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DEFORESTATION AND PRESERVATION OF THE ATLANTIC FOREST IN THE STATE OF SÃO PAULO, BRAZIL

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ABSTRACT

The Brazilian Atlantic Forest system originally stretched in an uninterrupted line from Rio Grande do Norte (northeast) to Rio Grande do Sul (south) and was one of the richest and most diverse macro-ecosystems in the world (Miller, 1994). Five hundred years of colonization and exploration have since taken a large portion of the original area. Most remnants of the original forest are widespread forest fragmentation found only on mountaintops and coastal mountain ranges facing the South Atlantic Ocean. Increasing attention over the past three decades has been given to the Brazilian Atlantic Forest for high deforestation rates and consequent fragmentation effects in tropical regions (Viana, 1997). This work intends to give a brief review of how deforestation of the Atlantic Forest (Mata Atlântica), has occurred and specifically, how it has affected the State of São Paulo. Secondly, this work discusses how preservation of remaining forest fragments of Atlantic Forest has developed. Finally, a discussion of preservation programs of the Atlantic Forest is presented.
KEY WORDS: Atlantic Forest, Deforestation, São Paulo, Agriculture, Preservation.

DESMATAMENTO E PRESERVAÇÃO DA MATA ATLÂNTICA DO ESTADO DE SÃO PAULO – BRASIL.

RESUMO

A Floresta Atlântica Brasileira abrangia uma linha continua que se extendia desde o Estado do Rio Grande do Norte até o Rio Grande do Sul e era considerada um dos mais ricos e diversos ecossitemas mundiais (Miller, 1994). Cinco séculos de colonização e exploração desmataram grande porção da área original desta floresta. Grande parte dos remanescente da Floresta Atlântica Brasiliera estão espalhados sob forma de fragmentos nos topos de montanhas ou em cadeias montanhosas da costa leste beirando o Oceano Atlântico. Nas últimas três décadas cresceram as atenções sobre a Floresta Atântica Brasiliera devido à alta taxa de desmatamento e fragmentação nas regiões tropicais (Viana, 1997). Este trabalho é uma breve revisão de como o desmatamento da Floresta Atlântica Brasileira (Mata Atlântica) vêm ocorrendo e especialmente, quais os efeitos no Estado de São Paulo. Em segundo lugar, este trabalho discute as ações de programas de preservação da Mata Atlântica.
PALAVRAS-CHAVE: Mata Atlântica, Desmatamento, São Paulo, Agricultura, Preservação.

I - INTRODUCTION

The Brazilian Atlantic Forest originally stretched in an uninterrupted line of approximately 4,000 km from Rio Grande do Norte (northeast) to Rio Grande do Sul (south). It was one of the richest and most diverse natural environment in the world (Miller, 1994; Por, 1992). Five hundred years of colonization and exploration have since taken a large portion of the original area. Most remnants of the original forest are widely scattered

on mountaintops and coastal mountain ranges facing the South Atlantic Ocean. Due to high deforestation rates and consequent fragmentation effects in tropical regions, increasing attention over the past three decades has been given to the Brazilian Atlantic Forest (Viana, 1997).

This paper intends to give a brief description of the Atlantic Forest (Mata Atlântica) followed by a historical backdrop of deforestation as it has occurred in Brazil, particularly in the State of São Paulo. Secondly this paper discusses how efforts to preserve the remaining forest fragments of Atlantic Forest have implemented in São Paulo. Finally, it is presented a discussion of conservation programs of the Atlantic Forest at government and non-governmental levels.

II - THE ATLANTIC FOREST CHARACTERISTICS

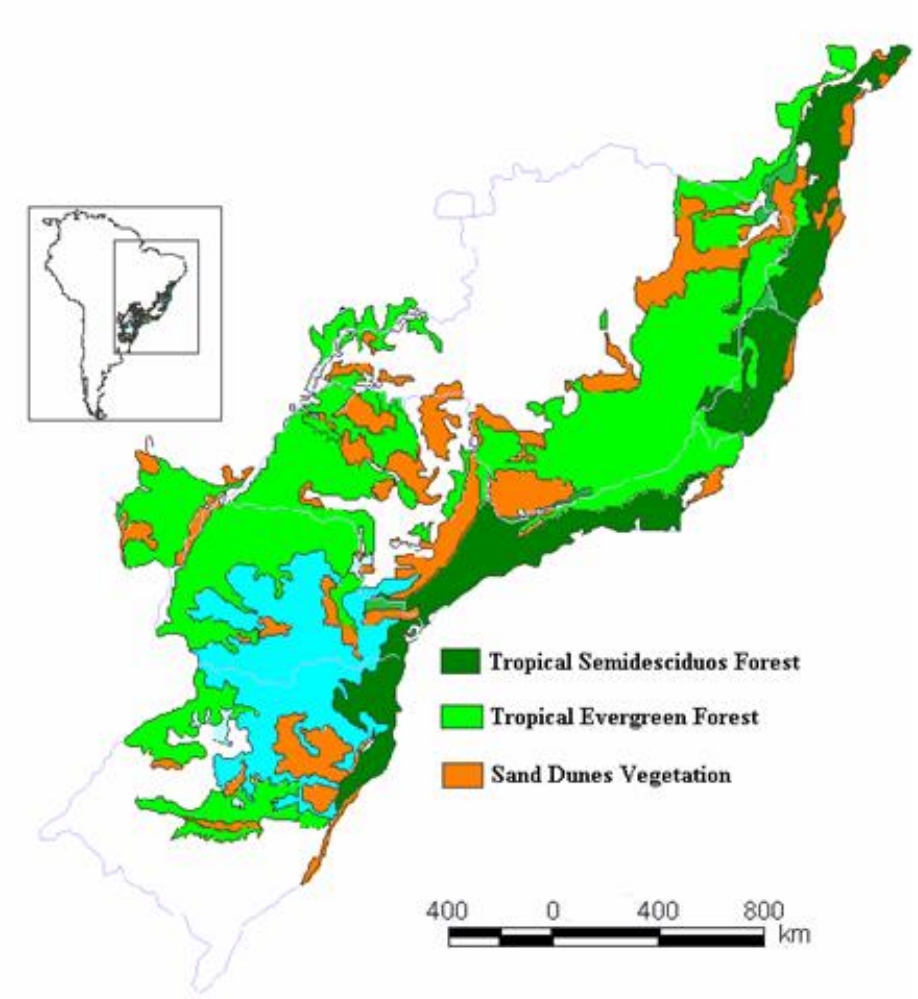
In the early 16th century, the Brazilian Atlantic Forest covered about one million square kilometers of eastern and southern Brazil, representing 12% of Brazil's total land surface (Câmara, 1991). This forest has been reduced to 8% its original size, though it still remains rich in biodiversity of flora and fauna (SOS MATA ATLÂNTICA and INPE, 1993; Quintela, 1990). Also, it is one of the most endangered ecosystems of the planet, most of its species are endemic and threatened with extinction. According to Quintela (1990), 51 mammal species, 160 bird species, 53% of the trees, 64% of the palms, and 74% of bromeliads are considered endemic to this ecosystem.

Fonseca (1985) subdivided the Atlantic Forest domain into two major regions based on its vegetation types and geographical features: the Tropical Evergreen Mesophytic Broadleaf Forest (TEMBF), which originally covered most of the Brazilian eastern slopes extending to the coastline and the Tropical Semideciduous Mesophytic Broadleaf Forest (TSMBF) extending the western range of the coastal hills, stretching to the region (Figure 1). The TEMBF is found at low and medium elevations with mean annual precipitation around 2000 mm and mean annual temperatures of 16-19 C. The TSMBF covered large parts of Minas Gerais, Rio de Janeiro, São Paulo, and Paraná States. The climatic factors of these Plateau Forests are annual rainfall of 1,000 - 1,500 mm with an average rainfall around 50 mm during the winter (5 to 6 months) (Fonseca, 1985).

Characterized by lower precipitation therefore a pronounced dry season, the Atlantic Forest concentrates evergreen and semideciduous species along the coast. Also, due to the agriculture and industry expansion, very little forest still remains in the Plateau region in São Paulo State. The Plateau forests consequently, have become scattered in a mosaic of forest fragments with 280,000 ha, or 2% of its original cover (SOS Mata Atlântica and INPE).

The fragmentation of the Atlantic Forest has affected the natural habitats of many species, especially fauna. According to Câmara (1991), to describe and analyze the Atlantic Forest fauna is very difficult due to the deficiency of studies qualifying natural species and destruction of natural habitats. Additionally, the fragmentation of the Atlantic Forest has resulted in the isolation of species into small population groups. Many mammals and birds species are either threatened with extinction or endemic to the region.

Figure 1. Original distribution of the Atlantic Forest region in southeastern Brazil



Tropical Semideciduous Forests and Tropical Evergreen Forest subdividing the state into two main vegetation. The darker black line delimits the State of São Paulo. *Source*: Adapted from Fundação Biodiversitas-CDCB 1996 <http//www.biodiversitas.org>.

The biodiversity in terms of large mammals of the Atlantic Forest is relatively poor compared to small mammals. Pioneer studies have provided a general database indicating at least 129 species of non-volant mammals in the Atlantic Forest, 40% of which are endemic (Fonseca, 1989). The mammal faunas found in the Atlantic Forest are, among others, Primates, Marsupials, Carnivores, Rodents, Xenarthra, and Perissodartyla. More specifically, the Atlantic Forest harbors six genera and 20 species of Primates, two genera (*Leontopithecus* and *Brachyteles*) and 17 species, which are endemic (Camara, 1991). The most endemic species of Primates are showed in Appendix 1. Four endemic species of "mico-leões", given in Appendix 1, inhabit lowland forest and are threatened with extinction as a result of man-made destruction (Por, 1992). According to Camara (1991) Brazil officially lists these particular four primates as included fauna species threatened with extinction.

The Atlantic Forest harbors approximately 214 endemic species and subspecies of birds (Por, 1992) with 160 species found in the 'Serra do Mar'. Additionally, studies have calculated that 22,6% of Brazil's bird species are detected in a restricted area of Paraná State (Câmara, 1991). A high number of endemic species located in the Atlantic Forest has also been found in the Amazon Forest, evidencing a previous existence of connection between these two regions in Brazil. According to Câmara (1991), there are 97 common species between these two regions.

As mentioned earlier, there is a large amount of bird species in the Atlantic Forest. Comparatively, more species of birds than mammals are found in this area though the number of species threatened with extinction is larger for birds. Hunting, one of the causes of elimination of birds, has intensified because of the high diversity of these species. The illegal markets within and outside of the country are another reason for the rapid elimination of these species. Thirdly, and not less important, deforestation of the forest has caused the eradication of natural habitats, a large contributor to the decline in avifauna. Appendix 1 shows some birds that make up part of the species threatened with extinction in Brazil even though the description of all types of species of birds threatened with extinction shown in Appendix 1 is beyond of scope of this paper. The most important issue is that birds, as a group, have been threatened in the Atlantic Forest and deforestation has been one of the important contributors to this problem.

III - ATLANTIC FOREST DEFORESTATION

The coastal region of the Atlantic Forest was the first to be explored and exploited. Original deforestation occurred when the Portuguese first entered in Brazil in the 1500s. The European established trading posts along the coast, especially in Bahia and Rio de Janeiro States, and provided the first routes of penetration into the country. The fertile soils of the coastal lands were first used for sugar cane, which became the major economic activity of the colony in the 16th and 17th centuries. In the late 16th century, gold and diamond mining led to penetration inland. Depletion of mining was subsequently followed by large-scale settlement supported by agriculture the most important economic activity in Brazil. Since then, this area, especially the southeastern, has become the main industrial center of Brazil, and therefore, the concentration of the majority of the population in the country (Fonseca, 1985).

Nearly five centuries of colonization and expansion of agriculture and urbanization of Brazil are causes for the decline of the Atlantic Forest. This region, historically, experienced severe cycles that represented economic development of the country such as coffee, sugar cane and recently, the modernization of agriculture and industrialization. Additionally, timber activity for supplying São Paulo an industrial center of the country and also the international market (Europe, North America, and Japan) has contributed to the destruction of natural vegetation. Most recently, the implementation of industries of cellulose paper and charcoal for metallurgic industry has increased destruction of the Atlantic Forest. The following section describes the path of expansion and modernization of the agriculture in São Paulo State.

Coffee Cultivation

Coffee was introduced to Brazil in the 18th century with promise to improve the economy, first in the State of Rio de Janeiro and then in the State of São Paulo, after the second half of the 19th century (Instituto de Economia Agrícola, 1973). Several factors contributed to the expansion of coffee in São Paulo including a favorable climate, fertile soils, abundant land, immigrant laborers (Italian, Portuguese, and Spanish) as well as the world's growing demand for coffee (Dean, 1983).

Characterized in the beginning as a migratory crop, coffee was planted on fertile lands that had not been used before for agriculture purposes. Dean 1983, stated:

> …"One of the reasons why it was held that coffee required primary forest soils was that it was observed that groves nearest the forest edge bore the heaviest yield of berries. Some of the planters thought that his phenomenon was due to the *bafo da mata*–"the breath of the forest"–, which passed over the trees and stimulated their growth. It takes little imagination to realize that the real effect was the higher pollination rate by forest dwelling wild bees. Planters in the mid-nineteenth century were unaware of this ecological relationship." (Page 62)

Therefore, most of the forests were burned-down by 'coffee-barons' to make place for new coffee plantations. When these soils became low fertile due to extensive coffee cultures, the cultivation had to move farther West (Por, 1992). The first deforestation happened in the Valley of Paraíba, next to the State of Rio de Janeiro, followed by deforestation, which expanded westward over the plateau that occurred between 1500 and 1845 (Figure 2 – A and B). Between 1845 and 1907 the decline of the original forest was 21 % (figure 2 – B and C) and between 1907 and 1952 the decline was 40% (Figure 2 – C and D). The decline of the forest with expansion of coffee cultivation was well retracted by Cândido Portinari in one of his famous painting – *Lavrador,* 1934 (Figure 3). Actual deforestation during these periods was mainly a consequence of coffee expansion followed by the introduction of new crops.

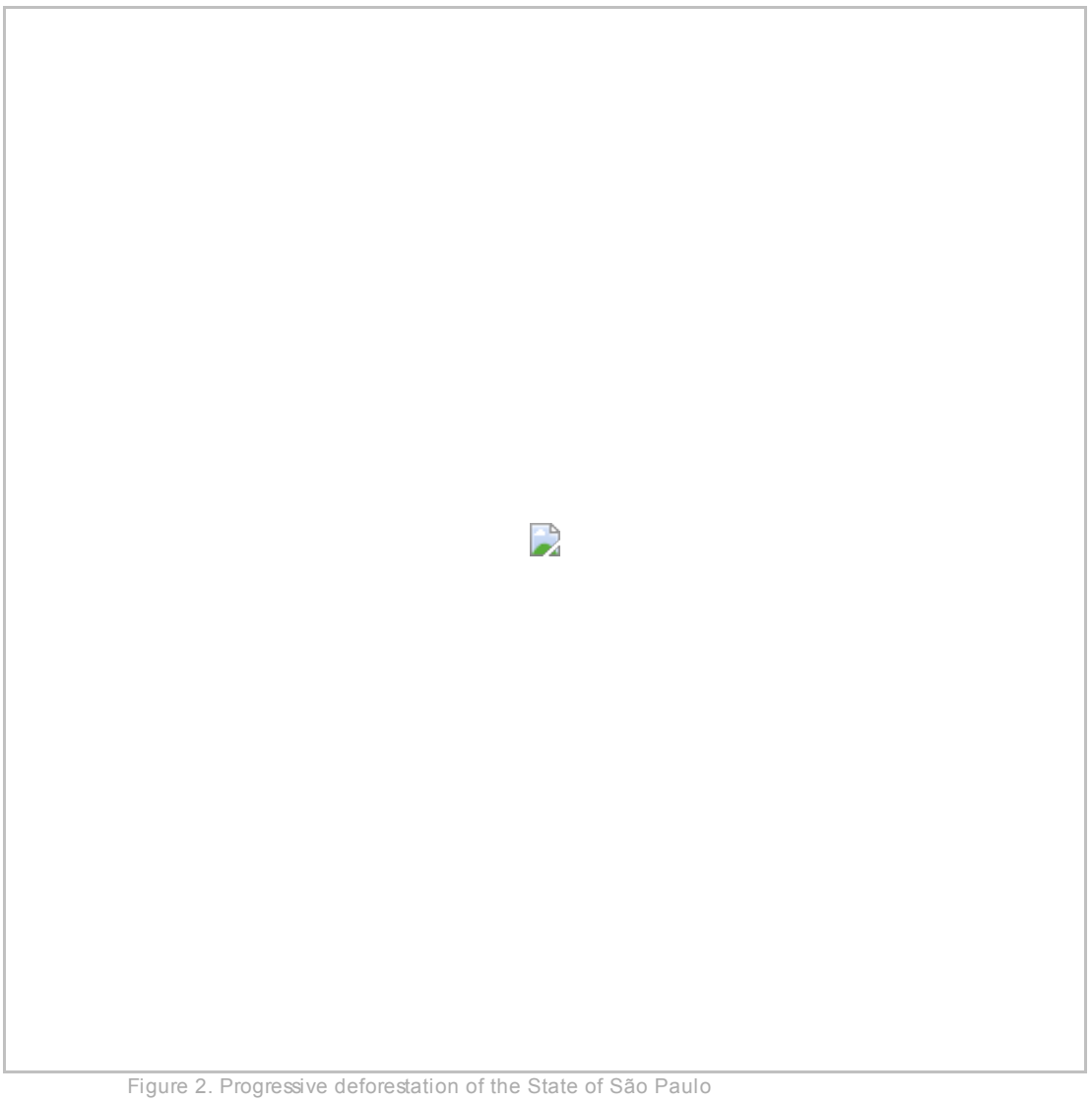


Figure 2. Progressive deforestation of the State of São Paulo

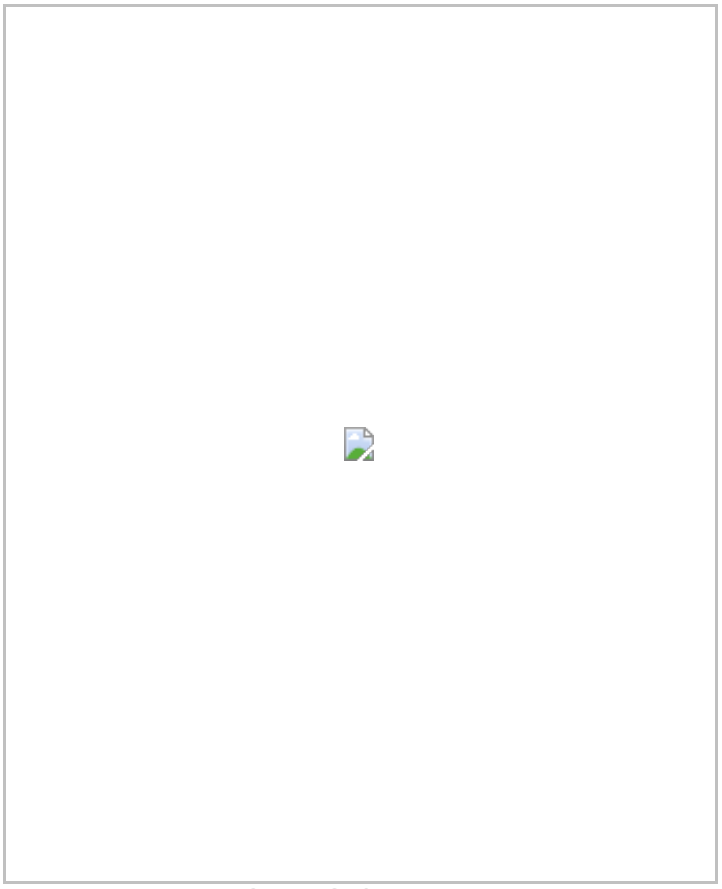
Reduction of Atlantic Forest in State of São Paulo: A (1500) supposed original forest coverage with 81.8 percent to E (1973) with 8.3 percent forest coverage. *Source*: adapted from Shafer, (1990).

By the early 1900s, São Paulo State was Brazil's most economically advanced region with coffee as the major exports (Instituto de Economia Agrícola, 1973). With the economic crash of 1929, São Paulo suffered a drastic loss in its export market and, consequently, in its economy. As the Instituto de Economia Agrícola reported in 1973:

> …"Coffee production thus swept across the state like a slow moving forest fire. However, behind the fire line coffee plantings were abandoned, as the soil became exhausted. No longer fit for coffee (which requires rich fertile soils) production on these worn-out lands shifted to other crops as well as pasture land." (Page 9)

This was the beginning of agricultural diversification in the state that brought years later modernization and intensification of agriculture. The following section attends to diversification and modernization of agriculture in the State of São Paulo.

Figure 3. Cândido Portinari's Painting – *Lavrador*, 1934.



Source: Gráficos, 1970.

The Period of Agricultural Diversification

Although cotton was economically insignificant in São Paulo State in the early 1930s, as coffee plantations started to decrease, cotton production increased significantly (Table 3). According to Por (1992), the lands left by coffee plantations were wastefully used and infertile, therefore forest areas had to be used for cotton plantation. At the end of the following ten years, São Paulo became one of the World's principal cotton producers (Instituto de Economia Agrícola, 1973). In the 1940 and 1950s sugarcane became an important cash crop in São Paulo and Paraná States. The installation of sugar and alcohol mills in the north and northwest of the state, which benefited from national sugar policy, promoted sugar cane expansion and urbanization of these regions. Additionally, the urbanization of the state increased food necessity, especially beef. Therefore landowners from west burned down the forests to become ranchers (Dean, 1995). Between 1952 and 1973 the decline of the forest in the state was approximately 10% (Figure 2 D-and E). According to Por (1992):

> …"The Atlantic Forest survived only in areas where it grows on steep mountain slopes inadequate for large-scale farming. The mountain ranges protected, up to a certain stage, their forest cover. Like later in Amazonia, road building gradually opened-up the inaccessible coastal mountain areas. The only large extension of relatively untouched Atlantic Forest, the so-called 'Lagamar' of São Paulo and Paraná, owes its existence in part to the stubborn resistance of the isolated mountain-promontory of the Serra da Juréia, which forces the southern interstate highway to run far inland." (Page 89)

The deforestation that continued around 1950s was associated with political and economical situation due to government prioritization of industry, which began to use charcoal as energy. As the demand for heavy metallurgy increased after World War II, the need for coal as energy concomitantly increased. As Brazil does not have mineral coal, and crude-oil production also is limited, larger amounts of charcoal were used relying on wood from the Atlantic domain for this purpose (Por, 1992). According to Lima (1993), by the year 1988, the Brazilian metallurgical industry consumed about 7.8 million-tons of charcoal. Native forest was responsible for 80% of its supply even though in the 1980s São Paulo State was considered self-sufficient in charcoal production by using Eucalyptus plantations.

As cited by Por (1992), studies predicted that between 1973 and 2000 the Atlantic Forest cover of the State of São Paulo could decrease from 8.3% to 3.0% (Figure 2 E – F) The prevision of deforestation that was estimated during that period, however, it was unreliable. Conservation movements and reforestation may be factors associated with the reduction of deforestation of Atlantic Forest (Por, 1992).

Table 3. Cultivated areas of the major crops in São Paulo State (1931–1980)

Year	Crop areas (1000 Ha)					
	Coffee	Cotton	Sugar cane	Orange	Corn	Soybean
1931/33	2.214,7	108,8	33,4	33,7	1.060,6	-
1934/36	1.904,3	660,4	59,5	39,3	920,3	-
1937/39	1.766,6	1.159,9	62,1	36,7	1.019,1	-
1940/42	1.159,8	1.498,1	83,2	41,1	524,8	-
1943/45	1.192,7	1.706,5	100,6	28,9	738,6	-
1946/48	1.306,5	1.200,6	116,6	19,7	884,5	-
1949/51	1.381,4	1.152,6	146,7	17,8	869,4	-
1952/54	1.451,7	1.115,3	209,2	15,7	898,9	-
1955/57	1.554,4	802,2	267,8	18,0	978,1	1,78
1958/60	1.633,9	649,7	345,9	29,2	997,2	2,64
1961/63	1.358,5	698,6	396,7	45,9	1.132,0	3,06
1964/66	1.081,9	674,3	487,1	63,5	1.220,2	3,68
1967/69	785,2	448,9	496,0	79,9	1.332,8	15,35
1970/72	719,5	594,3	544,0	105,1	1.357,2	46,16
1973/75	659,3	421,1	675,3	271,4	1.232,7	125,43
1976/78	593,0	289,5	794,8	298,4	1.118,7	373,40
1979/80	778,8	276,8	978,0	379,3	1.028,3	514,63

Source: Santos, (1984).

V - PRESERVATION OF THE ATLANTIC FOREST

Conservation movements in Brazil started in the beginning of this century. The first acts of preservation of the Atlantic Forest began at governmental level in that time. For example, the forests covering the headwaters, which supplied the water to the cities of Rio de Janeiro and São Paulo, were protected. According to Por (1992), in 1911 the Forestry Service was established and, in 1934, important laws were established, regulating water collection, forest exploitation, hunting, and fishing. However, it was only in 1967 that the Brazilian Institute of Forestry Development, (IBDF - Instituto Brasileiro de Desenvolvimento Florestal) was established. This governmental institute declared large areas of Atlantic Forest as “forestry reserves’. Ten years later, another governmental Institution, the Special Secretary of the Environment (SEMA – Secretaria Especial de Meio Ambiente), was established permitting Brazil to enter into the growing network of national and international environmental agencies (Por, 1992). SEMA priority was to implement protection and research to the forestry reserves called ‘Estações Ecológicas’ (Ecological Stations). Years later, both IBDF and SEMA were joined into a new Federal agency, the Brazilian Environmental Institute (IBAMA – Instituto Brasileiro de Meio Ambiente), which became the highest national authority on nature conservation in Brazil. In 1989, IBAMA declared the Atlantic Forest the most endangered biome of Brazil though there is controversy over what area constitute the Atlantic Forests under law (Por, 1992).

The diversity in terms of protected areas of the Atlantic Forest seems to be complex and very bureaucratic. A study organized in 1988 by SEMA and the Brazilian Institute of Geography and Statistic (IBGE - Intituto Brasileiro de Geografia e Estatística) showed that not only are there many kinds of conservation units for the Atlantic Forest but also that these units can be administered at different government levels, that is, Federal, State or Municipal (Câmara, 1991) (Table 4). Additionally, these units are classified according to their area and location (Figure 4). In São Paulo State, there are only two ‘Estações Ecológicas’ (Ecological Stations) on the littoral islands, which are administered at the Federal level and 20 Ecological Station administered at the State level. Moreover, São Paulo has 111 different categories of protected areas, which represents 14% (3.5 million hectares) of its land area (Por, 1992).

Table 4. Different categories of protected areas of Atlantic Forest in Brazil (1989)

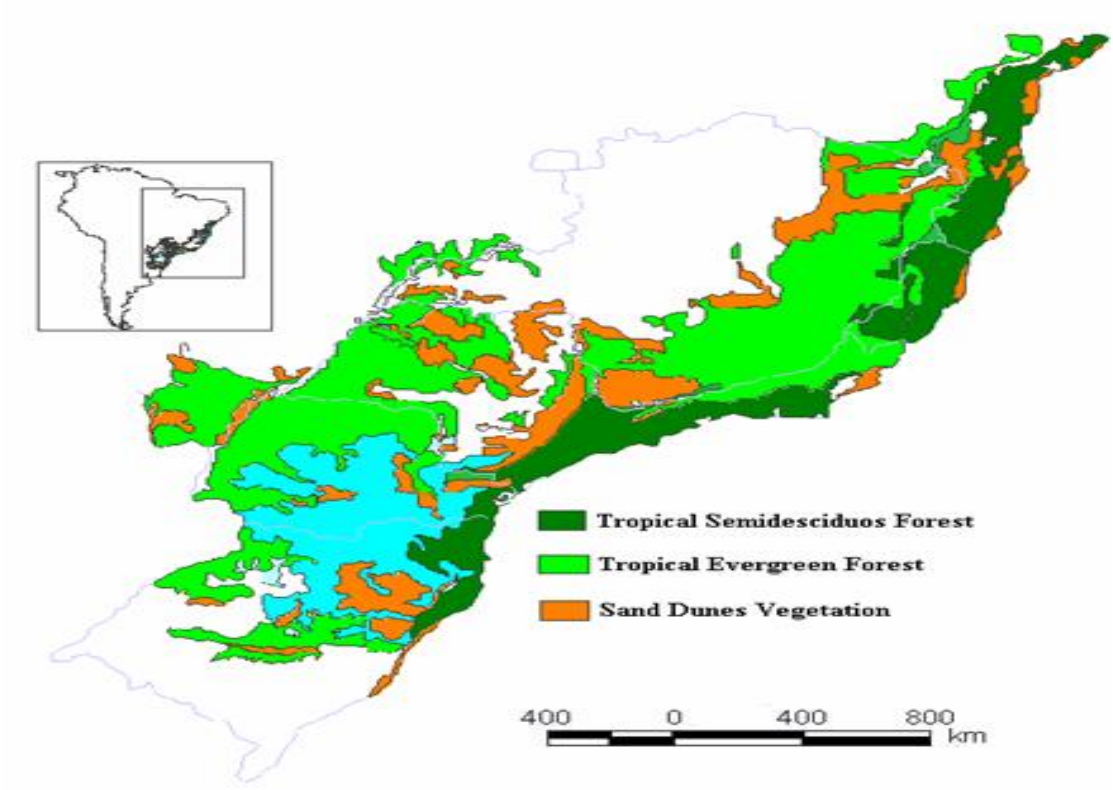
AEIT	Área de Especial Interesse Turístico	PAE	Parque Estadual
APA	Área de Proteção Ambiental	PAN	Parque Nacional
APAE	Área de Proteção Ambiental Estadual	PFE	Parque Florestal Estadual
APAF	Área de Proteção Ambiental Federal	PBE	Reserva Biológica Estadual
EEE	Estação Ecológica Estadual	PBF	Reserva Biológica Federal
EEF	Estação Ecológica Federal	UC	Unidade de Conservação

Source: Câmara, (1991).

Although Federal and State laws delimit the areas in detail, the units are not visibly delimited in the field therefore considerable practical problems in terms of protection of the areas arise. Additionally, legal protection is inhabited by a lack of policemen, cars, and boats to cover areas involved. In part because conservation units are located close to urban or agricultural areas, there is a concern about its preservation among the local population, especially in the 1980s and 1990s. The involvement of non-governmental agencies (NGOs) has grown giving way to the formation of 'Consórcio Mata Atlântica', an important movement coordinated by state and conservation authorities to preserve Atlantic Forests. The contributions of these NGOs are considerable: 'SOS MATA ATLÂNTICA', for example is involved in producing cartographic material and a wide-range of educational program as well (Por, 1992).

Finally, another important level of assistance is derived from several Universities such as the Federal University of Rio de Janeiro, the University of São Paulo, the University of Campinas and the University of Paraná, all of that are active in Atlantic Forest research and conservation. Research focused on Atlantic Forest fauna and vegetation has increased in Universities, which is one of the best contributions to the preservation of this world-ranked and richly biodiverse 'bioma'.

Figure 4. Parks and conservational units in São Paulo State (1999)



The remained forest in São Paulo State subdivided in three groups: b. coastal forests; c. interior forests; d. mountain forests. *Source*: Adapted from Fundação Biodiversitas, 1999 – <http//www.biodiversitas.org>.

V - CONCLUSIONS

The parameter of Brazilian Atlantic Forest was deforested in its area of São Paulo State in order to develop the agricultural frontier especially around the turn of the century with an emphasis on coffee plantations and subsequently agricultural diversification. Although these policies brought economic advantages and modernization to the state, they did not emphasize the preservation of biodiversity and the Atlantic Forest. The lack of both control on the part of government and planning on the part of farmers resulted in fragmentation of the forests and consequently destruction of most natural habitats of fauna and flora.

Agriculture and urbanization continue to pressure these forest fragments in São Paulo State. According to Câmara (1991), there are still 80 forest fragments in the state, a large area to limit the rate deforestation and increase preservation efforts. Also, most of these forests are in private hand, which inhibit preservation for reason of insufficient economic resources despite private ecological stations that are

benefiting from ecotourism.
Awareness of preservation and the 'bioma' richness is fostered in educational programs, which require extension to the population. Furthermore, the Atlantic Forest parks and reserves need more funds to develop studies and research and management programs that actually preserve and protect the biodiversity of the Atlantic Forests.

Extensive urbanization, especially in the City of São Paulo is one of the major factors endangering forest units of 'Mata Atlântica'. Although Federal and State governments displayed some protecting laws in the past three decades to preserve a few fragments of Atlantic Forest, more efforts, studies and research are necessary.

APPENDIX 1

The most endemic species of Primates of the Atlantic Forest Brazil

Species	Common name
Brachyteles arachnoides	Mono-carvoeiro, murigui
Callicebus personatus	Saá, Sauá ou Guigó
Callithrix flaviceps	Sagüí taquara ou Sauim
Callithrix aurita	Sagüí
Leontopithecus rosalia	Mico-leão-dourado
Leontopithecus chrysometas	Mico-leão-cara-dourada
Leontopithecus chrysopygus	Mico-leão-preto
Leontopithecus caissara	Mico-leão-cara-preta
Cebus appela xanthosthernus	Macaca-prego

Source: Subsídios técnicos para a elaboração do Relatório Nacional do Brasil para UNCED/92.

Species of birds of the Atlantic Forest Brazil threatened with extinction

Species	Common name
Tinamus solitaris pernambuceusis	Macuco-do-Nordeste
Mitu m. mitu	Mutum-do-Nordeste
Crax Blumenbachü	Mutum-do-Sudeste
Neomorphus geoffrogi dulcis	Jacu-estalo or Jacutaguara
Pipile jacutinga	Jacutinga
Amazona brasiliensis	Papagaio-da-cara-roxa
Amazona petrei	Papagaio-chorão
Amazona rhodo corytha	Papagaio-chauá
Amazona vinacea	Papagaio-curraleiro

Source: Subsídios técnicos para a elaboração do Relatório Nacional do Brasil para UNCED/92.

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