the Telegraph Hill. In the background the mangrove swamp, which forms the Biological Reserve of Guaratiba. 2. View of the mangrove swamp from REBIO Guaratiba. 3. shrub and arboreal vegetation of Restinga da Marambaia, in the area of Line 4. 4. mangrove vegetation of Marambaia, detail for *Avicennia shaueriana* (Acanthaceae) species and *Rhizophora mangle* (Rhizophoraceae), at the bottom the Sepetiba Bay.

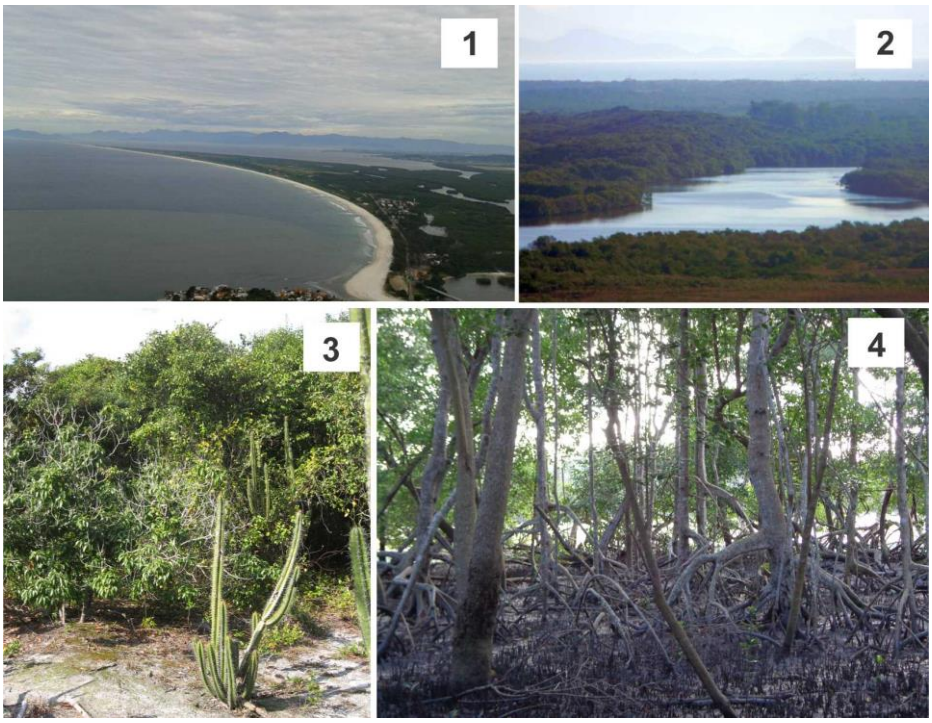


Table 3. Repercussion in the national scientific public research of the green areas of the West Zone of Rio de Janeiro from data from scientific article platforms, between the years 2015 to 2020.

Research Institutions**	Green areas	Ecosystem	Research area	Object of research	References†
UEZO UFF UFRJ UFRRJ UNIRIO	Pedra Branca	Forest	Teaching/Education, Geography, History/Archeology, Conservation Units, Botany, Zoology	Ecotourism, interpretative trails, land issues, traditional culture, agri-food systems, parasites	Castanheira and Baptista, 2015, Ribeiro and Ribeiro, 2016, Fernandes, 2016, Rodríguez Cáceres, 2017, Santos, 2018, Luz et al., 2018, Victório e Tadeu, 2019, Fernandez, Baptista, Silva, 2020
UFRJ UNIRIO	Mendanha	Forest	Engenieering, Geography, Environmental	River restoration, Urban ecology	Sartori et al., 2019, Veról et al., 2019
UERJ UEZO UFRJ	REBIO Guaratiba (Sepetiba Bay) and adjacent areas	manguezal	Environmental monitoring, Botany, Plant biotechnology, Chemistry, Zoology, deterritorialization	Fishing work, environmental pollution	Freitas and Rodrigues, 2014*, Morales et al., 2019, Victório et al., 2020, Pontes et al., 2020
FIOCRUZ UENF UFRJ	Grumari	restingas	Botany, Zoology	Flora and fauna	Couto et al., 2017, Calazans et al., 2017, Bechara et al., 2018

FIOCRUZ UERJ UEZO UENF UFRJ UFRRJ	Marambaia	coastal marine environments, restingas and mangroves	Environmental monitoring, Botany, Ecology, Fungi, Plant biotechnology, Chemistry, Zoology	Animals, animal carcasses, such as dolphins, whales, turtles and birds, other species. Plants, taxonomy, essential oils, plant extracts, analysis of the biological effect, morfoanatomy, remediation of heavy metals and other pollutants	Braz and Azevedo, 2016, Brum et al., 2016, Maia and Silva, 2016, Souza et al., 2016, Dias e Araújo, 2017, Camara et al., 2018, Victório et al. 2020
JBRRJ	Camboatá Forest	Forest	Plant Diversity	Plants	Relatório JBRJ, 2012*

*Scielo platform unique data: https://www.scielo.br/ **Some studies result from the partnership between different research and teaching institutions from other states. †Reference examples.

3.5. Ana Gonzaga Private Natural Heritage Reserve

The Ana Gonzaga - CEMAG Methodist Ecological Reserve is a Private Natural Heritage Reserve (PNHR) of sustainable use (Figure 5) by IBAMA (Brazilian Institute of Environment and Renewable Natural Resources), through Ordinance No. 44, DOU 91 of May 14, 1999, and covers an area of 73.12 ha. This PNHR is the largest in Rio de Janeiro's municipality. There is in the unit the Ecological Center Ana Gonzaga, and the vocation of this PNHR is Environmental Education and assistance services to the community. Reports from residents of the region cite sightings of wild dogs (*Cerdocyon thous*), snakes (jiboias and jararacas), as well as “tapitis” (bush rabbit), “pacas”, “capivaras”, and vast numbers of wild birds in PNHR, according to the Secretariat of Conservation and Environment of Rio de Janeiro (2017).

Figure 5. PNHR Ana Gonzaga, below the parking lot at Park Shopping Campo Grande.

3.6. Camboatá Forest

The deforestation of many areas of the Atlantic Forest has been throughout Rio de Janeiro's urbanization process. The last big remaining area of the flat Atlantic Forest of the city is in the district of Deodoro - Camboatá Forest (Figure 1). All the remaining forest is between 35 and 50 meters high and protects vegetation (Figure 6) (Veloso et al., 1991; Gribel et al., 2013); there are springs and wetlands on the site (Lira, 2020). During the flood season, in the wetlands, eggs of rivuline fish (*Leptopanchax opalescens*, Rivulidae) hatch, endangered, and not reported from 1985 to 2012. These fish are typical of seasonal or temporary aquatic environments (Lira, 2020).

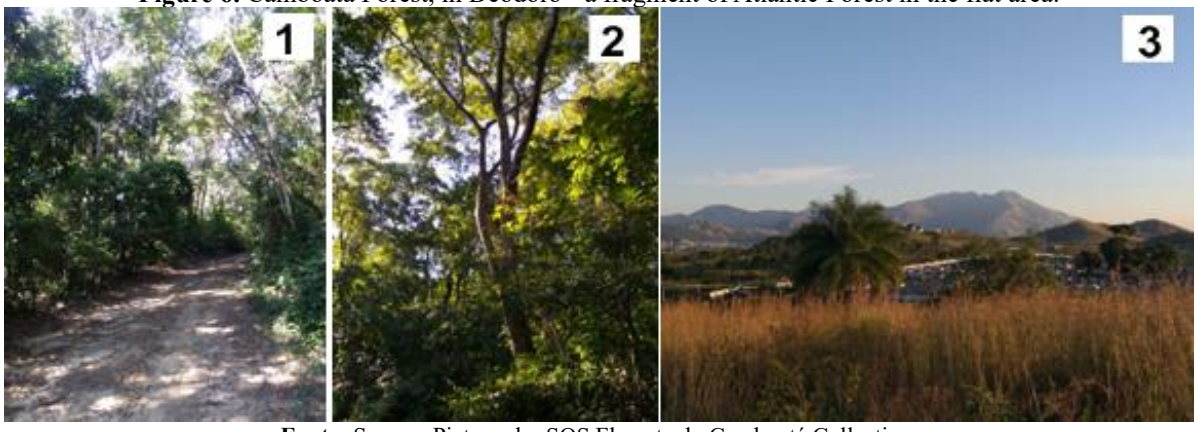
Due to its strategic location, between Pedra Branca and EPA Gericinó-Mendanha, the Camboatá Forest acts as a connector: rest, feeding, and migration for birds and other animals (Figure 1). It is an area of refuge for birds and bats cooperating for plant diversity through seed dispersal and pollination processes (Gribel et al., 2013; Lira, 2020).

Its ecological importance is in the research by the Research Institute Jardim Botânico do Rio de Janeiro (JBRJ) since the 1980s at the Army's request and publish in 2012 (Gribel et al., 2013). The research catalogs 125 species of native flora: 77 tree species, 18 shrubs, 12 herbaceous/epiphyte, and 18 vines, where the density is over 1,000 trees per hectare: ipês, angicos, ingás, cambarás, quaresmeiras, pindaíbas (*Duguetia lanceolata* A.St.-Hil.), pau-brasil and jacarandás. The studies show the presence of vulnerable trees like the *Mollinedia glabra* (Spreng.) Perkins and the jacaranda caviuna or graúna (*Dalbergia nigra* (Vell.) Allemão *ex.* Benth.) whose wood for the construction of musical instruments. The researchers of the JBRJ still point to the relevance of the Forest of Camboatá for the genetic viability of the natural populations of the fauna and flora of Rio de Janeiro. According to the researchers, the forest is a unique Atlantic Forest ecosystem in Rio de Janeiro, where approximately 60% is well preserved (Gribel et al., 2013).

Historical reports indicate that the site may contain an incredible number of unexploded explosive devices, remnants of the explosion of Deodoro's ammunition depots in the Anti-Aircraft Artillery Regiment (April 15, 1948, August 2, and October 2, 1958) (Nascimento, 2015).

Research in the Camboatá area is rare: except for the JBRJ report (2012), not find the keyword "Camboatá" associates with the Rio de Janeiro Atlantic Forest in the platforms for the publication of scientific articles, different from Marambaia, for example (Table 3).

Figure 6. Camboatá Forest, in Deodoro - a fragment of Atlantic Forest in the flat area.



Fonte: Source: Pictures by SOS Floresta do Camboatá Collective.

Table 3 gathers some research by educational and research institutions in the West Zone green areas. The research and scientific releases on green places reveal these ecosystems' diversity and characteristics and corroborate conservation areas.

4. Conclusion

The green areas of the West Zone of Rio de Janeiro reveal a historical component pre-colonial period and the beginning of colonization in Brazil, with records of quilombos and charcoal burning, economic development with the past and present connection. Such areas witness the anthropic interference from the discovery to the present day. According to Cabral et al. (2011), Rio de Janeiro's urban forests are "cultural landscapes" because they express the region's culture. Many problems are reveals, despite legal protection such as burning and deforestation, suppression of vegetation, and pollution by domestic and industrial waste.

The green areas are of high relevance for maintaining the Atlantic Forest's biological diversity and essential for rainwater runoff in contrast to waterproof asphalt; they soften the temperature and reduce air pollution and virus spread by arthropod vectors (Donalisio et al., 2017). The valorization of green areas in urban space follows vegetation's multifunctionality and corroborates environmental perception and conservation. Expanding the knowledge about urban green areas is essential for local development.

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Table 1. Data collection of the West Zone green areas protected by law, PA-5, Rio de Janeiro, RJ.

Data	PBSP[1]	Mendanha State Park and Municipal Natural Park [2]	Guaratiba Biological Reserve	PNHR[3] Ana Gonzaga	Marambaia	Camboatá Forest
Localization Area	PA-4 e PA-5	PA-5 (Rio de Janeiro), Nova Iguaçu* and Mesquita*.	PA-5 (Guaratiba) Sepetiba Bay	PA-5 (Campo Grande and Inhoaíba)	PA-5 (Guaratiba) Sepetiba Bay, Mangaratiba* and Itacuruçá*	PA-5 (Deodoro)
Estimated area (ha)	12.492	4.398,10	3.360	73,12		150-201
Overlapping conservation areas	Grumari and Prainha[4]	EPA Gericinó-Mendanha	EPA of Brisas EPA of Sepetiba Bay Area		EPA of Sepetiba Bay Area	--
Number of routes/name	Sector Pau da fome Camorim and Vargens Sector Rio da Prata Sector Sector Ilha de Guaratiba Piraquara Sector Beaches Sector	Trails to the Waterfalls	It has no registered trails because it does not allow recreational activities.	Three non-named routes	--	--
Environmental law	State Law No. 2,377 of June 28, 1974	State Decree No. 44,342 of August 22, 2013.	State Decree No. 7.549, November 20, 1974	Ordinance 44/99 D.O., 14/05/1999	Is not protected by specific environmental law** Army	Is not protected by specific environmental law** Army
Inspection bodies	State/INEA	State/INEA and Municipal	State/INEA	Federal	Federal	Federal

Data by consulting the INEA website. [1]Parque Estadual da Pedra Branca. [2]PE - State Park and PNM - Mendanha Municipal Natural Park. [3]Private Natural Heritage Reservation. [4]Parque Natural Municipal de Grumari (PNM de Grumari) and Prainha Municipal Natural Park. *Other municipalities in Rio de Janeiro State. **Atlantic Forest Law, nº 11.428, December 22, 2006. D.O. - Official Journal.