A Brief History of Biodiversity Conservation in Brazil

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Brazil is one of the world's richest megadiversity countries, vying with Indonesia for the title of our planet's biologically wealthiest nation. Privileged as it is, however, it rarely attracts attention for what it has; rather, it is criticized for what it is losing through deforestation; conversion of natural landscapes into plantations, soybean fields, and pastures; and industrial and urban sprawl. Although the threats to the country's wildlife and natural landscapes are dramatic, Brazil has also become a world leader in biodiversity conservation, primarily because of its ever-growing cadre of conservation professionals.

Destruction of Brazil's Atlantic Forest and its wildlife began in the early 1500s (Dean 1995; Coimbra-Filho & Câmara 1996), and the rate and ferociousness of the damage alarmed even the Queen of Portugal, who demanded in 1797 that the governor of the Capitania of Paraíba take appropriate measures to stop the ruination of her colony's forests (Jorge Pádua & Coimbra-Filho 1979). The first parks created in Brazil—Itatiaia in 1937 and Iguaçu, Serra dos Órgãos, and Sete Quedas in 1939—protected extraordinary landscapes, but an awareness of the need to conserve Brazil's wildlife was still incipient until the first half of the twentieth century. Only in the past 30 years has Brazil experienced major progress in conservation action and the development of conservation capacity. A key stimulus was the onslaught on the Amazon that accompanied the Brazilian economic miracle (1964–1980) and stemmed initially from construction of a network of highways in the early 1970s that included the Transamazon (Goodland & Irwin 1975). Powerful voices sounding the alarm then included Harald Sioli (1910–2004), founder of Amazon limnology, who was unwittingly responsible for the myth of the Amazon's role as the "lungs of the world" (Junk 2001), bee geneticist Warwick Kerr (Kerr 1976), then director of the National Institute for Amazon Research, and geographer Orlando Valverde, of the influential Campaign for the Defense and Development of Amazonia (Valverde & Freitas 1980).

The most tangible evidence for the rapid growth in conservation awareness and conservation science in Brazil since the early 1970s can be seen in the proliferation of parks and reserves. From 1976 through the 1990s, Brazil made an enormous commitment to parks and other protected areas at the federal, state, municipal, and private levels—one far exceeding that of any other tropical country and comparable to developed countries. Concurrently, Brazil has experienced major growth in nongovernmental conservation capacity and has developed a strong community of world-class conservation scientists and practitioners. These elements form a critical foundation for successful conservation.

This very brief summary of some aspects of Brazil's conservation history focuses on four areas: leadership in creating a national protected areas system, the development of national and state lists of threatened species, the emergence of strong and influential nongovernmental conservation organizations, and the advance of conservation science in the country and the critical role that it has played.

Development of the Brazilian Protected Areas System

The agronomist Wanderbilt Duarte de Barros (1916–1997), director of the Itatiaia National Park in 1940, wrote an influential book in 1946 (published in 1952) lamenting the existence of a mere three national parks totaling only 2258 km^2 (Urban 1998). By 1970 there were 14 national parks totaling 27,565 km^2, but there was only one park in Amazonia (the Araguaia National Park, then 20,000 km^2, now 5,000 km^2) and none in the Pantanal.

Using the U.S. Air Force aerial photographic survey of 1958–1959, agronomist Alceo Magnanini (1962) carried

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out the first nationwide evaluation of the extent of Brazil's natural vegetation types, estimating losses since 1500. Five percent of the Atlantic Forest in northeastern Brazil remained. Only the state of Alagoas retained significant forests (about 16% of the state), and Coimbra-Filho and Câmara (1996) documented their subsequent destruction in the 1960s and 1970s. The situation in southeastern Brazil was only marginally better.

In 1974 Amazônia National Park (10,000 km^2 along the Rio Tapajós) was created under the leadership of a tiny protected areas division of the Brazilian Forest Development Institute (IBDF), headed by Magnanini and Maria Tereza Jorge Pádua (Urban 1998). Growing national and international concern about Amazonia's future resulted in a program to identify priority areas for biodiversity, the first of its kind, based on a biogeographic analysis—conservation science. It was led by Jorge Pádua and Gary Wetterberg, then of the U.S. Fish and Wildlife Service, a partner in the endeavor. The analysis used phytogeographic regions (Ducke & Black 1953, modified by Prance 1973), vegetation types (Murça-Pires 1974), and the concept of Pleistocene refugia (see Whitmore & Prance 1987)—commonly equated with centers of endemism—to determine priority areas for Amazonian conservation (Wetterberg et al. 1976, 1981). From 1979 to 1989, five national parks and four reserves (80,871 km^2) were created in 9 of 25 priority areas entirely or partly within Brazil, resulting in the first formal structuring of a protected areas system (MA-IBDF, & FBCN 1979).

A parallel effort was taking place under the Special Secretariat for the Environment (SEMA) created within the Ministry of the Interior in 1973 and led by another of Brazil's great conservation pioneers, Paulo Nogueira-Neto (Urban 1998). A lawyer and researcher of stingless bees, he recognized the need for developing research stations and capacity and created a series of ecological stations (the name he attributes to Magnanini), protected areas representing all major Brazilian ecosystems (Nogueira-Neto & Carvalho 1979). He worked closely with Magnanini and Jorge Pádua, and the result today is 30 federal ecological stations throughout Brazil covering 71,706 km^2, most created while Nogueira-Neto was secretary (Nogueira-Neto 1992).

This period of rapid development of Brazil's park's system was truly historic and can be compared with the burst of conservation activity under President Theodore Roosevelt in the United States in the early part of the twentieth century. The combined efforts of SEMA and IBDF from 1974 to 1989 led to the creation of 22 national parks, 20 biological reserves, and 25 ecological stations, totaling 144,180 km^2—the size of Suriname and of New England in the United States, and close to the area of the state of Ceará in Brazil.

This effort, initiated and led by Jorge Pádua and Nogueira-Neto, created a tradition that has continued under the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), the 1989 successor to IBDF and SEMA. In 1988 the Brasília-based nongovernmental organization (NGO) Fundação Pró-Natureza (Funatura; created by Jorge Pádua) was asked to draw up a consolidated National Protected Areas System (SNUC). Nogueira-Neto, Admiral lbsen de Gusmão Câmara, and many other prominent conservation leaders were closely involved. More than 10 years later in 2000, SNUC was officially established by law, representing a historic moment for biodiversity conservation in Brazil, defining and regulating as it does the protected area categories at federal, state, and municipal levels. The SNUC recognized the system of private natural heritage reserves (RPPNs), pioneered in IBAMA in 1990, which has proved enormously successful in encouraging private-sector initiatives. The reserves are registered on a national list, and to date there are some 450, covering approximately 5,000 km^2. Although this area is relatively small, they serve a highly strategic function of protecting key habitat for threatened species in the Atlantic Forest, Cerrado, and Pantanal. The RPPNs are often better protected than federal or state areas.

The state of Acre was the birthplace of the extractive reserve—a consequence of the rubber-tappers' movement led by Chico Mendes. This type of reserve first arose in 1987, not as a protected area but as an instrument for securing rights to land use, attending particularly to communities suffering encroachment and the destruction of their forests through highway construction and cattle ranching in the southwest Amazon. The concept, promoted nationally and internationally by Mary Allegretti (later to hold important positions with the Ministry of the Environment), captured popular imagination as a way to combine the Amazonian people's needs with the protection and sustainable use of the resources on which their livelihoods depend. The National Council of Rubber-Tappers (CNS), created in 1985 during the early stages of this movement, still promotes the expansion and the interests of extractive reserves at the policy level. Although still mainly an Amazonian phenomenon, there are now terrestrial and marine extractive reserves all over Brazil.

States also create protected areas. São Paulo, Minas Gerais, Paraná, and Rio Grande do Sul were pioneers, establishing some state parks in the 1940s and 1950s. The majority of about 180 state parks existing today were created since the early 1980s. Nogueira-Neto was particularly active in encouraging the establishment of state environmental secretariats during the 1980s. Célio Valle and José Carlos de Carvalho in Minas Gerais and José Pedro de Oliveira Costa, Fábio Feldman, and Clayton Lino in São Paulo are among many who merit recognition in promoting an unprecedented state-level commitment to conservation. José Carlos de Carvalho, in particular, held many positions at state and federal levels and led important conservation initiatives that attracted significant international funding. José Pedro de Oliveira also worked

closely with the World Conservation Union (IUCN) for many years and was the driving force behind the creation of the Atlantic Forest Biosphere Reserve in Brazil.

Regional initiatives, several originating from state governments, include the concept of the Atlantic Forest Biosphere Reserve and the Cerrado Biosphere Reserve, among the largest ever recognized by the U.N. Educational, Scientific, and Cultural Organization. These provide important landscape-scale complements to site-specific actions, as do the more recent conservation or ecological corridors in many regions. These initiatives have spread to other states and have recently become a major feature of Amazonian conservation. Key to state-level protection in Amazonia was the sustainable development reserve concept, pioneered by José Márcio Ayres in Mamirauá in the early 1990s. This innovative approach, underpinned by an intense and prolonged program of research involving and supporting local communities, showed that conservation could be linked with appropriate local-scale development and led to a host of new conservation initiatives (Sociedade Civil Mamirauá 1996). The result is major commitment from several Amazonian states just since 2002. Particularly noteworthy examples include the state of Amapá, where protected areas and indigenous reserves now cover an astonishing 65% of the state. In 2003 Governor Waldez Góes announced plans to create further areas linking them to establish a "conservation corridor" that covers 71% of the 14,028 km^2 state.

Until 1989 there were no state-protected areas in Amazonas. The first—6 areas totaling 30,646 km^2—were decreed by Governor Amazonino Mendes in 1990. In 2003 Governor Eduardo Braga created 7 areas covering 42,155 km^2, and in 2004 a further 30,637 km^2 became protected in 9 state parks and reserves. These actions led to today's count of 29 state-protected areas totaling 155,858 km^2.

Under the leadership of Governor Jorge Viana, whose commitment to sustainable development dates to the days of Chico Mendes' struggle, the state of Acre has promoted what it calls the "government of the forest," which builds on the need to maintain standing forest as the basis for economic development. This includes the creation of a number of protected areas, which by December 2003 covered 40,662 km^2.

Also of great conservation significance are Brazil's demarcated indigenous lands, which now total 820,000 km^2, or 16.4% of the Legal Amazon, an area twice the size of California and considerably larger than that of biodiversity-focused parks and reserves. Nearly half were demarcated in the last 10 years under the leadership of the Fundação Nacional do Índio (FUNAI, National Indian Foundation) with funding from the Pilot Program for Brazilian Tropical Forests (PP-G7). Many of these areas have very low human populations and are still largely pristine, making them an important complement to national and state parks and reserves. The best example is the Kayapó Indigenous Territory, which covers 11 million ha with only 4,500 people.

Brazil's Threatened Species Lists

In 1964 Adelmar F. Coimbra-Filho and Alceo Magnanini outlined the threatened status of numerous species in Brazil, detailing the causes of their decline and the conservation measures needed (Coimbra-Filho & Magnanini 1968; Urban 1998). This formed the basis for Brazil's first threatened species' list, prepared by José Cândido de Melo Carvalho of the Brazilian Foundation for the Conservation of Nature (FBCN) (Carvalho 1968). This list contained 86 taxa and was eventually published in 1973. The first red data book was published a year earlier (ABC 1972). With Mittermeier, Coimbra-Filho was also responsible for all the data sheets on Brazilian mammals submitted to IUCN for the International Red Data book in 1974. The Brazilian Fauna Protection Law (No. 5197, 3 January 1967) forbade the capture, hunting, purchase, sale, and exportation of all threatened species and any products made from them. The list was revised in 1989, an initiative of IBAMA and the Brazilian Society of Zoology (SBZ), and coordinated by Ângelo Machado (Bernardes et al. 1990). The number of species rose to 218 (largely because insects were included). The latest reassessment, developed through a 2002 workshop led by the Fundação Biodiversitas, used the IUCN (2001) categories and criteria and increased the number of species to 395 terrestrial and 239 aquatic species (79 invertebrates and 160 fishes; Fundação Biodiversitas 2003).

The IBDF listed 13 plants as threatened in 1968 and added a fourteenth in 1980. A 1989 revision resulted in an official list of 108 species but, as pointed out by Giulietti et al. (2005 [this issue]), there are undoubtedly many more—405 of the world's threatened trees listed by IUCN (Oldfield et al. 1998) occur in Brazil, and the threatened plants of the state of Minas Gerais alone total 537 (Mendonça & Lins 2000).

Various Brazilian states, recognizing the usefulness of such lists, began carrying out their own assessments—the first was Paraná—and providing increasingly sophisticated red data books for conservation planning and priority setting (e.g., Machado et al. 1998; Fontana et al. 2002; Mikich & Bérnils 2004).

Emergence of Conservation NGOs

The last three decades have seen the emergence of a strong NGO movement for biodiversity conservation in Brazil. In 1970 there were only a handful of conservation

NGOs, the most prominent being the FBCN, the first of its kind in South America. It was founded in Rio de Janeiro in 1958 by a group of agronomists, including Wanderbilt Duarte de Barros, who were concerned with soil erosion and the destruction of the country's forests. The FBCN was particularly active from 1980–1986 under the leadership of Admiral Ibsen de Gusmão Câmara, who took over the presidency of FBCN in 1981. The foundation worked closely with international NGOs, especially the World Wildlife Fund (WWF), to create one of the most influential private conservation organizations in the tropical world. Through Admiral Ibsen, a paleontologist and lifelong conservationist (a leader in marine mammal research and a driving force behind Brazil's ban on whaling), FBCN was highly influential in the 1980s, collaborating with Pádua and Nogueira Neto in the protected areas boom and establishing, through SEMA, the current National Environment System (MMA 1999). The FBCN was the major partner in the rapidly growing WWF program in Brazil, led by R.A.M. and Thomas Lovejoy (then both of WWF). Câmara left office in 1986, and FBCN's prominence was gradually supplanted by other national conservation organizations.

The growing interest in conservation, the transition to a democratic government, the focus on new protected areas, and increased international interest (spearheaded by the WWF–U.S. and later The Nature Conservancy) also led to a number of new conservation NGOs. By 1988 new NGOs included SOS Mata Atlântica, inspired by José Pedro de Oliveira Costa, Fábio Feldmann, and other colleagues in São Paulo (1983); Funatura, founded by Jorge Pádua in Brasília (1986); the Sociedade de Pesquisa em Vida Selvagem e Educação Ambiental (SPVS), led by Clóvis Borges in Curitiba, Parana (1984); SOS Amazônia in Rio Branco in Acre (1988); and Fundação Biodiversitas, created by Célio Valle, Gustavo Fonseca, Sônia Rigueira, and Ângelo Machado (now responsible, among other contributions, for Brazil's official threatened species lists) in Minas Gerais (1988). (Fábio Feldman was elected to Congress in 1986 as its first environmental representative and was reelected for three consecutive mandates. In Congress he coordinated the group that wrote the chapter on the environment for the 1988 Constitution.) A second generation of NGOs emerged in the early to mid-1990s. These included the Instituto de Pesquisas Ecológicas (IPÊ), created by Suzana and Cláudio Pádua in São Paulo (1992); the Instituto Socioambiental (1994); Instituto do Homem e Meio Ambiente da Amazônia (IMAZON; 1990); the Fundação Vitória Amazônica (FVA; 1990); and the Instituto de Pesquisa Ambiental da Amazônia (IPAM; 1995). These NGOs took on largely complementary roles, developing strong scientific, analytical, and political capacity and stimulating conservation regionally and nationwide. They set up strong partnerships with international organizations and the government, notably in management and research in protected areas. Funatura, for example, is active in the Grande Sertão Veredas National Park, FVA in the Jaú National Park, and SOS Amazônia in the Serra do Divisor National Park. Many of their leaders periodically moved in and out of key government positions, contributing to their influence. These organizations also helped further the scientific base of conservation, often supporting protected area management, surveys, and other longer-term research needed to ensure sound scientific underpinnings. Another important trend was the creation of networks of NGOs that have effectively lobbied for policy change at regional levels: the Grupo de Trabalho Amazônico and the Rede Mata Atlântica and Rede Cerrado. A few grant-making foundations also emerged, the most notable of which is the Fundação O Boticário de Proteção a Natureza of the O Boticário cosmetics company. This fund is directed by Miguel Milano, whose many accomplishments include organizing the biannual Brazilian Parks Congress since 1997. We estimate that Brazil now has more than 500 private organizations focused on biodiversity conservation.

Capacity Building

Brazil has strived to build its conservation program on sound conservation science. Its conservation scientists have often also been its practitioners, which is not always the case in the developed countries.

Partnerships—Government, NGOs, and Academia

The NGOs are the intermediaries—the catalysts—linking conservation research (academia) and its application (government and increasingly corporations and industry). We provide here a few examples of some projects that have been enormously influential in conservation science and its application in Brazil and worldwide. One of the most prominent is the Biological Dynamics of Forest Fragments Project of the Smithsonian Institution and the National Institute for Amazon Research in Manaus (originally the Minimum Critical Size of Ecosystems Project, started with WWF–U.S.). The project, inspiration of Thomas Lovejoy, a pioneer and enduring campaigner for the conservation of the Brazilian Amazon, began in 1979. Specifically, the project conducts research on the long-term fate of different-sized forest fragments and the landscapes of clearcut and burned forest that has been converted to cattle pasture (Bierregaard et al. 2001).

The Pilot Program to Conserve the Brazilian Rain Forest (PP-G7), which began in 1997, has components of capacity building, policy, research, and management, dealing with parks and reserves (including indigenous lands), forest management, and the control of forest fires, among others. A particularly innovative move was the adoption of a model for broad regional landscape planning and conservation based on the concept of ecological, or biodiversity, corridors (inspired by a study commissioned

to IBAMA, Sociedade Civil Mamirauá, and Conservation International of Brazil; Ayres et al. 1997). This model is now an important element of conservation planning in Brazil and has led to a major interest in corridors internationally.

The Amazon Protected Areas (ARPA) program of the Ministry of the Environment and WWF–Brazil, supported by the World Bank and the Global Environment Facility, was officially launched at the World Summit on Sustainable Development, held in Johannesburg in 2002. It aims to increase the area of Amazon rainforest under federal protection to 500,000 km^2 (12%), based on the representation of 23 Amazonian ecoregions identified by WWF, and supports the development of management plans and protective measures for some existing areas (Serra da Cutia, the mountains of Tumucumaque national parks, and the Cautário Extractive Reserve).

Between 1998 and 2002, in collaboration with many organizations—particularly Conservation International do Brasil—the government carried out a broad consultation with researchers and NGOs to delineate and characterize priority areas for biodiversity conservation in the Cerrado and Pantanal (1998), Atlantic Forest and Southern Grasslands (1999), Amazonia (1999), marine and coastal ecosystems (1999), and the Caatinga (2000) (MMA 2002). The evaluation was an obligation of signatories to the Convention on Biological Diversity (MMA 1999, 2005) but was also a remarkable high point in relations between government, NGOs, conservationists, and scientists, with the government providing financing and the NGOs organizing, compiling, and analyzing results.

Primate Conservation and Flagship Species

Primates played a particularly important early role in the development of a strong conservation capacity in Brazil. In 1971 there was only one field primatologist in Brazil—Adelmar F. Coimbra-Filho, who had been studying the golden lion tamarin (*Leontopithecus rosalia*) since the early 1960s. A visionary, Coimbra-Filho saw the great value of primate science and had ambitious plans to develop a primate center (the Centro de Primatologia do Rio de Janeiro was inaugurated in 1979). He joined forces with R.A.M. in the early 1970s, publishing his pioneering research on marmosets and lion tamarins, and in 1973 organizing the first primate survey of Amazonia in 1973. In 1978, together with Célio Valle of the Federal University of Minas Gerais, they began a 10-year survey of primates and protected areas of the Atlantic Forest, putting the region on the international conservation agenda (Mittermeier et al. 1982). The Atlantic Forest was one of the top priorities in WWF's 1982 Tropical Forests and Primates Campaign and as a result brought what was then significant funding for conservation to many of the most important Atlantic Forest protected areas, complementing investments by the Brazilian government.

This survey program trained young primatologists and laid the groundwork for some long-term projects, notably the Golden Lion Tamarin Conservation Program (GLTCP), initiated in 1983 by Devra Kleiman (National Zoo, Washington, D.C.) and Coimbra-Filho in the Poço das Antas Biological Reserve. Although initially collaborating with FBCN, in 1992 the project spawned its own NGO, the Golden Lion Tamarin Association. Currently led by Denise Rambaldi, this association is now playing an increasingly prominent role in the conservation of the Atlantic Forest of southeast Brazil—including major programs in landscape restoration and environmental education—with the lion tamarin as the flagship species. With its components of captive breeding, demographic research, field studies, reintroduction, translocation, and environmental education, the GLTCP became a model for endangered species programs worldwide (Rylands et al. 2002). Three biological reserves and an ecological station were created specifically for lion tamarins, and the different programs inspired by the four species have benefited regional and local conservation endeavors in the Atlantic Forest in the states of Rio de Janeiro, Paraná, São Paulo, and Bahia.

The Muriqui (*Brachyteles hypoxanthus*) Program at Caratinga, Minas Gerais, was begun in 1982 by Karen Strier (University of Wisconsin-Madison) in collaboration with Célio Valle and Gustavo Fonseca and, most recently, Sérgio Mendes of the Federal University of Espírito Santo. It provides a remarkable case study of consistent and fruitful long-term monitoring and research and is an unparalleled success in providing field internships and training (Strier 1999). Using muriquis as a flagship species has led to many conservation programs and the creation of a number of protected areas, besides providing the stimulus for the intensification and improvement of the management of the now quite numerous protected areas where they occur.

Training

Significant for Brazilian conservation was the 1988 establishment of the country's first graduate course—Ecology, Conservation and Wildlife Management—at the Federal University of Minas Gerais (Lacher et al. 1991). This program has trained close to 150 students, many of whom now occupy key positions in Brazilian and international conservation. Notable too were the specialization courses in primatology offered annually (the first in 1983) by Milton Thiago de Mello, a veterinary scientist at the University of Brasília. Although primates were the focus of this program, numerous people who are prominent in conservation today benefited from the theoretical and field expertise they acquired in these courses.

The Brazilian Science Council (CNPq) and the Higher Education Authority (CAPES) must be credited with supporting training and higher education overseas, training

many of the professionals who eventually created or joined graduate-level training programs at Brazilian universities, and expanding the breadth of expertise in species conservation to include many other vertebrate taxa. Institutions outside Brazil that have played a particularly strong role in receiving Brazilian students in wildlife management, research, and conservation include the Program for Studies in Tropical Conservation at the University of Florida, Gainesville (J. F. Eisenberg, J. G. Robinson, and K. H. Redford); the Museum of Vertebrate Zoology at the University of California at Berkeley (J. Patton); the Training Center of the Durrell Wildlife Conservation Trust, Jersey, British Isles (J. J. C. Mallinson, D. Waugh, J. Fa), and increasingly the Durrell Institute for Conservation Ecology of the University of Canterbury, Kent; the Wildlife Research Group at Cambridge University, United Kingdom (D. J. Chivers); the University of East Anglia, United Kingdom (C. Peres); and the Smithsonian Institution's Center for Research and Conservation at Front Royal, Virginia (R. Rudran). These institutions and people have played an unquestionably important role in building competence in conservation science and practice in Brazil.

Literature Cited

ABC (Academia Brasileira de Ciências). 1972. Espécies da fauna brasileira ameaçadas de extinção. ABC, Rio de Janeiro (in Portuguese).

Ayres, J. M., G. A. B. da Fonseca, A. B. Rylands, H. L. Queiroz, L. P. de S. Pinto, D. Masterson, and R. Cavalcanti. 1997. Abordagens inovadoras para conservação da biodiversidade no Brasil: os corredores das florestas neotropicais. Volume 1 Aspectos gerais. Volume 2 Amazônia. Volume 3 Mata Atlântica. Versão 2.0. Report for PP/G7 – Programa Piloto para a Proteção das Florestas Neotropicais: Projeto Parques e Reservas. Ministério do Meio Ambiente, Recursos Hídricos e da Amazônia Legal, Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, Brasília (in Portuguese).

Barros, W. D. de. 1952. Parques nacionais do Brasil. Série Documentária, Ministério da Agricultura, Rio de Janeiro (in Portuguese).

Bernardes, A. T., Â. B. M. Machado, and A. B. Rylands. 1990. Fauna brasileira ameaçada de extinção. Fundação Biodiversitas, Belo Horizonte, Brasil (in Portuguese).

Bierregaard, R. O, Jr., C. Gascon, T. E. Lovejoy, and R. Mesquita, editors. 2001. Lessons from Amazonia: the ecology and conservation of a fragmented forest. Yale University Press, New Haven, Connecticut.

Carvalho, J. C. de M. 1968. Lista das espécies de animais e plantas ameaçadas de extinção no Brasil. Boletim da Fundação Brasileira para a Conservação da Natureza, Rio de Janeiro **3:**11–16 (in Portuguese).

Coimbra-Filho, A. F., and A. Magnanini. 1968. Animais raros ou em vias de desaparecimento no Brasil. Anuário Brasileiro de Economia Florestal **19:**149–177 (in Portuguese).

Coimbra-Filho, A. F., and I. de G. Câmara. 1996. Os limites originais do bioma Mata Atlântica na Região Nordeste do Brasil. Fundação Brasileira para a Conservação da Natureza, Rio de Janeiro.

Dean, W. 1995. With broadax and firebrand: the destruction of the Brazilian Atlantic Forest. University of California Press, San Francisco.

Ducke, A., and G. A. Black. 1953. Phytogeographical notes on the Brazilian Amazon. Anais da Academia Brasileira de Ciências **25:**1–46.

Fontana, C. S., G. A. Bencke, and R. E. Reis, edsitors. 2002. Livro vermelho da fauna ameaçada de extinção no Rio Grande do Sul. EDIPUCRS, Porto Alegre, Brasil (in Portuguese).

Fundação Biodiversitas. 2003. Lista da fauna brasileira ameaçada de extinção. Fundação Biodiversitas, Belo Horizonte, Brazil. Available from http://www.biodiversitas.org.br/ (accessed January 2005).

Giulietti, A. M., R. M. Harley, L. P. Queiroz, M. G. L. Wanderley, and C. Van den Berg. 2005. Biodiversity and conservation of plants in Brazil. Conservation Biology **19:**x–x.

Goodland, R. J. A., and H. S. Irwin. 1975. Amazon jungle: green hell to red desert? An ecological discussion of the environmental impact of the highway construction program in the Amazon basin. Elsevier Scientific Publishing, Amsterdam, The Netherlands.

IUCN (World Conservation Union). 2001. IUCN red list categories and criteria. Version. 3.1. IUCN Species Survival Commission, Gland, Switzerland.

Jorge Pádua, M. T., and A. F. Coimbra-Filho. 1979. Os parques nacionais do Brasil. Instituto Brasileiro de Desenvolvimento Florestal, Brasília (in Portuguese).

Junk, W. J. 2001. Appraisal of the scientific work of Harald Sioli. Amazoniana **16:**285–297.

Kerr, W. E. 1976. Considerações sobre a situação florestal brasileira. Ciência e Cultura **29:**269–273 (in Portuguese).

Lacher, T. E., Jr., G. A. B. da Fonseca, C. Valle, and A. M. P. B. Fonseca. 1991. National and international cooperation in wildlife management and conservation at a Brazilian university. Pages 368–380 in M. A. Mares and D. J. Schmidly, editors. Latin American mammalogy: history, biodiversity, and conservation. University of Oklahoma Press, Norman.

MA (Ministério da Agricultura)-IBDF (Instituto Brasileiro de Desenvolvimento Florestal), and Fundação Brasileira para a Conservação da Natureza (FBCN). 1979. Plano do sistema de unidades de conservação do Brasil. MA, IBDF, and FBCN, Brasília (in Portuguese).

Machado, Â. B. M., G. A. B. da Fonseca, R. B. Machado, L. M. de S. Aguiar, and L. V. Lins, editors. 1998. Livro vermelho das espécies ameaçadas de extinção da fauna de Minas Gerais. Fundação Biodiversitas, Belo Horizonte, Brasil (in Portuguese).

Magnanini, A. 1962. Aspectos fitogeográficos do Brasil: áreas características no passado e no presente Reviosta Brasileira de Geografia **4:**93–102 (in Portuguese).

Mendonça, M. P., and L. V. Lins. 2000. Lista vermelha das espécies ameaçadas de extinção da flora de Minas Gerais. Fundação Biodiversitas, Belo Horizonte, Brasil (in Portuguese).

Mikich, S. B., and R. S. Bérnils. 2004. Livro vermelho da fauna ameaçada no estado do Paraná. Instituto Ambiental do Paraná, Curitiba, Brasil (in Portuguese).

Mittermeier, R. A., and A. F. Coimbra-Filho. 1977. Primate conservation in Brazilian Amazonia. Pages 117–166 in H. S. H. Prince Rainier III of Monaco and G. H. Bourne, editors. Primate conservation. Academic Press, London.

Mittermeier, R. A., A. F. Coimbra-Filho, I. D. Constable, A. B. Rylands, and C. Valle. 1982. Conservation of primates in the Atlantic Forest region of eastern Brazil. International Zoo Yearbook **22:**2–17.

MMA (Ministério do Meio Ambiente). 1999. First national report for the Convention on Biological Diversity. Brazil. Secretaria de Biodiversidade e Florestas, MMA, Brasília.

MMA (Ministério do Meio Ambiente). 2002. Biodiversidade brasileira: avaliação e identificação de áreas e ações prioritárias para conservação, utilização sustentável e repartição de benefícios da biodiversidade brasileira. Secretaria de Biodiversidade e Florestas, MMA, Brasília (in Portuguese).

MMA (Ministério do Meio Ambiente). 2005. Second national report for the Convention on Biological Diversity. Brazil. Secretaria de Biodiversidade e Florestas, MMA, Brasília. Available from http://www.mma.gov.br/port/sbf/chm/doc/estrateg/2natrep.pdf (accessed January 2005).

Murça-Pires, J. 1974. Tipos de vegetação da Amazônia. Brasil Florestal **5:**48–58 (in Portuguese).

Nogueira-Neto, P. 1992. Ecological stations: a saga of ecology and environmental policy. Empresa das Artes, São Paulo.

Nogueira-Neto, P., and J. C. de M. Carvalho. 1979. A programme of ecological stations for Brazil. Environmental Conservation **6:**95–104.

Oldfield, S., C. Lusty, and A. MacKinven. 1998. The world list of threatened trees. World Conservation Union Publications, Cambridge, United Kingdom.

Prance, G. T. 1973. Phytogeographic support for the theory of Pleistocene forest refuges in the Amazon basin, based on evidence from distribution patterns in Caryocaraceae, Chrysobalanaceae, Dichapetalaceae and Lecythidaceae. Acta Amazonica **3:**5–28.

Rylands, A. B., J. J. C. Mallinson, D. G. Kleiman, A. F. Coimbra-Filho, R. A. Mittermeier, I. de G. Câmara, C. Valladares-Pádua, and M. I. Bampi. 2002. A history of lion tamarin conservation and research. Pages 3–41 in D. G. Kleiman and A. B. Rylands, editors. Lion tamarins: biology and conservation. Smithsonian Institution Press, Washington, D.C.

Strier, K. B. 1999. Faces in the forest: the endangered muriqui monkey of Brazil. Harvard University Press, Cambridge, Massachusetts.

Sociedade Civil Mamirauá. 1996. Mamirauá. Plano de manejo (síntese). Sociedade Civil Mamirauá, Tefé, Conselho Nacional de Desenvolvimento Científico e Tecnológico, Brasilia, and Instituto de Proteção Ambiental do Estado do Amazonas, Manaus, Brasil (in Portuguese).

Urban, T. 1998. Saudade do matão: relembrando a história da conservação da natureza no Brasil. Editora da Universidade Federal do Paraná, Curitiba, Brasil (in Portuguese).

Valverde, O., and T. L. R. de Freitas. 1980. O problema florestal da Amazônia brasileira. Editora Vozes, Petrópolis, Brasil (in Portuguese).

Wetterberg, G. B., M. T. Jorge Pádua, C. S. de Castro, and J. M. C. de Vasconcellos. 1976. Uma análise de prioridades em conservação da natureza na Amazônia. Projeto de Desenvolvimento e Pesquisa Florestal, PNUD/FAO/IBDF/BRA-45, Série Técnica **8:**63 pp (in Portuguese).

Wetterberg, G. B., G. T. Prance, and T. E. Lovejoy. 1981. Conservation progress in Amazonia: a structural review. Parks **6:**5–10.

Whitmore, T. C., and G. T. Prance, editors. 1987. Biogeography and Quaternary history in tropical America. Clarendon Press, Oxford, United Kingdom.