

Conservation action plan for the Brazilwood *Caesalpinia echinata* in Rio de Janeiro State, Brazil

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Introduction

Brazilwood (*Caesalpinia echinata* Lam., Leg. Caes.), Brazil's national tree, is a threatened species whose natural occurrence is confined to the Atlantic Coastal Forest, a vegetation area situated in the Southeastern coast of South America and considered a hotspot for biodiversity conservation.

In the past few years, the remnant areas of the Atlantic Forest have undergone intense environmental degradation. Along the coastal plain, where the rare forest fragments with Brazilwood populations are located, the situation is critical and requires that immediate action be taken in terms of planning and defining priority conservation areas. However, current knowledge about the areas in which they occur naturally is scarce and very fragmented and this makes it difficult to establish an effective strategy for the conservation of the species.

Brazilwood plays a major role in the country's history and culture. It represents one of the first economic resources used during the early period of Portuguese colonization, when its importance as a source of red dyes was recognized. The export of huge quantities of wood between 1501 and 1850, especially to Europe, contributed to the loss of large forest areas. In 1850 synthetic dyes (such as aniline) were developed and as result, there was less demand for natural colorants. However, to this day the wood of this species is still economically attractive to manufacturers of violin bows.

The Brazilwood Project is an interdisciplinary project that was developed at the Rio de Janeiro Botanical Garden Research Institute with the support of the Fauna and Flora International and the Margaret Mee Botanical Foundation for the purpose of filling crucial gaps that were identified at the Brazilwood Workshop in 1997. The Project's activities focused on strengthening conservation actions for the species in one of its most important natural distribution areas. The proposal also served as the catalyst of a national initiative toward the conservation of the species with the collaboration of national and international non-governmental organizations and representatives of the public and private sectors.

The final results will be presented as a conservation plan that is to be divulged in a digital medium (CD-ROM) among the proper authorities of Rio de Janeiro State and presented to other States as a model. Provisions have been made for the outcomes to be widely publicized both in Brazil and abroad by means of the Rio de Janeiro Botanical Garden Research Institute (www.jbrj.gov.br) website and of the Global Trees Campaign and Flagship Species Fund (<http://www.fauna-flora.org>) website.

The work guidelines of the Project are divided into four components: 1) Mapping, physiognomic-floristic analysis and environmental quality of remnant areas in which the species occurs in Rio de Janeiro State; 2) Population structure studies for the establishment of conservation strategies; 3) Population genetic variability and 4) Ethnobotany.

Objectives

Mapping, physiognomic-floristic analysis and environmental quality of remnant areas in Rio de Janeiro State

Specific objectives:

- To map the remnant areas in which the Brazilwood Tree occurs.

- To analyze the physiognomic and floristic aspects of the most representative remnants.
- To study the phenotypic variation of the Brazilwood Tree.
- To assess the conservation status of the forest remnants and their respective protection status.
- To supply copies of the spatial data from the Geographic Information Systems (GIS) to governmental and nongovernmental agencies involved in conservation in Brazil, and to the UNEP-WCMC (World Conservation Monitoring Center of the United Nations Environment Program) for inclusion in the Atlas of Endangered Tree Species proposal.

Population structure studies for the establishment of strategies for the conservation of the Brazilwood Tree

Specific objectives:

- To quantify the Brazilwood individuals of subpopulations in different relief situations (coastal plain and slope) in the Center of Plant Diversity of Cabo Frio.
- To assess the conservation status of the subpopulations, based on the regeneration and fertility rates of the individuals.
- To become familiar with the phenology of *Caesalpinia echinata* Lam. in the semi-deciduous seasonal forest remnants of the Center of Plant Diversity of Cabo Frio.

Genetic variability

Specific objectives:

- To assess the population genetic differentiation as measured by RAPD and AFLP variation levels.
- To determine the gene flow among the individuals in the forest remnants found in the State of Rio de Janeiro.

Ethnobotanical studies on the Brazilwood Tree

Specific objectives:

- To investigate and understand the relationships between the local communities and the Brazilwood Tree.
- To involve the local communities that live around areas containing remnant populations of Brazilwood in *in situ* conservation projects.

Results

Mapping, physiognomic-floristic analysis and environmental quality of remnant areas in Rio de Janeiro State

The Brazilwood occurrence points were obtained based on botanic materials deposited in the Rio de Janeiro Botanical Garden Herbarium (RB), on bibliographic references, on forest inventory reports and on field research. Some of these samples were obtained prior to the project and others are results of field surveys that have been carried out since 2004 for the purpose of expanding the volume of information on the areas in which Brazilwood occurs in the state of Rio de Janeiro.

The records were stored in a databank that contained the following fields: locality, municipality, latitude, longitude, origin (native/cultivated), herbarium reference (acronym, collector, collector number and date), bibliographic reference, inventory reference (author, year, report) and notes.

The georeferenced localities were reviewed for the purpose of standardizing the geographic coordinates in a GIS environment. The non-georeferenced localities were plotted with the help of the Cartographic Bases of the Brazilian Institute of Geography and Statistics (IBGE), of the Rio de Janeiro Information and Data Center Foundation (CIDE) and of the Geological Survey of Brazil-Company of Research in Mineral Resources (CPRM), all on a scale of 1:50000.

In all 54 points were catalogued as records of the occurrence of Brazilwood in the State of Rio de Janeiro (Figure 1). All the points correspond to the coastal strip that extends from Guaratiba, in the south of the municipality of Rio de Janeiro, to the municipality of Armação de Búzios in the Lakes Region.

The forest remnants in which the Brazilwood Tree occurs were identified based on the plotted records that overlapped with the map bases of the remnant vegetation cover of the Atlantic Forest (SOS Mata Atlântica, scale of 1:250.000, 1999; CIDE Foundation – Quality Index for Cities II, scale of 1:450.000, 2003). The remnants with botanic records were classified as confirmed areas of occurrence. The polygons containing confirmed occurrence were related to the following fields in the databank: area, floristic composition and physiognomy, geological and geomorphological features, soils, climatic data, decree establishing the area as a Conservation Unit, conservation status, source, land use and images.

Once the forest remnants with botanic records had been delimited and analyzed, the map of the 13 most representative remnant areas in which the Brazilwood Tree occurs in the State of Rio de Janeiro was elaborated. The areas are: 1 – Guaratiba; 2 – Sugarloaf Mountain/Leme; 3 – Niterói; 4 – Serra da Castellana; 5 – Jacarepiá; 6 – Ponta da Farinha (UFF area); 7 – Serra da Sapiatiba; 8 – São Mateus/Air-Sea Base; 9 – Morro dos Milagres; 10 – Morro do Mico/Piaçava; 11 – Boca da Barra/Praia das Conchas; 12 – Baía Formosa; 13 – Ponta do Pai Vitório/Praia da Gorda.

Population structure studies for the establishment of strategies for the conservation of the Brazilwood Tree

The individuals of Brazilwood sampled in 3.6 ha of five remnants of the Semi- Deciduous Seasonal Forest in the Center of Plant Diversity of Cabo Frio and in a small remnant in the city of Rio de Janeiro showed that the populations are regenerating, as was clearly demonstrated by the typical reverse *J*-shaped curve in which the highest percentages of sampled individuals are at the plantlet and young plant stages of growth.

Among the subpopulations sampled at the Center of Plant Diversity of Cabo Frio, only the Morro da Piaçava, a slope near the sea, presented a different structure: of the 144 individuals 2.8% are plantlets, 9.0% young, 40.2% pre-reproductive and 44.4% are adults 1 and 3.5% adults 2. The rest of the areas with different geological formations and relief presented the following percentages, respectively: (1) remnant on a coastal plain (Baía Formosa, José Gonçalves): 16.6% plantlets, 76.6% young, 1.9% pre-reproductive, 3.1% adults 1 and 1.8% adults 2 (N=615); (2) remnant on a mid-slope facing the sea (Praia Gorda): of the 377 sampled individuals, 40.6% are plantlets and 37.1% young plants, while only 9.0% are pre-reproductive plants and 7.2% are adults 1 and 6.1% adults 2. Two continental slopes share the greatest number of individuals, respectively, (3) Morro do Mico in Cabo Frio (Figure 2), with 628 sampled plants, 67.8% of which are plantlets and 22.1% are young, 3.2% are pre-reproductive, and 4.8% are adults 1 and 2.1% adults 2, and (4) Serra de Sapiatiba in São Pedro da Aldeia, with 824 sampled plants, 65.8% of which are plantlets, 23.8% young, 5.1% pre-reproductive, and 3.8% are adults 1 and 1.6% adults 2.

The other population that is also regenerating in the municipality of Rio de Janeiro is in (5) Pedra de Guaratiba, with 157 individuals growing on a continental slope, 64.0% of which are plantlets, 4.5% young, 4.5% pre-reproductive, and 7.6% are adults 1 and 18.5% adults 2.

Genetic analysis of the individuals of the Cabo Frio/Búzios, Saquarema and Guaratiba region

Caesalpinia echinata individuals collected in the areas in the Cabo Frio/Búzios (José Gonçalves, Morro da Piaçava, Morro do Mico and Sapiatiba), Saquarema and Guaratiba region were genetically assessed. The Cabo Frio and Búzios region is very fragmented and a similarity matrix based on the proportion of shared fragments was used to establish the relationship among the 41 sampled individuals of this region. The similarity matrix clearly demonstrated that the 41 individuals that represent these different areas make up a single population since no structuring of any kind is observed among the presumed subpopulations and the similarity scores among the individuals are higher than 85%. Therefore, for the purpose of analyzing intra-

population variation and variability distribution in and between populations, the samples originating from this region are considered to be an integral part of a single population. The genetic relationships with the Saquarema and Guaratiba populations, based on *F_{st}* values (rate of genetic differentiation) (Table 1) clearly demonstrate that the population of Cabo Frio bears a greater similarity to Saquarema's. These populations are about 60km apart and small stretches of forest connect them to one another, and they also present the highest gene flow, based on the number of migrants

Ethnobotanical studies on the Brazilwood Tree

The ethnobotanical research activities were carried out at the Center of Plant Diversity of Cabo Frio among three communities that exist in areas that are adjacent to the remaining Brazilwood populations. Two of these communities are located in the municipality of Cabo Frio: the Jacaré neighborhood (near Morro do Mico) and the Però neighborhood (near Morro da Piaçava); the other one, José Gonçalves, is near Baía Formosa and is inserted in the municipality of Armação de Búzios.

The people who live in these communities answered questions and were requested to participate revealing what they knew about the Brazilwood Tree. They were asked about their local perception in relation to the frequency, abundance, importance and current uses of the Brazilwood Tree, as well as about their proposals for the conservation of this species. 643 interviews were carried out with the residents of these three communities, 381 of which took place in the Jacaré community (and correspond to 20% of the total number of residences in this community), 194 in the Però neighborhood (18% of the residences) and 68 in the José Gonçalves community (10% of the residences).

In the three communities studied, Brazilwood was not mentioned as being a plant of great utilitarian interest at present. There was a consensus among the three communities in relation to the historical and environmental importance of this plant in Brazil.

Consequently, the interviews demonstrated that local perception in relation to the abundance of Brazilwood in the Jacaré and in the Però communities was that the quantity of Brazilwood trees has been decreasing in the past few years; in José Gonçalves, the community noticed that the quantity has been increasing, and in addition, it pointed out the presence of many young individuals growing in the wild.

Conclusions

Fieldwork results were exceptional in terms of the surveys for identification of new remnant areas. The current scenario is quite different because it is in the municipalities that the largest forest fragments with natural Brazilwood populations are located.

The categorization of the areas that surrounded the fragments made it possible to assess risk situations that were mainly a result of land use impacts. Remnants that are situated in urban areas are, as a rule, more susceptible to the effects of human activities. In these locations, in addition to the strong impact from the surrounding areas, the density presented by the populations is very low.

The management of remnant vegetation located around cities in areas in which human populations are present is not an easy task. Cities impose their growth and depending on the urban profile they have acquired and, on the level of awareness of their populations, their vegetation will be easier or more difficult to manage. However, the government agencies are the ones responsible for stimulating such awareness and for promoting exemplary measures for the conservation of remnant forest areas in or around cities as a means by which to ensure that the populations' quality of life will be better.

With regard to the remnant Brazilwood populations in original forest areas in the Center of Plant Diversity of Cabo Frio, which involves the municipalities of Saquarema, São Pedro da Aldeia, Cabo Frio and Armação de Búzios, the indicated management activities should not only aim to ensure legal protection for the remnant areas, but also to plant Brazilwood trees with a view to enriching the existing fragments. This is important for maintaining the structural integrity of the populations and consequently improving the quality of life in the location.

Local people were paid to plant Brazilwood seedlings in areas that already contained impoverished subpopulations of Brazilwood trees. This was a positive and novel method of forest-species population management.

The planting of seedlings in public places and yards in the regions in which Brazilwood trees occur must not be avoided, but rather encouraged, because new plantings will add to the natural vegetation remnants, and thus ensure the gene flow of the populations. However, the origin of the seedlings must always be considered for the sake of ensuring the identity of future populations.

The ethnobotanical studies undertaken in the communities of the Jacaré and Però neighborhoods (in the municipality of Cabo Frio) and of the José Gonçalves neighborhood (Armação de Búzios) presented broad agreement in relation to the proposals for managing the Brazilwood Tree in its remnant areas. Based on the 672 interviews that were carried out in these three areas, the proposals emphasized by the communities were those that considered the conservation of the remnant areas (60% of the interviewees) and the implementation and creation of additional regional horticultural nurseries for local cultivation of this species with the involvement of the local population and consequent generation of income (30% of the interviewees). Other proposals were also remarked on, such as building awareness in youngsters and adults (activities in the environmental education area); replanting Brazilwood trees in natural environments (reforestation); encouraging and strengthening environmental control and inspection by the agencies responsible; and creation of additional natural preservation areas.

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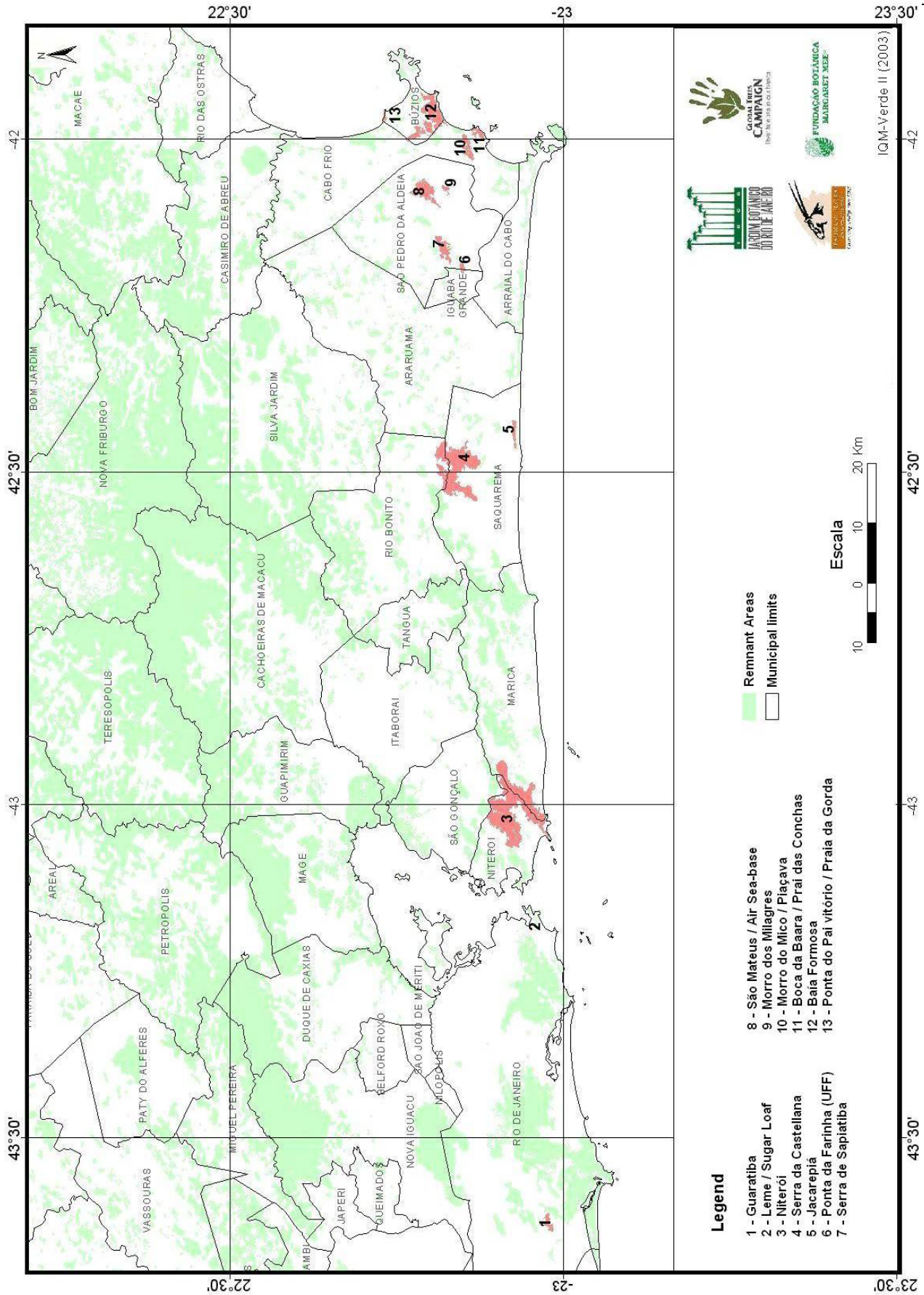


Fig.2 Botanical records of the Brazilwood Tree (*Caesalpinia echinata* Lam.) in Rio de Janeiro State



Fig 2 View of the City of Cabo Frio (Jacaré community) from the Morro do Mico, one of the last urban remnants of brazilianwood (Caesalpinia echinata Lam.). Photo: João Paulo G.R.Rodrigues