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David C. Oren

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BIODIVERSITY PATTERNS AND MANAGEMENT IN A CHANGING BRAZIL

David C. Oren

I. Introduction

Brazil is probably the richest nation on earth in terms of biodiversity, holding more species than any other. The reason we have to say "probably" is a reflection of two things. First, what do we mean by "biodiversity," a term that is used by many people to mean many things, ranging from the total number of species (the most common use) to total genetic diversity of living things in a given area, to functioning ecosystems? Let's settle on using the term as meaning numbers of species. That brings us to the second problem. We don't know how many species there are on the planet, and, unfortunately, although there seems to be a perception on the part of nonscientists that there is a tremendous effort to address this, less is being done than should be to correct this failure. The community of biologists still debates this question vigorously, and the accepted estimates range from 10 to 100 million species.[1] Our ignorance of life on earth is still far more encompassing than our knowledge, and in this case, we are talking only about numbers of species. The ecological requirements, reproductive patterns, and economic potential, among other pertinent questions, of the great majority of our fellow species on this planet are even less well deciphered. In any case, Brazil is unquestionably one of the megadiversity countries, sharing this title with five others: Colombia, Indonesia, Madagascar, Mexico, and Democratic Republic of the Congo.[2] Brazil is first in the number of primates (59 of 205 worldwide),

angiosperms (an estimated 55,000) and amphibians (516), and second in the number of bird species (1,705).[3]

Here I would like to discuss how the extraordinary wealth of Brazilian biodiversity is divided up into major ecosystems, or biomes, and some of the threats to these biomes, and then how these resources are being evaluated, managed, and protected. To that end, I shall discuss the importance of this in light of the recent and important changes that are taking place in Brazil with globalization, the national privatization program, and the consolidation of the Mercosul Agreement (which established a free trade zone between Brazil, Uruguay, Paraguay, and Argentina).

II. Brazilian Biomes

Brazil can be considered to have seven major biomes: the Atlantic Forest (Mata Atlântica, including sectors in the interior), the Caatinga, the Cerrado, the Pantanal, the Pampas and related ecosystems of the South ("Southern habitats"), coastal ecosystems, and Amazonian forests. These biomes can be divided into ecoregions.[4] The geographical extent of each ecoregion is as follows:

Atlantic Forest
- Interior 803,908 km^2*
- Sensu stricto 233,266 km^2**

Caatinga **
- 752,606 km^2

Cerrado *
- 1,982,249 km^2

Pantanal *
- 140,927 km^2

Southern habitats
- "Uruguayan" Pampas 336,000 km^2, approximately 20 percent of which is Brazilian
- Araucaria forests 206,459 km^2*

Coastal habitats
- Restinga 8,740 km^2**
- São Luís flooded grasslands 1,681 km^2**
- Northeastern Brazilian restingas 10,248 km^2**

Amazonia
- Amapá moist forests 195,120 km²*
- Uatuma moist forests 288,128 km²*
- Japurá/Negro moist forests 718,551 km²*
- Southwestern Amazonian moist forests 534,316 km²*
- Juruá moist forests 361,055 km²**
- Várzea forests 193,129 km²*
- Purus/Madeira moist forests 561,765 km²**
- Rondônia/Mato Grosso moist forests 645,089 km²*
- Tapajós/Xingu moist forests 630,905 km²**
- Tocantins moist forests 279,419 km²**
- Amazonian savannas 120,124 km²*
- Eastern Amazonian flooded grasslands 69,533 km²**
- Guianan savannas 128,375 km²
- Tepuis 49,157 km²
- Guianan moist forests 457,017 km²

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* majority Brazilian
** exclusively Brazilian

Each of these biomes has its own distinctive fauna and flora and these biomes can be used as the major unifying elements of Brazilian biodiversity.

A. Atlantic Forest Biome

This is the biome that has suffered the greatest human impact. It originally encompassed approximately 12 percent of the national territory, and only 1 to 5 percent is intact today.[5] World attention has been called mostly to the ecoregion of the coastal evergreen forests, and there are a number of important reserves, especially in the southern portions. Furthermore, in southern Bahia and in Espírito Santo, cacao plantations preserve large tracts of original forest canopy, allowing the survival of many characteristic native species. The last major wave of deforestation in the northern coastal forests was during the 1970s and early 1980s, when Brazil's energy program to substitute gasoline with sugarcane alcohol was in full swing, and now the northern extentions of this ecoregion are almost completely destroyed, with only small patches remaining.[6] Even more threatened than the coastal forests are the interior semideciduous forests, where

the terrains are more appropriate for agriculture and other economic activities, including reforestation with exotic species. Relatively small sections of interior Atlantic forest are found in Argentina and Paraguay, while the coastal Atlantic forest is exclusively Brazilian.

B. Caatinga Biome

The Caatinga is characterized by long dry seasons. In some regions it may not rain for more than a year at a time, although most of the biome precipitation patterns indicate a dry season of from six to eleven months. Cactus and thorny scrub are typical elements of the flora, but in regions with relatively rich soils, exuberant deciduous forests grow. There is no official estimate of how much of this biome has been affected by human activities, but it is certainly the majority, with special emphasis on the destruction of the deciduous forests since these hold important biomass for charcoal (Brazil's steel and iron industries are the only ones in the world that still depend 100 percent on charcoal) and grow on the richest soils. Major irrigation projects along the Rio São Francisco, for example, have put additional pressure on the remaining forests. There are very few conservation units in this biome. Caatinga is exclusively Brazilian.

C. Cerrado Biome

Cerrados are a kind of savanna, ranging from open grasslands, known as *campo limpo*, to almost closed-canopy forest called *cerradão*. Natural fire appears to be an important component of these ecosystems, and most of the vegetation shows adaptations for dealing with periodic burning. The dry season in this biome extends from three to five months of the year. Human influence is rapidly growing in the Cerrado. Fire frequency has increased in large sectors where cattle ranching is important, and the recent development of specially adapted varieties of soy has meant that increasing acreage is being converted to agriculture. Removal of the arborescent elements of the Cerrado is an important source of charcoal, and extensive regions are now in eucalyptus plantations for both charcoal and paper pulp. Silva[7] estimates that approximately 50 percent of the Cerrado has suf-

fered human alteration. Approximately 98 percent of the world's Cerrado is in Brazil, with a few small patches in Bolivia and Paraguay.

D. Pantanal Biome

The Pantanal is one of the world's largest marshy regions and is located in the headwaters of the Rio Paraguay basin. It has some of the greatest potential for ecotourism in Brazil due to its abundant and easily observed fauna, but it is threatened by gold-mining activities (erosion and resulting siltation and mercury poisoning), burning during the dry season, deforestation, clandestine hunting, and, perhaps most dangerously, plans to make the Rio Paraguay navigable, an engineering feat that would completely change the region's hydrology.[8] There is a single national park in the Brazilian section of the Pantanal, and it was recently increased in size through a purchase of two surrounding ranches, orchestrated by the U.S.-based nongovernmental organization the Nature Conservancy. Most of the Pantanal is in Brazil, with significant portions also found in neighboring Bolivia and small portions in Paraguay.

E. Southern Habitat Biome

The Southern Habitat biome comprises two ecoregions: Araucaria forests and the northern portion of the so-called Uruguayan Pampas. The vast majority of Araucaria forests are Brazilian, and exploitation for timber and agricultural expansion are the major threats to these forests. The Brazilian Constitution of 1988 formally protects the "Atlantic Forest," a term that currently encompasses the Coastal Atlantic Forest, the Araucaria forests, and portions of the Interior Atlantic Forest. Political pressure to change this definition is strong and would allow increased timber exploitation and farming. The Uruguayan Pampas extend into southernmost Rio Grande do Sul state, where they are known as the *Campanha*. Agriculture is important there, and major crops of rice, wheat, and soy are produced. Desertification is a problem in these ecoregions. Human influence has been extensive in this biome and some argue that most of the Araucaria forests are secondary in origin.

F. Coastal Habitat Biome

Mangroves and dune-associated vegetations make up this biome. In the North (Amapá, Pará, and Maranhão), the mangroves are largely intact and there are still good populations of such spectacular species as the scarlet ibis. Human utilization is increasing, however, and in some places over-exploitation of mangrove-related resources, such as crabs, is marked and has caused the stocks to decline. In northeastern, southeastern, and southern Brazil, human impact is greater and includes major industrial installations, widespread conversion for resorts, and filling and even intentional removal of mangroves to keep monkeys from invading coconut plantations.

G. Amazonian Biome

Depending on how one defines Amazonia, 80 percent (using the basin per se as basis) or 62 percent (adding the Orinoco and the Guianas) is Brazilian. Most of the region is covered by classic tropical rain forest, but there are also important tracts of open vegetation, seasonally flooded habitats, and white-sand savannas. Of the fifteen Amazonian ecoregions represented in Brazil, five are exclusively Brazilian and seven are mostly Brazilian. The vast majority of Amazonia is still intact, and estimates of deforestation range up to 20 percent. I am now going to explain the subdivision of biodiversity in the Amazon, the Brazilian biome that I have concentrated my research on, to try to shed light on the kinds of questions that affect all of Brazil's biomes and the administration of the nation's extraordinary biological wealth as a whole.

1. The Amazon Rain Forests

In a strict sense, the term "Amazon rain forest" is a very inappropriate one. We should talk about the "Amazon rain forests," because the region's biological diversity is very subdivided. Brazil-nut trees, for example, are found only in the eastern part of the basin. Rubber trees of quality are concentrated south of the Amazon River. Most bird species are found in only a portion of the basin, with widespread species the exception rather than

the rule. The fabulous biological wealth and its regional subdivision fascinated the earliest explorers, who noticed that the creatures on opposite sides of the banks of the major tributaries were often different. This led to a theory known as the "river theory" of Amazonian biodiversity, first proposed by Alfred Russel Wallace.[9] In 1969, Jürgen Haffer[10] proposed that climatic shifts during the Pleistocene had caused biological differentiation. This theory, known as the "Pleistocene refugia theory," was widely accepted and became essentially a paradigm to explain patterns of biological wealth in lowland tropical America. Nelson and colleagues[11] challenged this theory convincingly by showing that all putative refuges were coincident with major collecting localities. Essentially, how can a region be considered a refuge if it is unknown? Most recently, Finnish researchers working in Amazonian Peru have convincingly demonstrated that it is the geological dynamics[12] of the basin that have determined biological evolution in it.

2. What do we know about Amazonian biodiversity?

There is a misconception on the part of those who have never visited the Amazon that it is uniform, wall-to-wall, high terra firma forest. This is far from the truth, and there are important enclaves of other vegetation types.

How much information in fact exists regarding Amazonian biodiversity? There are three data bases that can be considered especially good: birds, butterflies, and primates. Because of their aesthetic appeal, the first two were the subject of intense commerce since the late eighteenth century. The third group is well known because of primates' close relationship with humans and their importance as experimental models for medical experiments. But even in primates, five new species have been discovered in the Amazon in the last six years and more are yet to be found. Butterflies have been the particular object of attention by an American scientist at the University of Campinas (Unicamp).[13] To give you an idea of our level of understanding regarding Amazonian biodiversity, I would like to show you the results of an exercise that a student of mine and I performed regarding the geographic distribution of bird collecting efforts in Brazilian Amazonia.[14] We can see from this that 60 percent of

the region is still unexplored for even the best known groups of organisms. For less well studied plants and animals, the coverage is even more fragmentary. It is not surprising that in a recent evaluation of mammal diversity in all of lowland tropical Central and South America, Voss and Emmons found only fifteen sites where the data bases were sufficiently complete to be able to make intelligent comparisons.[15]

When one superimposes maps of biological inventory effort, such as that for birds, over maps of deforestation,[16] we can see that the most deforested sections of Amazonian Brazil coincide with many of those still unstudied. This indicates the urgency of a concentrated effort to catalogue Amazonian biodiversity before it is lost.

3. Attempts to Challenge the Importance of Amazonian Biodiversity

In 1992, University of Oklahoma mammalogist Michael A. Mares[17] published a highly controversial article in *Science* titled "Neotropical Mammals and the Myth of Amazonian Biodiversity" in which he claimed that "drylands are the richest area [in South America] in numbers of species supported and are more diverse than the other habitats, including the lowland Amazon rain forest." Mares's intent — to show that dry habitats support important components of the continent's biological diversity" — is a valid one, but he used a biased data base, specious arguments, and an agressive style that are inappropriate for the standards of scientific debate.

In this article, Mares divided all of South America into six major macrohabitats: lowland Amazon forest, western montane forests, Atlantic forest, southern mesophytic forest, upland semideciduous forest, and drylands. There are a number of problems with this article. Because it was as influencial as it was for policy makers and published in such a high-profile scientific journal, it is important to deal with some of its methodology and conclusions to fully understand the true importance of Amazonian biodiversity.

In his "drylands macrohabitat," Mares lumped together such diverse regions as the Cerrado, the Caatinga, the Pampas, the Chaco, the Llanos, the savanna enclaves within Amazonia, and the high-altitude deserts of the altiplano of the Andes. The inclu-

sion of so many different major biomes in South America as a single "macrohabitat" is of questionable scientific usefulness; all the other macrohabitats are much more narrowly defined.

Mares himself has been one of the most active fieldworkers in the study and classification of South American mammals, concentrating precisely on drylands. Our knowledge of the mammals of these ecosystems is relatively good when compared with that of the Amazon rain forest or the Atlantic forest, for example; therefore, his data base for drylands is much more complete than that of the other habitats.

Mares did not include such taxa as manatees and dolphins, which, while aquatic, indirectly depend on the forested ecosystems of the Amazon. An unbiased analysis of mammal faunas of South America should include them, and would place the Amazon as much more important than in Mares's skewed data base.

A close view of Mares's data base[18] indicates that one of the ten nonvolant mammal orders used in his analysis is claimed by him not to be found in Amazonian lowland forests. The exclusion of this order, Lagomorpha, is inappropriate, since *Sylvilagus*, the tapiti, or South American Cottontail, is indeed found in forests in several parts of the basin.

Even if Mares's biased data set is accepted, his own conclusions are not supported by these data. The graphs[19] indicate that the richest areas for mammals in South America are the western montane forests, followed by the Amazon, when total number of species, total number of genera, and number of endemic species are considered. Only when endemic genera are considered do the drylands show importance above that of the Amazon and montane forests. If we include manatees and dolphins as part of the data base for the Amazon, the relationship for endemic genera again shows this region to be more important than the drylands.

The important conclusion here is to show that Mares's argument is a specious one and that the generally accepted notion that the Amazon is a center of biodiversity is valid.

4. "Hot Spot" Analysis

The concept of "hot spots" of biodiversity was created by Myers,[20] based on the fact that many rare and endangered

species have restricted ranges (e.g., 27 percent of all bird species have a global distribution of 50,000 km^2 or less). Bibby and collaborators[21] mapped all the hot spots for the birds of the world, and their work has had an impressive impact. On first examination, hot-spot analysis appears to be a very efficient way to establish priorities for conservation. In fact, many key agencies have formally adopted the hot-spot concept as the principal orienting factor for funding (e.g., the John D. and Catherine T. MacArthur Foundation). A closer examination of the concept, however, reveals several problems. First, it requires an excellent data base with a high level of confidence. Although birds represent one of the best-known groups of vertebrates, their ranges are not in all cases well documented. The data base used, therefore, is fragmentary. Second, the methodology uses an arbitrary limit of 50,000 km^2. The biodiversity sub-units in the Amazon are the major interfluvial regions, and even the smallest, the Xingu-Tocantins interfluvium, is approximately four times greater than the 50,000 km^2 limit. Amazonia will never appear as a priority for conservation or biodiversity studies based on hot-spot methodology. Because of the widespread adoption of hot spots to orient financing decisions, this represents a major problem for those seeking funding for studies in the Amazon.

III. Conservation of Biodiversity in Brazil

There are almost 100 federal conservation units in Brazil, but most of them exist only on paper, particularly in the Amazon. New legislation is being studied by the Brazilian Congress to administer these areas. The federal deputy in charge of drafting the new legislation is Brazil's only congressman from the Green Party, Fernando Gabeira. His proposals are highly controversial and include privatizing the national parks because, as he says, "only Iguassu National Park turns a profit." Gabeira's positions have caused a furor in the conservation community, and it is likely that his proposals will remain stalled in Congress.

Part of the Group of the Seven (G-7) support to help conserve Brazil's forests includes a conservation-unit component. Although originally off to a very bad start, the proposal of how to use this funding has recently been reformulated by the Brazilians. The new project is called Corridors of Neotropical Forest[22]

and is based on the Biosphere Reserve concept. Five corridors are proposed for the Brazilian Amazon and three for the Atlantic Forest. If primate distributions reflect those of other organisms, the authors claim, 80 percent of the forest species of Brazil will be conserved if the project is adopted. The plan includes combining areas of strict conservation with surrounding buffer zones that include extractivist reserves (existing or to be created) and Indian lands (existing). Emphasis will also be given to providing incentives to private landholders to place their lands in Private Reserves of Natural Patrimony (RPPNs — Reservas Particulares de Patrimonio Natural). Most of the corridors already have at least some existing conservation units, and this is a convenient way of establishing priorities for investments. The most problematic corridors are in southern Amazonia in the transition region between forest and the Cerrado (one of Amazonia's most deforested regions), where there is not a single existing conservation unit, and in the highly degraded northeastern portion of the Atlantic Forest.

It is important to point out that the Conservation Corridor concept can help to preserve the biodiversity of Brazil's forests only (this, in fact, is the principal proposition of the G-7 support to the nation). Protection of Brazil's biodiversity in the other biomes will depend chiefly on Brazil itself.

A. What is Being Done to Assess Brazilian Biodiversity?

Although Brazilian, foreign, and international institutions have been at work to assess Brazil's biological diversity in one fashion or another for decades, there has been no systematic attempt to do this in an organized, rational fashion. Finally (and belatedly, considering the country's vast size, biological wealth, and chronic fears of surreptitious foreign interference in the Amazon, in particular [some well founded]), Brazil is embarking on a national biological survey. In June 1996, President Fernando Henrique Cardoso formally announced the National Program of Biological Diversity (PRONABIO — Programa Nacional da Diversidade Biológica). (One may compare that the U.S. Biological Survey began, essentially, with the Lewis and Clark Expedition [1804–6].) At the end of January 1997 the program officially launched its first major action within the context of the Project

on the Conservation and Sustainable Utilization of Brazilian Biological Diversity (PROBIO — Projeto de Conservação e Utilização Sustentável da Diversidade Biológica Brasileira).[23] Given the lost time, this first project aims to rationalize the efforts for the medium and long terms. PROBIO divides the country into five major ecosystems: Amazon Forest; Cerrado (including the Pantanal); Caatinga; Atlantic Forest and Southern Campos; and Coastal and Marine Zone. In each ecosystem, a Geographic Information System-based diagnosis is to be developed to establish priorities in biological inventory, conservation, sustainable use, and related aspects of Brazilian biodiversity management. Associations of up to six regional institutions in each ecosystem are to be formed to coordinate the workshops and other activities necessary to make the diagnosis. PROBIO should present its first results by July 1998 and, if effective, will represent a major step forward in biodiversity management in Brazil.

PRONABIO includes another component known as the Fundação de Biodiversidade (FUNBIO), which is an entity with representatives from both the government and the private sector set up to administer Brazilian and Global Environmental Facility (GEF) funds for directed research on sustainable development. It is administered by the Fundação Getúlio Vargas in Rio de Janeiro and published its first call for projects in March 1997.[24] Five areas are contemplated: sustainable management of natural forests; conservation of natural ecosystems on private property; sustainable management of fishery resources; agriculture and biodiversity; and administration of conservation units. Depending on the success of FUNBIO, it may eventually be chosen to administer all the funds of PRONABIO, thus escaping the suffocating Brazilian government bureaucracy.

B. Management of Biodiversity in a Changing Brazil

As host to the Rio '92 (UNCED — United Nations Conference for Environment and Development) meetings, Brazil was one of the first signatory nations of the Convention on Biological Diversity (the fifth, on June 5, 1992). However, the Brazilian legislature has yet to ratify the convention. At the same time, Brazilian biological resources continue to be pillaged, both by outright smuggling and by mismanagement by foreign as well

as domestic economic interests. A recently leaked SAE (Secretariat for Strategic Affairs) report[25] estimates that 20,000 plant extracts are smuggled out of Brazil annually for testing in foreign laboratories. Illegal harvest of renewable natural resources (particularly timber) is widespread and is carried out by both national and foreign companies. In the lumber industry, many companies set up legal sawmills with management plans approved by the federal environmental agency IBAMA (Instituto Brasileiro do Meio Ambiente e Recursos Naturais Renovaveis). They then not only saw timber from their own managed stands, but also buy illegally cut timber from clandestine logging operations nearby. In some cases, the illegal timber amounts to ten times more wood than could be taken from the sustainably managed lands. Pará state has the highest index of illegally cut timber, amounting to 68 percent of the commercialized wood (Pará is also the most important wood producer, in volume). In addition to the problem of illegal extraction, the efficiency of timber operations is very low, and 60–70 percent of the wood cut in the forest is lost through mismanagement at all stages of the production process before reaching the final consumer.[26] Currently, 80 percent of the wood harvested in the Amazon is consumed domestically, but this will soon change. With the exhaustion of Asian and African tropical forests, Brazil will become the world's chief tropical timber exporter by 2015.[27] Economic interests are aware of this geographic shift in timber production, and Malaysian, Japanese, Chinese, American, and European timber companies are buying up large parcels of Amazonian lands.[28] Much stricter control is necessary to make sure that proper management and Brazilian national sovereignty are respected.

With Brazil's move to privatization and the generalized globalization of the world economy, the nation is facing new challenges in environmental management. The Companhia Vale do Rio Doce (CVRD), the world's largest mining company, was privatized in May 1997. It had a reputation for being one of the most environmentally responsible of all South American corporations. CVRD is the owner of some extremely important parcels of land with outstanding biodiversity value, in particular the Atlantic Forest reserve at Linhares in Espírito Santo and the 411,000-hectare concession area at Carajás in Pará. The federal

troops that once guarded the Carajás environmental buffer are now gone and the landless have announced their plans to invade the area for land reform. It is unclear what the future policies of the new managers will be. If profit is the only motive, expect major changes in CVRD's policies. Privatization is taking place so fast and with so few restrictions that environmental (and social) questions that seemed resolved (or resolvable) when the companies were state-owned are now unanswered. What will the new environmental policy of CVRD and similar privatized companies be? Only the new management can respond.

One problem in this changing Brazil that few have had the courage to address is the environmental cost of the invasions by the MST (Movimento dos Trabalhadores Rurais Sem Terra, or Landless Rural Workers' Movement) and associated organizations of the landless. Owners of invaded lands prefer to sign over their greenbelts, environmental buffer zones, or last stands of native forest rather than give up their pastures and soy fields. Precious last pieces of interior Atlantic forest are being carved up and devastated in São Paulo and Paraná states. On May 20, 1997, three environmental nongovernmental organizations (NGOs) — Apoema, IPE, and SOS Mata Atlântica — broke the silence and called for a more environmentally responsible attitude by the MST.[29] So far they have received no response. As one Brazilian commentator put it, perhaps the MST is wrong about everything, except the most fundamental point that they should have the right to till their own land. If this movement is to continue to enjoy the widespread support of Brazilian public opinion, this is a question that must be addressed.

C. The Environmental Movement in Brazil

Concern about environmental degradation in Brazil can be traced back to José Bonifácio, geologist, silviculturist, and political adviser to Dom Pedro I, Brazil's first emperor.[30] Unfortunately, his ideas were not incorporated into the constitution written after independence in 1822. Environmental concerns associated with the availability of potable water supplies and periodic droughts that raised food prices led to the first official government environmental measures in 1858, when further

deforestation of the Rio de Janeiro watershed was prohibited, and are prominantly marked by the reforestation of the Tijuca hills in Rio de Janeiro, begun in 1862 and completed in 1891.[31] Although debate in the Brazilian scientific establishment regarding environmental problems dates from the mid-1800s, the first formal major gathering to discuss these issues took place only in 1934.[32] Key figures in these discussions included Alberto Loefgren of the Museu Paulista, responsible for Brazilian Arbor Day (Dia da Árvore), established in 1902; Alberto José de Sampaio, director of the National Museum in Rio de Janeiro and an active conservationist from 1912 on; and Frederico Carlos Hoehne, head of the Botanical Institute in São Paulo, who wrote important texts and spearheaded a campaign to save the forests south of the city of São Paulo in 1924. The first Brazilian forestry code was written in 1934[33] and was strongly influenced by both Sampaio and Hoehne. Itatiaia, Brazil's first national park, was created in 1937.

Several nongovernmental organizations with environmental concerns appeared or consolidated their influence in the 1930s, including the Sociedade Amigos de Alberto Torres (named in honor of the nationalist essayist), Clube Amigos da Natureza, Sociedade Amigos de Árvores, and Sociedade dos Amigos da Flora Brasilica. Although they were pioneers and played important roles then, none of these has survived to the present day. The oldest extant environmental NGO in Brazil is the Fundação Brasileira para a Conservação da Natureza (FBCN), founded in Rio de Janeiro on August 28, 1958.

By 1992 there were 358 governmental organizations and 1,533 nongovernmental organizations operating in the environmental arena in Brazil.[34] Most have their headquarters in the major cities, but there has been an "interiorization" of the environmental movement, particularly in the last decade, and in many small towns there are NGOs concerned particularly with questions of local environmental quality. As elsewhere in the world, some Brazilian NGOs are well consolidated, and others have disappeared since the 1992 compilation. Some of the NGOs that are particularly important to the city where they are based include the following: FBCN (Rio de Janeiro); SOS Mata Atlântica (São Paulo); FUNATURA (Brasília); WWF-Brasil (Brasília); CI-Brasil (Belo Horizonte); Fundação Biodiversitas (Belo Horizonte);

Sociedade para a Preservação da Vida Silvestre (SPVS-Curitiba); Greenpeace-Brasil (São Paulo and Rio de Janeiro); TNC-Brasil (Brasília); Sociedade de Preservação aos Recursos Naturais e Culturais da Amazônia (SOPREN-Belém); Fundação Vitória Amazônica (Manaus); Fundação Ecotrópica (Cuiabá); Associação Maranhense para a Conservação da Natureza (AMAVIDA-São Luís); and SOS Amazônia (Rio Branco). Brazil's NGOs have been strengthened in the recent past by their accessibility to official government and international project funds, including those made available by the G-7 and United Nations support for the protection of Brazilian forests. They compete directly with government agencies for monies from the Ministries of Environment, and Science and Technology, as well as those from state secretariats. As the Brazilian government tries to downsize to meet the demands of globalization, NGOs are viewed as a viable and relatively inexpensive alternative to the traditional official government organs that operate in environmental policy and administration.

IV. Conclusion

As the world's richest country in biodiversity, Brazil has special responsibilities to its own citizens and to the world. The UN has called the twenty-first century "the Century of Water and Biological Diversity." No other country is as wealthy in both commodities as Brazil. There are finally some moves by the government that indicate it is at least partially aware of this reality. Bold initiatives, such as official adoption of the *Diversitas* program,[35] which proposes to inventory every organism from viruses to primates at selected sites around the world, could place Brazil in a leadership role in biodiversity management. This would depend on Brasília and would require an international effort. All the ingredients exist for the nation to be one of the world's leaders on these fronts, but an integrated national policy leading clearly to this role has yet to be articulated.

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