


A Directory of Neotropical Wetlands





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Compiled by

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for the

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Ducks Unlimited, Incorporated

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BRAZIL

INTRODUCTION

by Paulo de Tarso Zuquim Antas, Flavio Silva, Maria Alice dos Santos Alves and Susana de Moura Lara-Resende

Brazil, with an area of 8,511,965 sq. km, is the fifth largest country in the world. It comprises almost half of the South American continent, and borders on all the countries in the continent except Chile and Ecuador. The population of about 125 million is over half that of all South America.

The climate and topography vary greatly, but the country may be divided into five regions which, although based on political boundaries, roughly represent the major biogeographical zones. These are:

- a) Northern Region: the states and territories of Amazonas, Acre, Rondonia, Roraima, Amapa, Para and Maranhao.
- b) Northeast Region: the states of Piaui, Ceara, Rio Grande do Norte, Paraiba, Pernambuco, Alagoas, Sergipe and Bahia.
- c) Southeast Region: the states of Minas Gerais, Espirito Santo, Rio de Janeiro and Sao Paulo.
- d) Southern Region: the states of Parana, Santa Catarina and Rio Grande do Sul.
- e) West-central Region: the Distrito Federal and the states of Goias, Mato Grosso and Mato Grosso do Sul.

The Northern Region includes the greater part of the Amazon Basin, the Amazon delta and adjacent coasts, the southern edge of the Guiana highlands in the extreme north, and the ecotone between the Amazon forests and the open areas of northeastern Brazil. Most of the Amazon basin has an elevation of less than 250m and is hot and humid, with an annual rainfall of between 1,500 and 3,000 mm. The greater part of the region remains under primeval humid tropical forest, although there are scattered patches of wet and dry savanna and extensive flood plain and lacustrine systems along the major rivers. The human density is extremely low, and although man has cleared large areas of forest along the navigable rivers and near the coast, enormous tracts remain almost uninhabited and unexplored.

The wetlands of the region are very poorly known, except in some of the more densely populated areas near the delta and in central Amazonia. The Amapa coast and delta region have been fairly well surveyed and are known to be very important for the manatee *Trichechus manatus* and such notable waterfowl as *Eudocimus ruber* and *Phoenicopterus ruber*, although the latter no longer breeds. Work in central Amazonia has focussed largely on aquatic mammals, turtles and fishes.

The Northeastern Region extends east from the mouth of the Rio Parnaiba, and includes the semi-arid hinterlands of northeastern Brazil with an average annual rainfall of only 600 mm, and a more humid eastern coastal strip with an average annual rainfall of 1,800 mm. The dominant vegetation type in the interior is "caatinga", which is characterized by deciduous, thorny scrubland with many cacti and other succulents, and more or less bare ground. Humid tropical forest formerly covered the coastal strip in the east, but most of this has now been cleared. There are two large perennial rivers in the region, the Sao Francisco and the Parnaiba, and many smaller rivers in the east. The extensive shoreline is comprised mainly of sandy beaches and coastal sand dunes, with mangroves in the estuaries and sea bays. In the semi-arid interior, numerous small dams have been constructed over the past one hundred years to maintain water supplies for livestock through the dry season, and these now constitute an important wetland habitat for wildlife, particularly Anatidae. In addition, there are two large dams on the Sao Francisco and one on the Parnaiba.

The wildlife of the coastal zone is relatively well known, but little work has been carried out at the wetlands in the interior, and the importance of the large dams for waterfowl is unknown. Four species of sea turtle occur along the coast, and there are some small populations of *Trichechus manatus* in the larger estuaries. *Phoenicopterus ruber* formerly occurred but is now extinct in the region, and *Eudocimus ruber* is much reduced in numbers.

However, *Netta erythrophthalma erythrophthalma*, which is listed as "Indeterminate" in the WWF Red Data Book, occurs widely at coastal lagoons and dams in Ceara, Rio Grande do Norte, Alagoas and Bahia.

The Southeastern Region is the most densely populated and industrialized part of the country. The climate is humid tropical to subtropical, with a well defined rainy season from December to March. The coastal plain and Atlantic slopes of the coastal mountain ranges were formerly forested, but extensive forest clearance for agriculture and settlement has left very little forest below 1,500m above sea level. In the interior, most of the original grassland and cerrado vegetation has been converted to pastureland for cattle or arable land. All of the large rivers have been dammed, some in many places, for hydroelectricity, irrigation and water supplies to urban areas. Along the coast, many of the coastal marshes and mangrove swamps have been reclaimed for agriculture, particularly around the main urban areas, and most of the remainder are under threat.

The wildlife of the region is well documented. The massive changes brought about in the environment by man over the past two hundred years have resulted in the extinction or near extinction of many species in the region, including waterfowl such as *Tigrisoma fasciatum*, *Eudocimus ruber* and *Mergus octosetaceus*. Other species have however adapted well, and a variety of waterfowl including *Dendrocygna viduata*, *Amazonetta brasiliensis* and various Ardeidae have been able to take advantage of the large man-made wetlands and expand their ranges in the region.

The Southern Region extends south from the Tropic of Capricorn to the border with Uruguay, and has a subtropical to temperate climate with warm summers and mild wet winters. The coastal mountain ranges of southeastern Brazil extend south to the region of Porto Alegre; thereafter the land is rolling with hills not exceeding 600m. The forested regions of the north give way to open pampas in Rio Grande do Sul and a landscape similar to that of Uruguay and Argentinian Pampas. The region is densely populated, and the standard of living is high.

This region has some of the most extensive lacustrine systems in Brazil, and the greatest diversity of waterfowl of any region; Anatidae are particularly abundant, and several species occur here at the extreme northern edge of their range. Mangroves extend south along the coast to 28°30'S; from there to the Uruguayan border the shoreline is a sandy beach backed by sand dunes and a chain of some sixty lagoons. Lagoa dos Patos, which stretches for 250 km between Porto Alegre and Rio Grande, is the largest lake in Brazil, and together with Lagoa Mangueira, Lagoa Mirim, and associated lagoons, comprises a vast wetland system with close affinities to the Rio de la Plata wetlands. Some of the more interesting waterfowl include the two swans *Cygnus melancoryphus* and *Coscoroba coscoroba*, wintering *Phoenicopterus chilensis*, and a small population of *Mergus octosetaceus* on rivers in the west.

The West-central Region is the only region to lack a coastline. The climate is continental, with an average annual rainfall of over 1,600 mm falling mainly between December and March, and a long dry season from April or May to September. The region is dominated by the central Brazilian tableland, with cerrado vegetation characterized by fairly open woodland with semideciduous, gnarled, low trees and coarse grassland. In the north, the region includes the ecotone between the humid tropical forests of the Amazon basin and the campos and cerrado of the highlands, with fingers of tropical forest extending south along the major river valleys to about 10° to 11°S. Human population density is low, and the predominant form of land use is cattle ranching on large estates.

The region includes the headwaters of several great rivers, including the Paraguay, Guapore, Tapajos, Xingu, Tocantins and Araguaia. Heavy rainfall during the summer months and impeded drainage result in extensive seasonal flooding along the main rivers, creating some of South America's largest wetlands; the Pantanal in the headwaters of the Rio Paraguay (150,000 sq. km) and the fluvial system of the middle Rio Araguaia (40,000 sq. km) are particularly impressive. Many of the wetland areas remain almost uninhabited and difficult of access, and wildlife populations are almost undisturbed. Waterfowl are particularly abundant, and several species which are becoming scarce or local in other parts of South America, still occur in large numbers.

Institutional Base for Wetland Conservation and Research

There are numerous organizations and institutions, both governmental and non-governmental, in Brazil which are concerned in some way with the environment and the conservation of natural resources. In 1982, the Ministry of the Interior published a 470 page book cataloguing over 300 bodies concerned with the environment (SEMA/SAP, 1982). At national level, the principal bodies are as follows:

Instituto Brasileiro de Desenvolvimento Florestal (IBDF): within the Ministry of Agriculture, and with headquarters in Brasilia. Established in 1967; the principal governmental organization responsible for nature conservation and research. IBDF includes the National Parks Service, and is responsible for enforcing the Game Laws and Regulations. The Centro de Estudos de Migracoes de Aves (CEMAVE) in the National Park Service conducts ornithological research and coordinates bird banding throughout Brazil. IBDF publishes the results of its research in its technical and scientific journal "Brasil Florestal".

Secretaria Especial do Meio Ambiente (SEMA): within the Ministry of the Interior, and with headquarters in Brasilia. Created in 1973 to set up and conduct research in Ecological Stations, and to conduct research on environmental pollution.

Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq): with headquarters in Brasilia. Created in 1974 to promote scientific and technological research in Brazil.

Fundacao Brasileira para Conservacao da Natureza (FBCN): the largest private conservation organization in Brazil, with headquarters in Rio de Janeiro. Established in 1958 to promote the conservation of nature.

Associacao de Preservacao da Flora e Fauna (APREFFA): a private society with headquarters in Curitiba. Created in 1975 to promote nature protection and to campaign against over exploitation of wildlife and environmental pollution.

Departamento Nacional de Aguas e Energia Electrica (DNAEE): within the Ministry of Mines and Energy, with headquarters in Brasilia. Established in 1965 to study the water resources of Brazil, to evaluate their potential for hydroelectricity, and to control water pollution.

Associacao Brasileira de Engenharia Sanitaria e Ambiental (ABES): a private society with headquarters in Rio de Janeiro. Established in 1966 to campaign for improved control of environmental pollution and better basic sanitation.

At regional or state level, the principal organizations are as follows:

Northern Region

Conselho Estadual do Meio Ambiente (CEMA): based in Manaus; active in Amazonas.

Instituto Nacional de Pesquisas da Amazonia (INPA): based in Manaus; active in Legal Amazonia.

Museu Paraense Emilio Goeldi: based in Belem; active in the Amazon Basin.

Secretaria de Economia, Agricultura e Colonizacao - Departamento de Recursos Naturais: based in Porto Velho; active in Rondonia.

Northeastern Region

Coordenadoria de Recursos Naturais (SENART): based in Sao Luis; active in Maranhao.

Fundacao Instituto de Tecnologia e Meio Ambiente (SENART - ITEMA): based in Sao Luis; active in Maranhao.

Laboratorio de Ciencias do Mar (UFCE - ABOMAR): based in Meireles-Fortaleza; active on the northeast coast.

Superintendencia do Desenvolvimento do Estado do Ceara (SUDEC): based in Fortaleza; active in Ceara.

Sociedade Norte Riograndense de Protecao do Meio Ambiente: based in Natal; active in Rio Grande do Norte.

Universidade Federal do Rio Grande do Norte (UFRN): based in Natal; active in Rio Grande do Norte.

Estacao Ecologica do Tapacura - Universidade Federal do Pernambuco: based in Sao Lourenco; active throughout the northeast.

Companhia Pernambucana de Controle da Poluicao Ambiental e Administracao de Recursos Hidricos (CPRH): based in Recife; active in Pernambuco.

Conselho Estadual de Protecao Ambiental (CEPRAM): based in Maceio; active in Alagoas.

Administracao Estadual do Meio Ambiente (ADEMA): based in Aracaju; active in Sergipe.

Secretaria Executiva de Control de Poluicao: based in Aracaju; active in Sergipe.

Instituto de Biologia da Universidade Federal da Bahia (IB-UFBA): based in Salvador; active in Bahia.

Centro de Pesquisas e Desenvolvimento (CEPED): based in Estrada de Camacari; active in Bahia.

Southeastern Region

Instituto Estadual de Florestas (IEF): based in Vitoria; active in Espirito Santo.

Comissao de Politica Ambiental (COPAM): based in Belo Horizonte; active in Minas Gerais.

Instituto Estadual de Florestas (IEF): based in Belo Horizonte; active in Minas Gerais.

Secretaria de Estado de Ciencia e Tecnologia: based in Belo Horizonte; active in Minas Gerais.

Comissao de Controle da Poluicao da Baia de Guanabara: based in Rio de Janeiro; active in Rio de Janeiro State.

Comissao Estadual de Controle Ambiental (CECA): based in Rio de Janeiro; active in Rio de Janeiro State.

Fundacao Estadual de Engenharia do Meio Ambiente (FEEMA): based in Rio de Janeiro; active in Rio de Janeiro State.

Instituto Florestal (Secretaria da Agricultura): based in Sao Paulo; active in Sao Paulo State.

Southern Region

Associacao de Defesa e Educacao Ambiental: based in Curitiba; active in Parana.

Superintendencia dos Recursos Hidricos e Meio Ambiente (SUREHMA): based in Curitiba; active in Parana.

Fundacao de Amparo a Tecnologia e Meio Ambiente (FATMA): based in Florianopolis; active in Santa Catarina.

Coordenadoria de Controle do Equilibrio Ecologico, Superintendencia do Desenvolvimento da Regiao Sul (Ministry of the Interior): based in Porto Alegre; active in Rio Grande do Sul.

Fundacao Zoobotanica do Rio Grande do Sul (FZB): based in Porto Alegre; active in Rio Grande do Sul.

Secretaria de Saude e Meio Ambiente: based in Porto Alegre; active in Rio Grande do Sul.

Unidade de Preservacao e Controle de Recursos Naturais Renovaveis (Secretaria da Agricultura): based in Porto Alegre; active in Rio Grande do Sul.

Associacao Gaucha de Protecao ao Ambiente Natural (AGAPAN): based in Porto Alegre; active mainly in Rio Grande do Sul.

West-central Region

Companhia de Agua e Esgoto de Brasilia (CAESB): based in Brasilia; active in the Federal District.

Departamento de Botanica - ICBI: based in Goiana; active in Goias.

Superintendencia Estadual do Meio Ambiente (SEMAGO): based in Goiana; active in Goias.

Instituto de Preservacao e Controle Ambiental de Mato Grosso do Sul (INAMB): based in Campo Grande; active in Mato Grosso do Sul.

Associacao para Defesa da Flora e Fauna do Pantanal: based in Corumba; active in the Pantanal Matogrossense.

Progress in Wetland Conservation

Legislation concerning the natural environment has been in effect in Brazil since 1934. The first law specifically related to wetlands was the *Codigo de Aguas* (1934), which regulated the use of rivers, lakes and lagoons. Since that time, a very large number of laws concerning the environment has been adopted. In general, however, the enforcement of the laws is poor. In

an attempt to educate lawyers and law enforcement personnel in environmental legislation, the Fundacao Brasileira para Conservacao da Natureza and Cia. Energetica de Sao Paulo have recently published a 510 page book summarizing all the nation's environmental legislation (Camara, Strang & Moretzsohn Rocha, 1983).

Commercial hunting has been banned throughout Brazil since 1967, and sport hunting permitted only in those states which are able to demonstrate on a scientific basis that an open season can be justified. Since 1980, the only state able to do this, and therefore the only state in which hunting has been permitted, is Rio Grande do Sul.

Some of the main laws relating to wetlands and their wildlife are as follows:

- a) The Codigo de Aguas in 1934.
- b) A decree in 1948 approving the Convention for the Protection of Fauna, Flora and Scenic Natural Beauty in the Americas.
- c) A decree in 1961 regulating the pollution of inland and marine waters.
- d) A law in 1962 creating the Superintendencia de Desenvolvimento da Pesca, the agency responsible for fisheries in Brazil.
- e) A law in 1967 banning the commercial hunting of wildlife in Brazil, and establishing hunting seasons. All wildlife became the property of the Federation, and could only be hunted under permit.
- f) A law in 1967 creating the Instituto Brasileiro de Desenvolvimento Florestal (IBDF), the agency responsible for nature conservation throughout the country, and for managing National Parks and Biological Reserves.
- g) A decree in 1973 creating the Secretaria Especial do Meio Ambiente (SEMA), the agency responsible for Ecological Stations, and for research on environmental pollution. Ecological Stations have some similarities with Biological Reserves, and there is thus some overlap between SEMA and IBDF.
- h) A decree in 1975 approving Brazil's adherence to the Convention on International Trade in Endangered Species.
- i) Two decrees in 1975 relating to industrial pollution.
- j) A decree in 1979 approving Brazil's adherence to the International Convention on Oil Pollution.

Considerable progress has been made in the establishment of protected areas, and by 1983, over 12 million hectares were under Federal protection in a network of National Parks, Biological Reserves and Ecological Stations. The National Parks Service in IBDF is responsible for National Parks and Biological Reserves, and can create National Forest Reserves in which forest exploitation can occur. By the end of 1983, there were 25 National Parks, 14 Federal Biological Stations, and 14 National Forest Reserves. SEMA is responsible for Ecological Stations, which are established to preserve good examples of all Brazilian ecosystems and to serve as study areas for baseline research. SEMA can also designate Environmental Protection Areas and legislate over private property in regions of special interest. By October 1983, 23 Ecological Stations had been established, and a further seven were at the planning stage. Eighteen of these areas contain important wetland habitat. At state level, some state governmental entities create and preserve State Parks and Ecological Stations. The Codigo Florestal (Law No. 4771) allows for the establishment of permanent private reserves in which land use activities are restricted. In return, the owners are exempt from Federal land taxes. Private reserves can similarly be established through the regulations of IBDF, under the name of Refugios de Fauna (Faunal Refuges).

The protected areas which include significant wetland habitat are as follows:

Northern Region

Cabo Orange National Park, on the north coast of Amapa: 619,000 ha; established 1980.

Lencois Maranhenses National Park, on the east coast of Maranhao: 155,000 ha; established 1981.

Lago Piratuba Biological Reserve, on the central Amapa coast: 395,000 ha; established 1980.

Trombetas Biological Reserve, on the Rio Trombetas in Para: 385,000 ha; established 1979.

Abufari Biological Reserve, in Amazonas: 288,000 ha; established 1982.

Guapore Biological Reserve, on the Rio Guapore in Rondonia: 600,000 ha; established 1982.

Maraca-Roraima Ecological Station, in Roraima: 92,000 ha.

Maraca-Amapa Ecological Station, on the Amapa coast: 70,000 ha.

Anavilhanas Ecological Station, on the lower Rio Negro in Amazonas: 350,000 ha.

Cunia Ecological Station, in Rondonia: 100,000 ha.

Juami-Japura Ecological Station, on the lower Rio Japura in Amazonas: 273,238 ha.

Northeastern Region

Praia do Peba Ecological Station, on the coast of Alagoas: 3,000 ha.

Southeastern Region

Serra da Canastra National Park, in the highlands of Minas Gerais: 71,525 ha; established 1972.

Parapitinga Ecological Station, in Minas Gerais: 10,000 ha.

Pirai Ecological Station, in Rio de Janeiro State: 4,000 ha.

Jureia Ecological Station, in Sao Paulo State: 30,000 ha.

Southern Region

Iguacu National Park, on the Rio Iguacu in Parana: 170,000 ha; established 1939.

Taim Ecological Station, on the south coast of Rio Grande do Sul: 32,000 ha.

Guaraquecaba Ecological Station, in Parana: 73,640 ha.

Carijos Ecological Station, in Santa Catarina: area unknown.

Babitonga Ecological Station, in Santa Catarina: area unknown.

West-Central Region

Chapada dos Veadeiros National Park, in Goias: 60,000 ha; established 1972.

Araguaia National Park, at Ilha do Bananal on the Rio Araguaia, Goias: 562,312 ha; established 1959.

Pantanal Matogrossense National Park, in the Pantanal, Mato Grosso: 135,000 ha; established 1981.

Taiama Ecological Station, in the Pantanal, Mato Grosso: 12,000 ha.

Cocos-Javaes Ecological Station, in Goias: 37,000 ha.

Alto Guapore Ecological Station, on the upper Rio Guapore, Mato Grosso: area unknown.

Progress in Research on Wetlands and Waterfowl

A considerable amount of research has been conducted on the natural resources of Brazil, and the flora and fauna of the country are now relatively well documented. However, very little work has been done on wetland ecosystems and their wildlife except locally in Amazonas, Amapa, Para, Sao Paulo and Rio Grande do Sul. In Amazonia, the Instituto Nacional de Pesquisas da Amazonia (INPA) has been particularly active in wetlands research, with major projects on fisheries resources, crocodilians, freshwater turtles and aquatic mammals. The Aquatic Mammal Project at INPA has in the past concentrated on *Trichechus inunguis*, but in recent years has expanded the scope of its activities to include the Cetaceans and otters *Pteronura* and *Lutra*. Some limnological work has been conducted on the flood plain systems near Manaus and on the lower Rio Tapajos, and attempts have been made to interpret the aquatic resources of central Amazonia using Landsat imagery. IBDF biologists, the Goeldi Museum in Belem, and the Museu Costa Lima in Macapa have carried out investigations on *Trichechus manatus*, sea turtles and waterfowl in the delta area and along the Para and Amapa coasts.

In the south, J. G. Tundisi and colleagues of the Federal University of Sao Carlos have conducted limnological studies at man-made lakes in Sao Paulo and lacustrine systems in Rio de Janeiro (Henry & Tundisi, 1983; Matsumura-Tundisi & Tundisi, 1976; Rocha *et al.*, 1982; Tundisi, 1981 & 1983a; Tundisi *et al.*, 1978); and limnologists at the Federal University of Rio Grande do Sul have investigated the coastal lagoons of that state (Chomenko, 1981; Schwarzbald, 1982).

As regards research on waterfowl, very little work has been done in Amazonia, and indeed rather few researchers have specialized in this group anywhere in Brazil. Recent investigations of note include aerial surveys of the entire Brazilian coastline for wintering shorebird

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populations by Canadian Wildlife Service and IBDF biologists (Morrison, 1983a & 1983b); a survey of *Phoenicopterus ruber* and *Eudocimus ruber* populations on the Amapa coast by Teixeira and Best (1981); a study of game species and colonial waterbirds in the Pantanal by IBDF biologists (initiated in 1983); studies on game bird management and sport hunting in Rio Grande do Sul by biologists at the Fundacao Zoobotanica; experiments with the management of *Amazonetta brasiliensis* as a game species in Sao Paulo by a private timber company; and a detailed avifaunal survey of Rio Grande do Sul by Belton (1984). A study of the importance of Lagoa do Peixe, Rio Grande do Sul, for waterfowl, particularly wintering Nearctic shorebirds, will be initiated by S. Lara-Resende in 1985.

Brazil does however have a very active bird banding programme coordinated by CEMAVE, and this has included a number of projects involving waterfowl. Recent banding projects have included the following:

- a) Colonially nesting Ardeidae, mainly *Egretta alba* and *Ardea cocoi*, in Amapa, by Antonio Carlos Farias of the Museu Costa Lima.
- b) Shorebirds and Laridae, particularly *Sterna hirundo*, on the northeast coast, by biologists from CEMAVE, the Canadian Wildlife Service, the Goeldi Museum and several local universities.
- c) *Sterna* spp in the Atol das Rocas Biological Reserve, by IBDF biologists.
- d) *Sterna hirundinacea* in Guanabara Bay, Rio de Janeiro, by Norma Crud Maciel and Dante Teixeira.
- e) Nearctic shorebirds in Rio de Janeiro, by Pedro Ernesto Correa Ventura and Elias Pacheco Coelho.
- f) Anatidae, particularly *Dendrocygna viduata*, in Sao Paulo, by the Sao Paulo Zoo, the Cia. Energetica de Sao Paulo, and a private timber company.
- g) Colonially nesting Ardeidae and *Anhinga anhinga* in Minas Gerais by Marco Antonio Andrade.
- h) Anatidae and sea-birds in Santa Catarina, by Lenir Alda do Rosario and colleagues.
- i) Anatidae and colonially nesting Ciconiiformes in Rio Grande do Sul, by Flavio Silva and colleagues.
- j) Shorebirds on the southern coast, by Martin Sander of the Universidade do Vale do Rio dos Sinos.
- k) Colonially nesting Ciconiiformes in the Pantanal, by the Instituto de Preservacao e Controle Ambiental in Mato Grosso do Sul.

Major Threats to Wetlands and Waterfowl

The wetlands of Brazil are under heavy human pressure. Most of Brazil's population is concentrated in the southeastern and southern regions, where the nation's largest cities and advanced industrial development pose particularly serious threats to wetland ecosystems. In other parts of the country, agricultural development, especially the cultivation of rice, is the principal threat, while in coastal zones development for recreation and the destruction of mangrove forests for timber and fuel add to the pressures on wetlands. Despite the fact that hunting has been prohibited in all states except Rio Grande do Sul since 1980, the commercial exploitation of wildlife and subsistence hunting continue everywhere at a high level and threaten many populations of preferred species with local extinction.

Northern Region

The population density remains very low almost throughout the northern region and the destruction of wetland habitat for agricultural land has had a serious impact only at a very local level; e.g. in the Sao Luis area where wetlands have been reclaimed for rice culture and pastureland. However, one habitat type, namely the floodplains of white water rivers, has come under considerable pressure because of the fertility of the soils, and this habitat has now largely disappeared from the major navigable white water rivers of central and lower Amazonia. Elsewhere in the region, illegal commercial and subsistence hunting pose the most

serious threat to wetland fauna. Species under particular pressure include the crocodylians (notably *Melanosuchus niger*), the freshwater turtles (notably *Podocnemis expansa* and *P. unifilis*), the manatees *Trichechus inunguis* and *T. manatus*, and a variety of waterfowl including *Eudocimus ruber*, *Neochen jubata*, *Dendrocygna* spp and *Porphyryla martinica*. The flamingo *Phoenicopterus ruber* has become extinct as a breeding species in Brazil because of intensive persecution in the past. Pollution from pesticide runoff is beginning to affect some riverine systems, and the construction of a number of enormous dams in the coming decades will have a major impact on most of the large rivers of the region.

Northeastern Region

Most of the wetlands are situated on the densely populated coastal plain, where the large industrial centres of Salvador and Recife and many smaller cities create serious pollution problems. Almost all of the mangrove swamps are being affected by cutting and drainage, and coastal development for recreation is a problem in some areas. Illegal hunting is widespread; sea turtles, principally *Eretmochelys imbricata*, and Anatidae, principally *Dendrocygna viduata*, are particularly under pressure.

Southeastern Region

The long history of colonization, very dense human population and extensive industrial development have resulted in major changes to natural ecosystems throughout the southeast. Wetlands have been seriously affected by reclamation for agriculture and urban development, domestic and industrial pollution, contamination with pesticides and, along the coast, development for recreation and tourism. Large tracts of wetland habitat have been destroyed, and few areas remain in anything like pristine condition. Hunting, although now illegal throughout the region, continues to take a heavy toll, and several species of waterfowl have been exterminated locally or reduced to very low levels. In recent years, attempts have been made to control *Dendrocygna viduata* as a pest on rice crops, and Aldrin has been used illegally in at least one region in Sao Paulo.

Southern Region

Wetlands in the southern region have been subjected to all the same pressures as those in the southeast, but have not to date suffered as badly. The principal threat in most areas is the reclamation of land for rice growing which continues at an accelerating pace. Overgrazing by domestic livestock is a problem in some of the ranching areas in the south. In Rio Grande do Sul, there is an open season for sport hunting of Anatidae from 15 May to the end of August (15 June to the end of September for *Netta peposaca*), and some 12,000 hunters are licensed each year. However, despite poor law enforcement and a lack of management, waterfowl populations remain high.

West-central Region

Population pressures remain low throughout much of the west-central region, and although wetlands have been reclaimed for agriculture and ranching, the total area affected to date is relatively small. However, a large expansion in agriculture is planned in the region, and areas such as the Pantanal and middle Araguaia are increasingly coming under pressure. Deforestation of watersheds has affected flooding cycles and sedimentation rates in the floodplains of the major rivers, and the widespread use of pesticides on agricultural land is also beginning to affect the riverine systems. Illegal hunting is a serious problem, particularly the commercial exploitation of *Caiman crocodilus yacare* in the Pantanal. The skins are smuggled across the border into neighbouring Bolivia to enter the international trade. Subsistence hunting of waterfowl is widespread, but it is doubtful if this is having any detrimental effect on populations. However, there are indications that avicides are being used to kill ducks, mainly *Dendrocygna* spp, in rice growing areas in the Araguaia Valley (Rio Formosa).

BRAZIL



WETLANDS

Site descriptions based on information and data sheets provided by Maria Alice dos Santos Alves, Marco Antonio de Andrade, Paulo de Tarso Zuquim Antas, Joao Henrique Auler Junior, Marlise Becker, Lenir Alda do Rosario Bege, Robin C. Best, James M. Dietz, Selma Mattos Diniz, Jean-Luc Dujardin, Antonio Carlos da Silva Farias, Luiz A. Pedreira Gonzaga, Susana de Moura Lara-Resende, Norma Crud Maciel, Pedro Scherer Neto, Marcos da Silva Noffs, Fernando C. Novaes, David Oren, Benedito Vitor Rabelo, Paul Roth, Helmut Sick, Flavio Silva, Dante Luiz Martins Teixeira, Walter A. Voss and Carlos Yamashita.

The Amazon Basin (1)

Location: 5°00'N to 11°00'S, 48°00'W to 73°00'W; the Amazon Basin from the Delta near Belem and Macapa to the borders of the Guianas, Venezuela, Colombia, Peru and Bolivia, and the highlands of central Brazil.

Area: The entire catchment is about 7,000,000 sq. km, of which nearly three-quarters (4,975,000 sq. km) lie in Brazil. No reliable estimate of the total area of wetland habitat is available. However, it has been estimated that in Brazil alone there are between 70,000 and 100,000 sq. km of floodplain habitat, and over 100,000 sq. km of lakes and swamps. There are 40,000 km of navigable stretches of river, and probably an even greater extent of wetland in the form of creeks and streams. Thus the total area of wetland in the Brazilian Amazon almost certainly exceeds 300,000 sq. km (30 million ha), and may be much more.

Altitude: 0-300m; the major wetlands of central and lower Amazonia lie below 100m above sea level.

Province and type: 8.4.1/8.5.1/8.6.1, with some 8.28.10 in the extreme north; 09, 10, 11, 12, 15, 16 & 18.

Site description: The Amazon River and its tributaries comprise the greatest riverine system on earth, discharging one sixth of the fresh water entering the world's oceans. The Brazilian portion of the Amazon Basin constitutes 58% of that country and over a quarter of the South American continent. The annual rainfall over much of the basin is between 2,000 and 3,000 mm; it exceeds 3,000 mm in the delta region in the east and in the Andean foothills in the west, and is as low as 1,600 mm in some north-central areas. Rain falls year round, with a peak between January and May and a low between July and November in the central and eastern areas.

Three major divisions of aquatic system are widely recognized:

- Black water systems, arising on bleached sands and podzols of the central Amazon lowlands. The water is rich in dissolved humic substances, dark brownish in coloration, and transparent, with a low concentration of dissolved minerals and an extremely low pH (about 4). Black waters are amongst the most nutrient poor waters on earth and have a low productivity.
- White water systems, arising mainly in the Andes and foothills. The water is rich in inorganic particles in suspension and turbid, with a relatively high concentration of dissolved minerals and a pH of about 7. White waters have a fairly high nutrient content, and high productivity.
- Clear water systems, arising in the crystalline Precambrian shield of central Brazil in the south and the Guianas in the north. The water is greenish in coloration and transparent, with a very low to relatively high concentration of dissolved minerals, a pH ranging from very acid to neutral, and low to medium productivity. The two main clear water rivers are the Xingu and Tapajos.

Junk (1983) recognizes eight main wetland habitats in the Amazon Basin:

- Rivers: all are influenced by wide fluctuations in water level. Rivers flowing south from the northern parts of the basin reach flood peaks between June and August; those flowing north into the Amazon, between February and June. The Amazon itself reaches its maximum normally at the end of June. The magnitude of the fluctuations decreases from west to east, with fluctuations of 16-20m in the Andean foothills, 8-15m at Manaus in central Amazonia, and 4-6m near the delta.
- Creeks: the Amazon basin has the greatest density of creeks on earth. They show a great diversity in water chemistry, extent of solar irradiation, rate of flow, and permanence, and

thus constitute a very complex system of different habitats with a huge diversity of aquatic organisms. (In one study, 40 species of fishes were found in a 300m stretch of forest creek 1-2m wide.)

- c) Deep closed lakes: deep lakes with more or less closed basins are rare in Amazonia. Probably the only real deep closed lake basins in the Brazilian portion are the Morro de 6 Lagos, a group of six small lakes in the highlands of the upper Rio Negro. The area is difficult of access, and the lakes have never been studied.
- d) Closed shallow lakes: these are very common in the savanna areas of Roraima. Some are perennial, others temporary; they are mainly oligotrophic, but some are eutrophic and these may have extensive swamps with a great diversity of wildlife.
- e) Open shallow lakes or floodplain lakes: these are shallow lakes which are connected with rivers for at least a part of the year, allowing an exchange of nutrients, energy and biological material on an annual basis. They include oxbow lakes, lateral levee lakes, lakes in abandoned channels, and lakes in depressions formed by uneven aggregations of sediments during floods. Most are subject to wide fluctuations in water level.
- f) Floodplains: these are areas which for parts of the year have aspects of terrestrial habitats, but for the remainder are flooded and united with the shallow floodplain lakes. Nutrient cycles are extremely complex, and the organisms living in these transitional systems show a wide range of special morphological, physiological and ethological adaptations. Extensive flooding occurs along white water rivers, forming enormous shallow lakes up to 40 km wide and 100 km long. Along the Solimoes-Amazon alone, there are over 6,400,000 ha of this "varzea" habitat in a strip 20 to 100 km wide. The higher ground is covered with forest; the low-lying areas are primarily overgrown with bushes and grasses during the dry period. Flooding occurs to a lesser extent along black water rivers, and here the flooded regions are covered by "igapo", a characteristic type of forest which can survive flooding for several months of the year.
- g) Swamps: these occur mostly along creeks and small rivers, and in long abandoned river channels where the groundwater table reaches the surface during most of the year. Although there are over 10,000,000 ha of swamps in central Amazonia, they have been little studied and their ecology remains poorly understood.
- h) Man-made lakes: these include large hydro-electric dams, fish ponds and areas of rice cultivation. Only three large dams have been completed in Amazonia to date, but many more are under construction or in the planning stages. There are only small areas of fish ponds and rice cultivation at present, but these too are likely to be extended enormously in the coming decades.

Some of the most important wetland areas in the Amazon basin and the delta region are described separately below (site 1a - 1i, and site 2).

Principal vegetation: Humid tropical forest covers 68% of the Amazon basin. Non-forested terrestrial formations include dry savannas and areas of low vegetation on white sand known as campinas. Wetland habitat includes seasonally flooded forest along white water rivers (varzea); seasonally flooded forest along black water rivers (igapo); swamps with emergent macrophytes and stands of *Mauritia flexuosa*; and eutrophic lakes with fringing marshes of Cyperaceae and beds of *Eichhornia* sp, *Pistia* sp and the floating stages of *Paspalum repens*.

Land tenure: A mixture of Federal, State and private ownership.

Protection: Very little of the wetland habitat is under protection. Although a number of large National Parks, Biological Reserves and Ecological Stations have been established in wider Amazonia, and give some measure of protection to over eight million hectares, the emphasis has been very largely on preserving terra firma forests. Very little white water floodplain forest (varzea) has been protected, and no significant tracts of black water swamp forest (igapo) occur in any of the reserves. The commercial exploitation of wildlife was banned throughout the region in 1967, and full legal protection given to the manatee *Trichechus inunguis* and otters *Pteronura brasiliensis* and *Lutra enudris* in 1973, but enforcement of the regulations is almost non-existent outside the reserves.

The following protected areas have been established in the Amazon proper; all include some wetland habitat, but only the Rio Trombetas Biological Reserve, and Anavilhanas, Maraca-Roraima and Juami-Japura Ecological Stations include large tracts of important wetland habitat:

Jau National Park: 2,272,000 ha; established 1980. Along a western tributary of the Rio Negro.

Amazonia (Tapajos) National Park: 1,258,000 ha; established 1974. On the middle Rio Tapajos in southern Para and southeastern Amazonas.

Pico da Neblina National Park: 2,200,000 ha; established 1979. On the upper Rio Negro on the Venezuelan border.

Rio Trombetas Biological Reserve: 385,000 ha; established 1979. On the lower Rio Trombetas and Rio Maquera.

Abufari Biological Reserve: 288,000 ha; established in 1982. Between the Rio Purus and the Rio Coari.

Anavilhanas Ecological Station: 350,000 ha; established 1981. On the lower Rio Negro, and including a large archipelago in that river.

Maraca-Roraima Ecological Station: 92,000 ha; established 1976. An island in the Rio Uraricuera, a tributary of the Rio Negro, in the extreme north.

Rio Acre Ecological Station: 77,500 ha; established 1981. On the Rio Acre, a tributary of the Rio Purus, on the Peruvian border.

Apiacas Ecological Station: 500,000 ha; date of establishment unknown. On the middle Rio Tapajos, in the transition zone between humid tropical forest and cerrado.

Cunia Ecological Station: 100,000 ha; date of establishment unknown. On the upper Rio Madeira in northern Rondonia.

Juami-Japura Ecological Station: 273,238 ha; date of establishment unknown. On the lower Rio Japura near its confluence with the Solimoes-Amazon.

Land use: The human population of the Amazon Basin is extremely low, with an estimated total of only six million inhabitants in the entire basin of 7,000,000 sq. km. However, almost the entire population is concentrated along the main water courses and is very largely dependent on the rivers for transportation, and the floodplains for cultivation. There is a very important subsistence and commercial fishery; it has been estimated that the potential of the Amazon could exceed 600,000 metric tons of fish per year, but only a small fraction of this is currently being harvested. Fish farming in fish ponds is being attempted in some areas, and this activity is likely to increase enormously in the future. Agriculture is generally at a very primitive subsistence level except around the main centres of habitation where maize, rice and jute are the principal crops. Rice production is however increasing rapidly and is likely to take over large areas of floodplain in the future. There is also some cattle ranching in open areas.

Hunting for food and for skins has long been an important activity in much of the Amazon and has focussed on the readily accessible wildlife of the rivers and riverbanks. There was a massive trade in skins of crocodilians, *Capybara* *Hydrochoerus hydrochaeris* and otters in the 1950s and 1960s, but with the virtual extermination of some species over much of their ranges and the introduction in 1967 of legislation prohibiting commercial hunting, the level of harvest has dropped off considerably. Freshwater turtles continue to be harvested for food on a large scale, although the preferred species *Podocnemis expansa* is becoming increasingly rare.

Waterfowl: The waterfowl of Amazonia have received remarkably little attention from ornithologists or ecologists, perhaps because they show none of the interesting speciation phenomena associated with Pleistocene forest refugia which have captivated so many biologists working in the Amazon in recent decades. In fact, the aquatic avifauna of the Amazon is extremely homogeneous; of the 30 species typical of rivers, creeks, oxbow lakes and wet forest, all but two occur throughout the Amazon Basin. Thus even those species which occur at very low densities, such as *Zebrilus undulatus* and *Agamia agami*, must, in terms of total population size, be relatively common birds.

Characteristic species include *Phalacrocorax olivaceus*, *Anhinga anhinga*, *Tigrisoma lineatum*, *Zebrilus undulatus*, *Ptilerodius pileatus*, *Egretta alba*, *Ardea cocoi*, *Agamia agami*, *Mesembrinibis cayennensis*, *Anhima cornuta*, *Neochen jubata*, *Cairina moschata*, *Opisthocomus hoazin*, *Aramides cajanea*, *Laterallus exilis*, *L. melanophaius*, *Porphyryla martinica*, *Heliornis fulica*, *Eurypyga helias*, *Jacana jacana*, *Hoploxypterus cayanus*, *Charadrius collaris*, *Phaetusa simplex*, *Sterna superciliaris* and *Rynchops niger*. The two humid forest species with restricted ranges in western Amazonia are *Aramides calopterus* and *Laterallus fasciatus*.

A variety of species typical of large open wetlands such as the llanos of Venezuela or Pantanal of central Brazil have a rather patchy distribution in Amazonia, dependent on the presence of open lacustrine and floodplain systems or wet savannas. These include several Ardeidae, the three storks Ciconiidae, *Theristicus caudatus*, *Ajaia ajaia*, *Dendrocygna viduata*, *D. autumnalis*, *Amazonetta brasiliensis*, *Sarkidiornis melanotos*, *Oxyura dominica*, *Aramus guarauna*, *Vanellus chilensis* and *Himantopus himantopus*.

Several species of Nearctic shorebirds cross Amazonia on a broad front on their way to and from wintering areas further to the south. Although few areas hold large numbers of birds at any one time, every wide river, floodplain lake and swamp provides some habitat for shorebirds during the migration seasons, and the basin as a whole must constitute a vital refuelling area for large sections of the entire population of some species. The principal species involved are *Pluvialis dominica*, *Bartramia longicauda*, *Tringa melanoleuca*, *T. flavipes*, *Calidris fuscicollis*, *C. melanotos*, *Micropalama himantopus* and *Tryngites subruficollis*. Two species *Tringa solitaria* and *Actitis macularia* remain in the Amazon throughout the northern winter, this constituting an important wintering area for these species.

Because of the extent and relatively undisturbed nature of the wetland habitats, and the low human population density, none of the species typical of the Amazon are in any foreseeable danger of extinction except for the Orinoco Goose *Neochen jubata*. As an inhabitant of wide rivers and riverbanks, this popular game species and surprisingly confiding bird has been particularly susceptible to hunting pressure, and has now disappeared from most of the navigable rivers of Amazonian Brazil.

Other fauna: The manatee *Trichechus inunguis* occurs widely in the Amazon Basin, but in much reduced numbers as a result of excessive hunting in the 1950s and 1960s. It has recently been introduced into the Curua-una Dam near Santarem to control the spread of aquatic vegetation. The two Cetaceans *Sotalia fluviatilis* and *Inia geoffrensis* are still common and widespread. The two otters, *Pteronura brasiliensis* and *Lutra enudris*, are much reduced in numbers as a result of intensive hunting in the past; the former is now confined to the remotest areas, and is thought to be the most endangered mammal in Amazonia. Despite heavy hunting pressure, the Capybara *Hydrochoerus hydrochaeris* is thriving, as forest clearance for agriculture and ranching provides increased foraging.

The two larger crocodylians *Caiman crocodilus* and *Melanosuchus niger* are still widespread and *C. crocodilus* remains fairly common despite heavy hunting pressure, particularly in the 1950s and 1960s. *M. niger* is rare in all accessible unprotected areas, but some populations are beginning to recover under protection. Freshwater turtles include *Podocnemis expansa*, *P. unifilis*, *P. dumeriliana*, *P. erythrocephala*, *P. sextuberculata*, *Chelus fimbriatus* and *Platemys platycephala*. The larger *Podocnemis* have been subjected to heavy hunting pressure; *P. expansa* is now rare in many areas, and *P. unifilis* is declining, but the other commonly persecuted species, *P. dumeriliana*, remains common on black water and clear water streams in the Rio Negro basin.

Some 1,500 species of fishes have been described, and it is supposed that about 2,000 occur. Some of the economically more important species include *Astronotus ocellatus*, *Colossoma macropomum*, *Apapaima gigas* and *Cichla* spp. Piranhas *Serrasalmus* spp are ubiquitous. The aquatic invertebrates are very poorly known; recent studies have indicated that in some families, up to 80% of the species remain undescribed.

Threats: Traditional land use activities in the Amazon basin, such as slash and burn agriculture, timber extraction, rubber collection and hunting have concentrated on the riverine forests and floodplains which have always been readily accessible by way of the extensive network of navigable rivers. White water varzeas with their fertile soils have been the most seriously affected by human colonization and have almost completely disappeared from large areas in eastern Amazonia. However the black water floodplains are also increasingly coming under pressure, and as they have very little potential for agriculture or animal husbandry, their utilization is creating great ecological damage without providing any long term benefits. The threats to floodplain ecosystems are likely to increase greatly in the coming decades as these regions have been declared areas for intensive colonization and utilization for agriculture and ranching. Experiments with rice culture in the varzea have yielded positive results and there is likely to be a great increase in this form of cultivation in the near future.

The other serious threat at present is the massive programme of dam building for hydroelectric power. As many as 40 dam projects have been put forward, affecting every major river in the basin. Three large dams have already been completed; the Curua-una Dam near Santarem in Para (10,000 ha), the Paredao Dam on the Araguari River in Amapa (10,000 ha), and the Tucuruí Dam on the Tocantins River in Para (246,000 ha). Dams already under construction or in an advanced planning stage include the Balbina Dam on the Uatuma River (210,000 ha); the Samuel Dam on the Jamari (64,500 ha); the Porteira Dam on the Trombetas (140,000 ha); and the Babaquara Dam (610,000 ha) and Cararo Dam (120,000 ha) on the Xingu. These enormous dams will have a profound effect on the ecology not only of the rivers themselves but also of large tracts of surrounding land. Insufficient information is

available to predict the full consequences of these projects, but it is clear that flood cycles downstream of the dams will be reduced or eliminated, and the water chemistry, sediment load and discharge of the rivers will be altered. Many fish species make long spawning migrations which will be disturbed or completely interrupted by dam construction on some rivers. The Curua-una dam has been studied for several years, and the negative effects already observed include changes in fish fauna, mass development of aquatic macrophytes, and deterioration in water quality, principally in the form of a high oxygen deficit. Intensive studies were conducted in the Tucuui area prior to the construction work, and thus some baseline material is available to permit a better assessment of the impact of that dam.

Other threats include deforestation in the catchment areas causing changes in the amount of discharge, sediments and dissolved substances in the rivers, and pollution from industrial wastes and pesticides from agricultural land. Pollution is a particularly serious problem on floodplains because contaminants deposited during periods of high water are likely to enter terrestrial food chains when the water recedes. Defoliant sprays have been used to clear forest at dam construction sites, and the effects of this have been felt far downstream.

A great expansion in fish culture creates a potential threat to the native fauna, with the possible spread of diseases and parasites, and the introduction of exotic species. Tilapias have already escaped into the wild in parts of Amazonia.

Excessive hunting, although illegal, continues to threaten some species, particularly the crocodilians, larger freshwater turtles and otters. The Cetaceans have never been seriously persecuted in the past, but they could be affected by the new fishing methods being introduced into the region, and an FAO report in 1961 went so far as to suggest that they be controlled as predators on fish stocks.

Research and conservation: A considerable amount of research has been conducted by the Instituto Nacional de Pesquisas da Amazonia (INPA) based in Manaus. Attention has focussed on the fisheries resources, crocodilians, freshwater turtles and aquatic mammals, and relatively little work has been done on wetland ecosystems as such or wetland ecology. The Aquatic Mammal Project initiated at INPA in 1974 has been particularly active in studies on the status, biology, management and conservation of the manatee *Trichechus inunguis*, Cetaceans and otters, and plans to expand this work in the future. One aspect of the work has been the identification of critical areas for these species with a view to the establishment of appropriate wetland reserves.

The limnology of the floodplain lakes around Manaus is relatively well known, and a detailed study of the limnology of the lakes on the lower Rio Tapajos has been made, but generally the limnology of Amazonian wetlands is very poorly studied. Goulding (1980) looked at the importance of floodplains for fish populations, and concluded that about 75% of the commercial fish catch in the Amazon depends on food chains originating in the flooded forests. Junk (1975 & 1983) has discussed the fisheries resources and wetland habitats of Amazonia, and Bayley and Moreiras (1978) made preliminary interpretations of the aquatic resources of the central Amazon Basin using Landsat imagery.

Despite the volume of research which has already been carried out in the Amazon, there remains an urgent need for a large scale project on the overall importance of the floodplain ecosystems for wildlife, fisheries production and agriculture.

The general problems for conservation in the wider Amazon Basin have recently been reviewed by Barrett (1980). Wetterberg *et al* (1976) made recommendations concerning priority areas for conservation, and identified thirty sites totalling 17,500,000 ha. In 1979, this proposal was incorporated in a proposed system for conservation units in Brazil adopted by the Federal Government. However, the emphasis was on forest refugia and terrestrial wildlife. It has often been assumed that the protection of the terrestrial ecosystems in Amazonia will automatically include an adequate protection of wetland habitats, but there is no reason to suppose that the theory of forest refugia should apply to aquatic communities; indeed, this seems unlikely to be the case in a contiguous riverine system.

As Junk (1983) points out, the protection of riverine systems poses several special problems:

rivers and floodplains are densely colonized and utilized for agriculture, animal husbandry and timber extraction;

the rivers themselves are used for transportation and fisheries, and will in many cases in the future be used for the generation of hydroelectricity;

pollution or changes in the discharge and sediment load in unprotected areas may have dramatic effects in distant protected areas;

Brazil

rivers and creeks are open systems, transporting organisms by drift, or allowing active migration over long distances.

For adequate conservation of the system as a whole, it is essential that well defined aquatic habitats including entire watersheds, lake systems and archipelagos be protected in different sections of the main rivers. In addition, large reserves should be created in the floodplains so that adequate tracts of varzea and igapo are preserved to maintain commercially important fisheries and turtle populations.

References: A very extensive literature exists on the Amazon Basin, and much of this has been listed by Junk (1975 & 1983) and Barrett (1980). Sources utilized in the present account include: Antas (1983); Barrett (1980); Bayley & Moreiras (1978); Best (1984); Costa (1983); Domning (1982); Goulding (1980); Hueck (1978); IUCN (1982); Junk (1975 & 1983); Kempf (1984); Marigo (1979); MINTER & SEMA (1977); Rebelo & Magnusson (1983); Rylands & Mittermeier (1983); Smith (1979 & 1980-1981); and Wetterberg *et al* (1976). Other publications relevant to the wetlands include Sioli (1964 & 1965); Marlier (1967); Schmidt (1973); Fittkau *et al* (1975); Rai (1978 & 1979); Rai & Hill (1981); Zaret *et al* (1981); Fittkau (1983); and Leopoldo (1983).

Source: See references.

Criteria for inclusion: 123.

The middle Rio Purus (1a)

Location: 5°45'S, 64°25'W to 9°00'S, 68°35'W; the middle course of the Rio Purus from Sena Madureira downstream for 750 km to the Rio Tapaua, Amazonas.

Area: Approximately 50,000 ha of lakes along 750 km of river.

Altitude: 60-130m.

Province and type: 8.5.1; 09, 11 & 18.

Site description: A slow flowing white water river with adjacent seasonally flooded varzea forest, in humid tropical lowlands. The river is remarkable for its extremely meandering course and the high number of associated oxbow lakes and abandoned river channels. There are at least 150 lakes in excess of 200 ha, and several between 1,000 and 2,000 ha. Maximum flooding occurs in February.

Principal vegetation: Humid tropical forest and varzea forest.

Land tenure: No information.

Protection: None; the middle Purus was identified as a priority area for conservation by Wetterberg *et al* (1976).

For other information see (1).

Lakes on the lower Rio Japura (1b)

Location: 1°25'-2°55'S, 65°02'-67°25'W; near the confluence of the Rio Japura and Rio Solimoes, Amazonas.

Area: c.67,000 ha of lakes.

Altitude: 70m.

Province and type: 8.5.1; 09, 11, 12 & 18.

Site description: A group of about 65 large freshwater lakes along the lower Rio Japura and between it and the Rio Solimoes, near the confluence of the two rivers. The Rio Auati Parana linking the Japura and the Solimoes cuts across the middle of the area. The principal lakes are: Lago de Maracai (3,800 ha); Lago Marimari (1,400 ha); Lago Parica (6,400 ha); Lago Panaua (2,200 ha); Lago Angaiara (2,900 ha); Lago de Guedes (3,400 ha); and Lago Jauato (1,800 ha). The Solimoes is a white water river with numerous islands and sand banks, and extensive areas of seasonally flooded varzea forest; the Japura is a black water river with igapo forest.

Principal vegetation: Humid tropical forest and varzea forest.

Land tenure: No information.

Protection: Largely included within the recently established Juami-Japura Ecological Station (273,238 ha). This area was listed as a priority area for conservation by Wetterberg *et al* (1976).

Land use: No information.

Waterfowl: Known to be a very important breeding area for resident waterfowl and staging area for migrant Nearctic shorebirds.

Other fauna: The entire wild population of the monkey *Cacajao calvus calvus* occurs in the forests of this region, and *Melanosuchus niger* is still relatively common.

For other information see (1).

The lower Rio Solimoes and lower Rio Purus (1c)

Location: 2°30'-4°30'S, 60°00'-65°00'W; the Solimoes-Amazon from the Rio Japura to the Rio Negro, and the lower Rio Purus, Amazonas.

Area: c.2,500,000 ha of wetlands including 350,000 ha of large lakes.

Altitude: 25-70m.

Province and type: 8.5.1; 09, 11, 12, 16 & 18.

Site description: A vast complex of broad river channels, islands and seasonally inundated varzea forest with hundreds of permanent and seasonal floodplain lakes, along 650 km of the Rio Solimoes from its confluence with the Japura to its confluence with the Negro, and along the lower 150 km of the Rio Purus. Maximum flooding occurs between February and May, and water levels are lowest between July and December. The principal lakes are: Lago Amaná (19,100 ha); Lago Urini (4,100 ha); Lago de Tefe (16,100 ha); Lago Caiambe (4,100 ha); Lago de Coari (75,000 ha); Lago Mamia (24,700 ha); Lago Piorini (36,000 ha); Lago Badajos (24,000 ha); Lago Aiapu (20,000 ha); Lago Paricatuba (2,700 ha); and Lago Grande de Manacapuru (31,500 ha).

Principal vegetation: Humid tropical forest, varzea forest and some seasonally flooded grassland.

Land tenure: A mixture of federal and private ownership.

Protection: None; the Abufari Biological Reserve (288,000 ha), established in 1982, lies to the south, between the Rio Purus and Rio Coari.

Land use: Subsistence hunting and fishing, and agriculture on a small scale.

Waterfowl: Little information is available: some of the most important areas for waterfowl appear to be Lago Manacapuru, Lago Badajos and Lago Piorini. Large concentrations of *Dendrocygna* spp and *Rynchops niger* have been recorded at Manacapuru, and *Neochen jubata* still occurs in the Badajos area.

Other fauna: An important area for *Trichechus inunguis*. The Abufari Biological Reserve is particularly important for *Podocnemis expansa*.

Source: Paulo de Tarso Zuquim Antas, Robin C. Best and Susana de Moura Lara-Resende.

For other information see (1).

The lower Rio Negro (1d)

Location: 0°10'-3°00'S, 60°20'-65°00'W; the lower Rio Negro from Tapuruquaru to its confluence with the Solimoes-Amazon at Manaus, Amazonas and Roraima.

Area: c.1,640,000 ha, including 1,240,000 ha of rivers and islands, and 400,000 ha of lakes and swamps.

Altitude: 25-70m.

Province and type: 8.5.1; 09, 11, 12, 16 & 18.

Site description: The lower 650 km of the Rio Negro, a black water river up to 20 km wide, with countless large and small islands, numerous channels, sandy beaches, and an extensive floodplain system with permanent and seasonal lakes and swamps, igapo forest and seasonally flooded grassland. There are hundreds of oxbow lakes and associated swamps along the lower courses of the Rio Branco, Rio Araca and Rio Unini, which enter the Negro in this area. The Anavilhanas Archipelago, a group of large and small islands in the Rio Negro, lies 100 km northwest of Manaus, and is about 90 km long and 15 km wide.

Principal vegetation: Humid tropical forest, igapo swamp forest, seasonally inundated "campinarana" grassland, and swamps.

Land tenure: The Anavilhanas Archipelago is owned by SEMA.

Brazil

Protection: The Anavilhanas Archipelago and a large area of adjacent terra firma forest are included in the Anavilhanas Ecological Station (350,000 ha) established in 1981; part of the western bank of the Rio Negro is included in the Jau National Park (2,272,000 ha) established in 1980.

Land use: All land use activities are prohibited in the Ecological Station.

Waterfowl: One of the richest areas for waterfowl in the Amazon, with a wide variety of resident species and large numbers of Nearctic shorebirds during the migration seasons.

Other fauna: The rich mammalian fauna includes *Pteronura brasiliensis*, *Trichechus inunguis* and *Hydrochoerus hydrochearis*. *Melanosuchus niger* and *Caiman latirostris* are relatively common.

Source: Joao Henrique Auler Junior, Susana de Moura Lara-Resende and David Oren.

For other information see (1).

Ilha Maraca (1e)

Location: 3°15'-3°35'N, 61°22'-61°58'W; 120 km WNW of Boa Vista, Roraima Federal Territory.

Area: 92,000 ha.

Altitude: 150m.

Province and type: 8.28.10; 09, 11, 12, 16 & 18.

Site description: An island between the Santa Rosa and Maraca channels of the Rio Uraricoera, in a transition zone between savannas and humid tropical forest, with numerous water courses, freshwater lakes, swamps, palm groves, swamp forest (igarape), and seasonally inundated grassland.

Principal vegetation: Humid tropical forest, wet savanna, dense formations of *Mauritia vinifera*, and swamps with abundant aquatic vegetation.

Land tenure: Owned by SEMA.

Protection: Comprises the Maraca-Roraima Ecological Station (92,000 ha) established in 1976.

Land use: An ecological research station, only slightly modified by man.

Waterfowl: An important area for waterfowl of both swamp forest and wet savanna. Significant numbers of Nearctic shorebirds occur on migration.

Other fauna: The area has a very diverse avifauna. Mammals include *Pteronura brasiliensis* and *Tapirus terrestris*.

Source: Joao Henrique Auler Junior and David Oren.

For other information see (1).

The central Amazon and lower Rio Madeira (1f)

Location: 1°15'-4°15'S, 55°40'-59°55'W; the Amazon from near Manaus to Obidos, and the lower Rio Madeira from the Borba region, Amazonas and Para.

Area: Over 3,000,000 ha.

Altitude: 10-70m.

Province and type: 8.4.1/8.5.1/8.6.1; 09, 11, 12, 16 & 18.

Site description: A vast complex of broad river channels, sandy beaches, large and small islands, shallow freshwater lakes, swamps, varzea forest and seasonally flooded grassland in a belt 30-80 km wide along the Amazon River from its confluence with the Rio Negro 550 km downstream to the region of Obidos; and similar habitat along the lower 100 km of the Rio Madeira and lower stretches of the Rio Preto da Eva, Rio Urubu, Rio Uatuma, Rio Nhamunda, Rio Trombetas, Rio Maues Acu, Rio Canuma and Rio Madeirinha. There are several large lakes, including Lago de Erepecu (15,000 ha) and Lago Batata (8,500 ha) on the lower Rio Trombetas, and hundreds of smaller lakes throughout the region.

Principal vegetation: Humid tropical forest, varzea forest, seasonally flooded grassland, and lakes and swamps with abundant aquatic vegetation.

Land tenure: The Rio Trombetas Biological Reserve is largely owned by IBDF; important wetland areas between Nhamunda and Juruti are in an area under dispute between the states of Amazonas and Para.

Protection: The lower Rio Trombetas, lower Rio Maquera and Lagoa Jacare are included in the Rio Trombetas Biological Reserve (385,000 ha) established in 1979; the remainder of the area is unprotected.

Land use: Subsistence hunting, fishing and agriculture.

Waterfowl: A very important area for a wide variety of resident and migratory waterfowl. Ilha Tupinambarana, a large island with lakes, varzea forest and seasonally inundated grassland in the Rio Solimoes, is particularly important for Nearctic shorebirds, and is thought to be one of the most important wetland areas for waterfowl in the Amazon. *Numenius borealis* was collected there at the end of the 19th century.

Other fauna: Mammals include *Pteronura brasiliensis*, *Lutra enudris*, *Trichechus inunguis* and *Hydrochoerus hydrochaeris*; reptiles include *Caiman crocodilus* and *Melanosuchus niger*. There are important nesting beaches for *Podocnemis expansa* in the Rio Trombetas Biological Reserve.

Source: Paulo de Tarso Zuquim Antas and Robin C. Best.

For other information see (1).

The lower Rio Tapajos and adjacent Amazon (1g)

Location: 1°45'-4°50'S; 53°30'-55°50'W; the Rio Tapajos from its mouth upstream for 350 km, and the Rio Amazon between Obidos and Prainha, Para.

Area: c.1,325,000 ha (350,000 ha along Tapajos, 975,000 ha along Amazon).

Altitude: 10-60m.

Province and type: 8.6.1; 09, 11, 12, 16 & 18.

Site description: The lower stretches of the Rio Tapajos, with extensive tracts of seasonally flooded igapo forest; and a vast complex of sand banks, islands, freshwater lakes, marshes and varzea forest along the Amazon between Obidos and Prainha. The principal lakes are Lago Grande do Curuai (40,000 ha), Lago Itandena (30,000 ha), Lago Piracacira (8,500 ha) and Lago Grande (25,000 ha). Water levels in the Rio Tapajos are highest between February and May, and lowest between July and December.

Principal vegetation: Varzea and igapo forest rich in *Euterpe oleracea* and *Mauritia flexuosa*, with adjacent humid tropical forest.

Land tenure: No information.

Protection: Unprotected except for the southernmost 90 kms of the Rio Tapajos which are included in the Amazonia (Tapajos) National Park (1,258,000 ha) established in 1974.

Land use: No information.

Waterfowl: Very little information available, but known to be an important area for passage Nearctic shorebirds.

Other fauna: Wildlife recorded in the National Park includes *Pteronura brasiliensis*, *Sotalia fluviatilis*, *Inia geoffrensis*, *Trichechus inunguis*, *Tapirus terrestris*, *Melanosuchus niger*, *Caiman crocodilus*, *Podocnemis expansa* and *P. unifilis*.

Source: Paulo de Tarso Zuquim Antas.

For other information see (1).

The lower Rio Xingu (1h)

Location: 1°30'-3°00'S, 51°55'-53°05'W; the lower Rio Xingu from Belo Monte 180 km to the Rio Amazon, Para.

Area: c.420,000 ha (150,000 ha of river, 270,000 ha of marshes and swamp forest).

Altitude: 10-60m.

Province and type: 8.6.1; 09, 11, 12, 16 & 18.

Site description: The broad lower stretches of the Xingu, over 10 km wide, with numerous sandy beaches and small islands, and an extensive area of marshes and seasonally flooded grassland to the west of its confluence with the Amazon. The river reaches its highest levels in February.

Principal vegetation: In humid tropical forest.

Land tenure: No information.

Brazil

Protection: Turtle nesting beaches north of Altamira are protected during the breeding season; otherwise the area is unprotected.

Land use: Fishing and some agriculture.

Waterfowl: Little information available, but known to be important for passage Nearctic shorebirds.

Other fauna: *Inia geoffrensis*, *Trichechus inunguis* and *Caiman crocodilus* are known to occur. The beaches at Volta Grande do Rio Xingu north of Altamira are particularly important for nesting *Podocnemis expansa*.

Source: Paulo de Tarso Zuquim Antas.

For other information see (1).

The lower Rio Tocantins (1i)

Location: 1°50'-3°25'S, 49°10'-49°45'W; the lower Rio Tocantins from Ilha Grande de Jutai to its mouth in the Rio Para, Para.

Area: 205,000 ha of river and islands.

Altitude: 0-30m.

Province and type: 8.6.1; 09, 11, 12, 16 & 18.

Site description: The broad lower stretches of the Rio Tocantins, up to 15 km wide, with hundreds of small islands and sand banks. This stretch of river lies below the recently completed Tucuruí Dam, and will be greatly affected by the dam.

Principal vegetation: In humid tropical forest.

Land tenure: No information.

Protection: None.

Land use: No information.

Waterfowl: Little information available, but known to be important for passage Nearctic shorebirds.

Other fauna: *Trichechus inunguis* is reported to occur.

Source: Paulo de Tarso Zuquim Antas.

For other information see (1).

The Amazon Delta (2)

Location: 1°10'N-1°35'S, 49°20'-51°55'W; the main channels of the Amazon west of Ilha Marajo, Para.

Area: 3,500,000 ha of river and islands.

Altitude: 0-15m.

Province and type: 8.6.1; 02, 03, 05, 06, 07, 08, 09, 16 & 18.

Site description: A vast complex of broad river channels, large and small low-lying islands, mangrove swamps, intertidal mudflats, brackish lagoons and marshes, palm swamps and seasonally flooded grassland and swamp forest. The region extends from the southwest tip of Ilha Grande de Gurupa 350 km northeast to Ilha do Brique, Ilha Janauco, Ilha Caviana, Ilha Mexiana and western Ilha Marajo. The maximum tidal variation is about 8m.

Principal vegetation: Extensive mangrove swamps, brackish grassy marshes, and palm swamps with *Euterpe oleracea*, *Raphia taedigera*, *Manicaria saccifera* and *Mauritia flexuosa*.

Land tenure: Mainly privately owned.

Protection: None.

Land use: Fishing; livestock rearing in some areas; and hunting.

Waterfowl: Known to be rich in waterfowl, but no detailed surveys have been made. 7,500 *Eudocimus ruber*, 2,000 *Dendrocygna autumnalis* and several thousand Nearctic shorebirds were observed in the Ilha Caviana and Ilha Mexiana area in January 1982. *Phoenicopterus ruber* occurs as a non-breeding visitor in small numbers.

Other fauna: There is still a significant population of *Trichechus inunguis* in the area, and this continues to be hunted, (at least 17 killed in 1977). *T. manatus* may also occur. The turtle *Kinosternon scorpioides* is common and locally important as a source of food.

Threats: No information.

Research and conservation: Despite the obvious importance of the vast mangrove systems, the area remains very poorly studied.

References: Smith (1979); Domning (1981); Morrison (1983a); Morrison *et al* (1985).

Source: Paulo de Tarso Zuquim Antas and Dante Luiz Martins Teixeira.

Criteria for inclusion: 123.

Cabo Orange and Rio Cassipore Marshes (3)

Location: 2°30'-4°24'N, 50°50'-51°38'W; on the north Amapa coast, south from the French Guiana border to the region of Calcoene, Amapa Territory.

Area: c.580,000 ha.

Altitude: 0-5m.

Province and type: 8.4.1; 02, 06, 07, 08, 09, 13, 16 & 18.

Site description: The estuarine systems of the Rio Oiapoque (Oyapock), Rio Cassipore and Rio Uaca, with extensive intertidal mudflats and mangrove swamps; and a vast area of fresh to brackish lagoons, including Lago Maruani, and seasonally flooded savannas with palm groves, swamp forest and islands of humid tropical forest. The tidal rise and fall is up to 9m; the rainy season is from February to June.

Principal vegetation: Mangrove swamps with *Rhizophora mangle*, *Avicennia germinans* and *Laguncularia racemosa*; swamps with *Montrichardia arborescens* and *Mauritia flexuosa*; palm savannas with *Euterpe oleracea*, *Chrysobalanus icaco* and species of *Echinoa*, *Panicum*, *Paspalum* and *Oryza*. In the transition zone between humid tropical forest and open campos.

Land tenure: The National Park is owned by Amapa Territory; adjacent areas are within the Oiapoque Indian Reservation.

Protection: Cabo Orange National Park (619,000 ha), established in 1980, includes the greater part of the area and 120,000 ha of adjacent marine habitats. The remainder is within the Oiapoque Indian Reservation.

Land use: Access to the National Park is difficult, and the area is little disturbed. There is some cattle ranching and agriculture in adjacent areas.

Waterfowl: A very rich area for waterfowl, with large resident populations of *Phalacrocorax olivaceus*, *Anhinga anhinga*, many Ardeidae, all three Ciconiidae, *Theristicus caudatus*, *Mesembrinibis cayennensis*, *Eudocimus ruber*, *Ajaia ajaja*, *Dendrocygna autumnalis*, *Cairina moschata*, *Opisthocomus hoazin*, *Aramus guarauna*, various Rallidae, *Heliornis fulica*, *Jacana jacana*, *Vanellus chilensis* and *Rynchops niger*. A breeding colony of 1,000 pairs of *E. ruber* was located in 1971, and a total of 1,276 birds were observed at this site and at site 4 during an aerial survey in January 1982. *Phoenicopterus ruber* occurs regularly in small numbers, but there has been no evidence of breeding since 1971. *Anhima cornuta* was observed in 1983 near the French Guianan border.

The area is very important for passage and wintering Nearctic shorebirds: in an aerial survey in January 1982, over 28,000 shorebirds were observed along the Amapa coast, mainly small *Calidris* species but also significant numbers of *Pluvialis squatarola*, *Numenius phaeopus* and *Tringa* spp.

Other fauna: *Trichechus manatus*, *Hydrochoerus hydrochaeris*, *Chelonia mydas* and *Dermochelys coriacea* occur in the National Park.

Threats: None known.

Research and conservation: Several avifaunal surveys have been conducted but otherwise the region remains poorly known.

References: Spaans (1975a); Teixeira & Best (1981); IUCN (1982); Antas (1983); Morrison (1983a); Dujardin (1984); Morrison *et al* (1985).

Source: Paulo de Tarso Zuquim Antas, Jean-Luc Dujardin, Antonio Carlos da Silva Farias, Benedito Vitor Rabelo and Dante Luiz Martins Teixeira.

Criteria for inclusion: 123.

Ilha de Maraca, Piratuba lakes and Campos do Macacoary (4)

Location: 0°30'-2°30'N, 49°53'-51°00'W; between Calcoene and Macapa, coastal Amapa Territory.

Area: c.1,200,000 ha including 850,000 ha of lakes and marshes and 150,000 ha of campos.

Altitude: 0-10m.

Province and type: 8.4.1; 02, 03, 06, 07, 08, 09, 11, 12, 16 & 18.

Site description: Two large low-lying offshore islands, Ilha de Maraca and Ilha Tipioca, with extensive mangrove swamps, brackish marshes, seasonally flooded savannas and small "islands" of scrubby forest; 300 km of the Amapa coast with extensive intertidal mudflats and mangrove swamps; a vast complex of some 75 fresh to brackish lakes and marshes north of the Rio Araguari, including Lago Piratuba (6,500 ha), Lago Novo (15,000 ha), Lago dos Gansos (2,700 ha) and Lago dos Bagres (2,200 ha); the estuarine system of the Rio Araguari; and the Campos do Macacoary, some 150,000 ha of seasonally flooded grassland and varzea forest. The main period of flooding is from February to June.

Principal vegetation: Mangrove swamps with *Avicennia germinans*, *Laguncularia racemosa* and *Rhizophora mangle*; lakes and marshes with *Nymphaea rudgeana*, *Cabomba aquatica*, *Salvinia auriculata*, *Azolla* sp, *Nymphoides indica*, *Habenaria* sp, *Eichhornia crassipes*, *E. azurea*, *Pistia stratiotes*, *Ceratopteris pteroides*, *Echinodorus paniculatus*, *Utricularia foliosus*, *Typha domingensis*, *Neptunia oleracea*, *Montrichardia arborescens* and species of Gramineae and Cyperaceae; palm savannas with species of *Echinoa*, *Panicum*, *Paspalum* and *Oryza*, and the palm *Mauritia flexuosa*.

Land tenure: Partly state owned and partly privately owned in large ranches; Piratuba Biological Reserve is owned by Amapa Territory, and Maraca-Tipioca Ecological Station is owned by SEMA.

Protection: Ilha de Maraca and Ilha Tipioca are included within the Maraca-Tipioca Ecological Station (70,000 ha) established in 1981; part of the lake system and coastal areas north of the Rio Araguari are included within the Lago Piratuba Biological Reserve (395,000 ha) established in 1980. The Campos do Macacoary are unprotected.

Land use: There is very little human activity in the Biological Reserve and Ecological Station, and the areas are difficult of access. In unprotected areas there is intensive fishing, cattle ranching and hunting, particularly for *Dendrocygna* spp.

Waterfowl: A very rich area for waterfowl, with a similar avifauna to that of the Cabo Orange area (site 3). *Phoenicopus ruber* is a regular non-breeding visitor; over 100 were observed on Ilha Maraca in 1978. Huge numbers of *Dendrocygna viduata* and *D. autumnalis* occur, and there are large passage and wintering populations of Nearctic shorebirds.

Other fauna: Mammals include *Pteronura brasiliensis*, *Leo onca*, *Trichechus inunguis*, *Hydrochoerus hydrochaeris*, *Tapirus terrestris* and possibly *Trichechus manatus*; reptiles include *Melanosuchus niger*, *Caiman crocodilus*, *Chelonia mydas*, *Eunectes murinus* and possibly *Dermochelys coriacea*. There is a very rich fish fauna in the lake system.

Threats: Wardening in the reserves is reported to be poor, and there is some poaching. The principal threat in unprotected areas is the expansion of ranching activities, with large projects currently being implemented or in the planning stages. There is excessive hunting in some areas, and wholesale slaughter of moulting *Dendrocygna* spp has been reported.

Research and conservation: Preliminary faunal and floral surveys have been conducted in the reserves, and aerial surveys have been made by Teixeira and Best (1981) and Morrison (1983a). Antonio Carlos da Silva Farias is currently carrying out ecological studies on *Phalacrocorax olivaceus*, *Anhinga anhinga* and Ardeidae.

References: Novaes (1974 & 1978); Spaans (1975a); MINTER & SEMA (1977); Teixeira & Best (1981); IUCN (1982); Antas (1983); Morrison (1983a).

Source: Paulo de Tarso Zuquim Antas, Antonio Carlos da Silva Farias, David Oren, Benedito Vitor Rabelo and Dante Luiz Martins Teixeira.

Criteria for inclusion: 123.

Eastern Ilha Marajo and Baia de Marajo (5)

Location: 0°10'-1°35'S, 48°22'-49°50'W; the eastern half of Ilha Marajo and adjacent bay, Amazon delta, Para.

Area: 1,500,000 ha.

Altitude: 0-5m.

Province and type: 8.6.1; 01, 06, 07, 08, 12 & 16.

Site description: A large sea bay with extensive intertidal mudflats and mangrove fringe; and tidal creeks, mangrove swamps, fresh to brackish lakes, marshes and seasonally flooded grassland on the eastern half of Ilha Marajo. The largest lake is Lago Arari (16,500 ha).

Principal vegetation: Mangrove swamps dominated by *Rhizophora mangle*; seasonally flooded grassland (campos).

Land tenure: Ilha Marajo is mainly privately owned in large ranches.

Protection: None.

Land use: Extensive cattle ranching on Ilha Marajo.

Waterfowl: Little information is available, but the area is known to be very rich in waterfowl, with a large resident population of *Eudocimus ruber*. *Phoenicopterus ruber* is an occasional non-breeding visitor. The area is very important for passage and wintering Nearctic shorebirds, particularly *Catoptrophorus semipalmatus*, *Calidris alba* and *C. fuscicollis*; *Larus atricilla* and *Sterna hirundo* winter in large numbers in the bay.

Other fauna: *Trichechus inunguis* occurs; the turtle *Kinosternon scorpioides* common, and locally important as a source of food.

Threats: Pollution from the city and port of Belem affects the bay, and there is overexploitation of the coastal mangroves.

Research and conservation: Some ornithological surveys have been conducted, but the area remains poorly known.

References: Teixeira & Best (1981).

Source: Paulo de Tarso Zuquim Antas.

Criteria for inclusion: 123.

The Para and west Maranhao coast (6)

Location: 0°32'-2°25'S, 44°30'-48°00'W; from Muraja on Baia de Marajo east for 450 km to Guimaraes and Baia do Cuma, Para and Maranhao.

Area: c.1,000,000 ha.

Altitude: 0-10m.

Province and type: 8.6.1/8.29.10; 01, 02, 03, 05, 06, 07, 08, 09 & 11.

Site description: An extremely indented coastline with over 35 major inlets and estuaries fringed with mangrove swamps and separated by headlands with white sand beaches and coastal sand dunes. The larger bays include Baia de Maracana, Baia de Gurupi, Baia de Turiacu and Baia do Cuma. There are numerous low-lying offshore islands, including the large islands of Maiiau and Mangunca in the east; inland there are fresh to brackish lagoons and marshes, riverine marshes, areas of seasonally flooded grassland, palm groves and patches of forest. Tidal variation is up to 8m.

Principal vegetation: Mangrove swamps dominated by *Avicennia germinans* and *Rhizophora mangle*; sandy areas with *Chrysobalanus icaco*, *Bulbostylis capillaris* and *Ipomoea pescaprae*.

Land tenure: Mainly privately owned.

Protection: None.

Land use: Fishing, a little agriculture, and cutting of mangroves; recreation in the few readily accessible areas. Much of the coast is remote and almost undisturbed.

Waterfowl: An important area for breeding waterfowl including *Phalacrocorax olivaceus*, many Ardeidae, *Eudocimus ruber*, *Aramides mangle*, *Eurypyga helias* and *Rynchops niger*; and a very important area for passage and wintering Nearctic shorebirds. During an aerial survey of the western part in January 1982, over 27,000 shorebirds were counted, including 15,500 small *Calidris* sandpipers and significant numbers of *Numenius phaeopus*, *Tringa* spp, *Catoptrophorus semipalmatus*, and *Calidris alba*. Other common species include *Pluvialis squatarola*, *Charadrius semipalmatus*, *C. wilsonius*, *Actitis macularia*, *Arenaria interpres* and *Limnodromus griseus*. *Larus atricilla* and *Sterna hirundo* are also common winter visitors.

Other fauna: *Trichechus manatus* formerly occurred throughout the region, but is now probably extinct in most areas. Many of the beaches are important for nesting sea turtles, and the

estuaries are a very important nursery ground for commercially important shrimp and fish populations.

Threats: Mangroves are being destroyed in some areas, and there is considerable disturbance from tourist development in the Salgado region, between Marapanim and Salinópolis.

Research and conservation: F. C. Novaes and colleagues of the Goeldi Museum in Belem have conducted ornithological surveys and banded waterfowl on the Para coast, and Morrison (1983a) carried out an aerial census of shorebirds in 1982.

References: Novaes (1981); Antas (1983); Morrison (1983a).

Source: Paulo de Tarso Zuquim Antas, Fernando C. Novaes and Paul Roth.

Criteria for inclusion: 123.

Baia de Sao Marcos and the Rio Mearim Estuary (7)

Location: 2°22'-4°17'S, 44°10'-45°28'W; west and south of Sao Luis to the region of Bacabal, Maranhao.

Area: Over 1,000,000 ha.

Altitude: 0-15m.

Province and type: 8.29.10; 02, 06, 07, 08, 09, 11, 12, 16 & 17.

Site description: The vast estuarine system of the Rio Mearim, Rio Pindare, Rio Grajau and many smaller rivers, with several large islands, very extensive seasonally inundated fresh to brackish marshes, and about 80 freshwater lakes of several hundred to 6,000 ha in extent and up to 10m deep, draining into Baia de Sao Marcos. There are extensive mangrove swamps and intertidal mudflats around the bay.

Principal vegetation: Mangrove swamps; coastal marshes with species of *Fimbristylis*, *Cyperus*, *Dichromena*, *Panicum* and various grasses and sedges covered at the highest tides; freshwater marshes; and gallery forest along the rivers.

Land tenure: No information.

Protection: None.

Land use: Cattle ranching, agriculture and illegal commercial hunting of waterfowl; there are important fish and shrimp industries in the bay.

Waterfowl: A very rich area for both breeding waterfowl and passage and wintering Nearctic shorebirds. Resident species include *Tigrisoma lineatum*, *Egretta caerulea*, *E. thula*, *E. alba*, *Ardea cocoi*, *Mycteria americana*, *Jacana jacana*, *Porphyryla martinica*, *Vanellus chilensis*, *Charadrius collaris*, *Larus cirrocephalus*, *Phaetusa simplex* and *Sterna superciliaris*. The commoner Nearctic shorebirds include *Pluvialis squatarola*, *Charadrius semipalmatus*, *C. wilsonius*, *Numenius phaeopus*, three species of *Tringa*, *Catoptrophorus semipalmatus*, *Actitis macularia*, *Arenaria interpres*, *Limnodromus griseus*, *Calidris alba* and *C. pusilla*. *Sarkidiornis melanotos* and *Gelochelidon nilotica* have been recorded.

Other fauna: There is thought to be a sizeable population of *Trichechus manatus* in the estuary, and the area is of great importance as a nursery ground for commercially important fishes and shrimps.

Threats: Wetlands are being drained for pastureland and rice cultivation; there is considerable pollution in the bay from the city of Sao Luis; and despite a ban on hunting in 1978, commercial hunting of waterfowl, particularly *Porphyryla martinica*, continues, possibly at a higher level than ever before.

Research and conservation: Domning (1981) has proposed the establishment of a manatee reserve.

References: Aguirre (1962); Domning (1981); Antas (1983).

Source: Paul Roth and references.

Criteria for inclusion: 123.

Baia do Tubarao (8)

Location: 2°15'-2°37'S, 43°20'-43°55'W; 70 km east of Sao Luis, Maranhao.

Area: 130,000 ha.

Altitude: 0-5m.

Province and type: 8.29.10; 01, 03, 05, 06, 07 & 08.

Site description: A large sea bay fed by several small rivers, and with numerous large low-lying islands including Ilha de Santana, Ilha Carrapatal and Ilha Mucunambiba. Wetland habitats include intertidal mudflats, sandy beaches and mangrove swamps; the tidal rise and fall is up to 8m.

Principal vegetation: Mangrove swamps dominated by *Rhizophora mangle*.

Land tenure: The part within the National Park is owned by the Navy and Federal Government; the ownership of the remainder is unknown.

Protection: The eastern part of the area is included within the Lençóis Maranhenses National Park (155,000 ha) established in 1981.

Land use: Fishing and recreation.

Waterfowl: *Eudocimus ruber* formerly nested in the mangroves. The area is very important for passage and wintering shorebirds and Laridae, particularly *Pluvialis squatarola*, *Numenius phaeopus*, *Catoptrophorus semipalmatus*, *Arenaria interpres*, *Calidris canutus*, *C. alba*, *C. pusilla*, *C. minutilla*, *Larus cirrocephalus* and *Sterna* spp.

Other fauna: Sea turtles occur along the coast.

Threats: Pollution from the city of São Luís; destruction of mangroves for fuel and timber; and development for recreation.

References: IUCN (1982).

Source: Paul Roth.

Criteria for inclusion: 3a.

Rio Parnaíba Delta (9)

Location: 2°45'S, 41°45'W; between Tutoia and Parnaíba, Maranhão and Piauí.

Area: 145,000 ha.

Altitude: 0-5m.

Province and type: 8.29.10; 02, 03, 05, 06, 07, 08 & 12.

Site description: The estuarine and delta system of the Rio Parnaíba, with extensive fresh to brackish lakes and marshes, sandy beaches, coastal sand dunes, mangrove swamps, intertidal mudflats and numerous low-lying islands. The tidal rise and fall is up to 8m.

Principal vegetation: Mangrove swamps dominated by *Rhizophora mangle*.

Land tenure: Privately owned.

Protection: None.

Land use: Fishing and recreation; ranching and agriculture in surrounding areas.

Waterfowl: *Eudocimus ruber* occurs as a non-breeding visitor at the eastern limit of its present distribution in Brazil. The area is very important for passage and wintering Nearctic shorebirds, and for wintering *Sterna* spp.

Other fauna: *Trichechus manatus* and *Caiman latirostris* are known to occur.

Threats: Drainage of the marshes for agriculture, and destruction of mangroves for fuel and timber.

Source: Paulo de Tarso Zuquim Antas and Paul Roth.

Criteria for inclusion: 2a & 3a.

Rio Jaguaribe lakes and marshes (10)

Location: 4°15'-5°30'S, 37°45'-38°30'W; 130 km southeast of Fortaleza, Ceará.

Area: 80,000 ha, including 60,000 ha of riverine and coastal marshes and 20,000 ha of lakes.

Altitude: 0-100m.

Province and type: 8.20.4; 02, 05, 06, 07, 08, 09, 11, 12, 16 & 17.

Site description: The estuarine system and lower 160 km of the Rio Jaguaribe, with extensive riverine marshes, over 80 small lakes and dams on the surrounding plains, large areas of seasonally inundated grassland and arable land, a chain of small brackish coastal lagoons and marshes, coastal sand dunes, sandy beaches, mangrove swamps and intertidal mudflats. There is also a complex of salt pans near the coast.

Principal vegetation: No information.

Brazil

Land tenure: Mainly private ownership.

Protection: None.

Land use: Fishing; agriculture; cattle ranching; and illegal hunting.

Waterfowl: Little information is available, but the area is known to be important for passage and wintering shorebirds and Laridae. *Dendrocygna viduata* is common, and *Netta erythrophthalma erythrophthalma* has been observed on the coastal lagoons.

Other fauna: No information.

Threats: Illegal commercial hunting of waterfowl, mainly *Dendrocygna viduata*; pollution from the town of Aracati; drainage of the marshes for agriculture; and development for recreation.

Research and conservation: Biologists from IBDF, two local universities and the Canadian Wildlife Service have banded shorebirds in the estuary.

Source: Susana de Moura Lara-Resende and Dante Luiz Martins Teixeira.

Criteria for inclusion: 3a.

Areia Branca and Macau coastal marshes and salt pans (11)

Location: 4°55'-5°15'S, 36°10'-37°15'W; on the coast between Areia Branca and Sao Bento do Norte, Rio Grande do Norte.

Area: 70,000 ha (Areia Branca 27,500 ha, Macau and Sao Bento do Norte 42,500 ha).

Altitude: 0-5m.

Province and type: 8.20.4; 02, 05, 06, 07 & 08.

Site description: 115 km of sea coast and several small estuaries, with sandy beaches, intertidal mudflats, mangrove swamps, sand dunes, brackish coastal lagoons and marshes, and large areas of salt pans, particularly around Areia Branca and Macau.

Principal vegetation: No information.

Land tenure: No information.

Protection: None.

Land use: Salt extraction.

Waterfowl: Little information available, but known to be important for passage and wintering shorebirds and Laridae.

Other fauna: No information.

Threats: No information.

Source: Susana de Moura Lara-Resende and Dante Luiz Martins Teixeira.

Criteria for inclusion: 0.

Coastal marshes near Natal (12)

Location: 5°15'-6°22'S, 35°00'-35°30'W; the coast between Touros and Canguaretama, north and south of Natal, Rio Grande do Norte.

Area: 43,500 ha, including 33,500 ha of estuaries and marshes, and 10,000 ha of lakes.

Altitude: 0-10m.

Province and type: 8.20.4; 02, 05, 06, 07, 08 & 12.

Site description: 140 km of sea coast, several small estuaries, and a chain of some 40 small lakes on the coastal plain at the extreme northeastern tip of Brazil; with sand beaches, intertidal mudflats, mangrove swamps, and fresh to brackish lakes and marshes. There is a belt of coral reefs about 2 km offshore.

Principal vegetation: Mangroves dominated by *Rhizophora mangle*.

Land tenure: Mainly private ownership.

Protection: None.

Land use: Fishing; agriculture; cultivation of coconuts; and recreation along the coast.

Waterfowl: Little information available, but known to be important for passage and wintering Nearctic shorebirds.

Other fauna: An important area for *Trichechus manatus*.

Threats: Excessive exploitation of mangroves; overfishing; pollution from Natal city; tourist development; and drainage for agriculture.

Source: Paulo de Tarso Zuquim Antas and Dante Luiz Martins Teixeira.

Criteria for inclusion: 2a & 3a.

The Mamanguape Estuary (13)

Location: 6°46'S, 34°57'W; 40 km north of Joao Pessoa, Paraiba.

Area: 3,000 ha.

Altitude: 0m.

Province and type: 8.20.4; 02, 05, 06, 07 & 08.

Site description: The estuary of the Rio Mamanguape, with fringing mangrove swamps, sandy beaches, intertidal mudflats, and some brackish marshes.

Principal vegetation: No information.

Land tenure: State owned.

Protection: Within the recently established Mamanguape Ecological Station (3,000 ha).

Land use: Fishing and recreation.

Waterfowl: Little information available but known to be important for migratory shorebirds.

Other fauna: An important area for *Trichechus manatus*.

Threats: Disturbance from recreation activities; the Ecological Station has no wardens.

Source: Paulo de Tarso Zuquim Antas.

Criteria for inclusion: 2a & 3a.

Ilha de Itamaraca and the Rio Goiana Estuary (14)

Location: 7°30'-7°50'S, 34°48'-34°55'W; 30-70 km north of Recife, Pernambuco.

Area: 25,000 ha.

Altitude: 0-5m.

Province and type: 8.20.4/8.7.1; 02, 03, 05, 06 & 08.

Site description: A large low-lying island with extensive mangrove swamps and ocean beaches; and the estuary of the Rio Goiana with mangrove swamps and intertidal mudflats.

Principal vegetation: No information.

Land tenure: Private ownership.

Protection: None.

Land use: Fishing; exploitation of mangroves; recreation; and farming on Ilha de Itamaraca.

Waterfowl: Little information available, but the area is known to be important for migratory shorebirds, and *Egretta caerulea* occurs.

Other fauna: An important area for *Trichechus manatus*.

Threats: Destruction of mangroves; the use of chemicals to eliminate snails in a programme of disease control; and pesticide runoff from adjacent sugar cane plantations. The island suffers heavy disturbance from tourist recreation.

Source: Paulo de Tarso Zuquim Antas.

Criteria for inclusion: 2a & 3a.

Maceio Lagoons and Praia do Peba (15)

Location: 9°35'-10°10'S, 35°45'-36°15'W; from Maceio southwest along the coast for 70 km, Alagoas.

Area: 19,000 ha.

Altitude: 0-15m.

Province and type: 8.7.1; 02, 05, 06, 07, 08 & 12.

Site description: 110 km of sea coast with long sandy beaches, intertidal sandflats, sand dunes and offshore reefs; several small estuaries with mangrove swamps; and a chain of brackish coastal lagoons and marshes.

Principal vegetation: No information.

Land tenure: Mainly private ownership; the Ecological Station is state owned.

Protection: 3,000 ha of sandy beach and sand dunes in the south are included within the Praia do Peba Ecological Station, established to protect turtle nesting beaches.

Land use: Fishing.

Waterfowl: Little information available, but known to be important for migratory shorebirds, and *Netta erythrophthalma erythrophthalma* has been recorded on the lagoons.

Other fauna: Praia do Peba is an important nesting beach for the sea turtles *Chelonia mydas* and *Caretta caretta*; *Lepidochelys olivacea* may nest.

Threats: There is some threat of oil pollution along the sea beaches.

Source: Paulo de Tarso Zuquim Antas.

Criteria for inclusion: 2a & 3a.

The Sergipe coast (16)

Location: 10°45'-11°55'S, 37°00'-37°38'W; from the Aracaju area SSW along the coast to the Conde area, Sergipe and extreme northeastern Bahia.

Area: 95,500 ha.

Altitude: 0-10m.

Province and type: 8.7.1; 02, 05, 06, 07 & 08.

Site description: 140 km of coastline with ocean beaches, and coastal sand dunes; and four large estuarine systems with extensive brackish lagoons and marshes, intertidal mudflats and mangrove swamps. The principal rivers are the Rio Sergipe, Rio Vaza-Barris, Rio Piaui, Rio Real and Rio Itapicuru. The area includes the very extensive Barra de Estancia marshes, and the Praia de Pirambu (beach).

Principal vegetation: Mangrove swamps and brackish marshes.

Land tenure: Private ownership.

Protection: No habitat protection; Praia de Pirambu is protected during the turtle nesting season.

Land use: Fishing; exploitation of mangroves; and tourist recreation.

Waterfowl: Little information is available, but the area is known to be important for migratory shorebirds.

Other fauna: The estuaries are important for *Trichechus manatus*; and Praia de Pirambu is an important nesting beach for *Chelonia mydas*, *Caretta caretta* and *Lepidochelys olivacea*.

Threats: Destruction of mangroves; excessive disturbance from tourist recreation; pollution from pesticide runoff; and oil exploration at Barra de Estancia.

Source: Paulo de Tarso Zuquim Antas.

Criteria for inclusion: 2a & 3a.

Baia de Todos os Santos and central Bahia coast (17)

Location: 12°35'-14°10'S, 38°25'-39°10'W; from the Salvador area south to the Camamu area, Bahia.

Area: 180,000 ha.

Altitude: 0-15m.

Province and type: 8.7.1; 01, 02, 03, 05, 06, 07 & 08.

Site description: Baia de Todos os Santos is a large sea bay containing the estuary of the Rio Paraguacu, and with a narrow connection to the sea; there are extensive tidal mudflats and fringing mangrove swamps. To the south there is a chain of small estuaries and large low-lying islands, with tidal mudflats, mangrove swamps, brackish coastal lagoons and marshes, and ocean beaches, extending 150 km to the region of Camamu.

Principal vegetation: Mangrove swamps dominated by *Rhizophora mangle*.

Land tenure: Mainly private ownership.

Protection: None.

Land use: The city of Salvador with its large industrial centre lies on Baia de Todos os Santos; elsewhere there is fishing, exploitation of mangroves, tourist recreation, and oil exploration.

Waterfowl: Little information is available. A variety of Ardeidae has been recorded, and the coastal mudflats constitute a major wintering area for Nearctic shorebirds, particularly *Pluvialis squatarola*, *Numenius phaeopus*, *Catoptrophorus semipalmatus*, *Calidris pusilla* and *C. minutilla*.

Other fauna: No information.

Threats: There is a considerable amount of pollution from the city of Salvador and oil exploration activities.

References: Antas (1983).

Source: Paulo de Tarso Zuquim Antas.

Criteria for inclusion: 0.

The Rio Pardo and Rio Jequitinhonha Estuaries (18)

Location: 15°40'-15°50'S, 38°52'-39°00'W; near Canavieiras and Belmonte, Bahia.

Area: 6,000 ha.

Altitude: 0m.

Province and type: 8.7.1; 02, 05, 06, 07, 08 & 12.

Site description: The estuarine systems of the Rio Pardo and Rio Jequitinhonha, with extensive mangrove swamps, intertidal mudflats, brackish coastal lagoons and marshes, and adjacent sandy beaches; there are some freshwater lakes and marshes inland.

Principal vegetation: No information.

Land tenure: Private ownership.

Protection: None.

Land use: Fishing and exploitation of mangroves.

Waterfowl: Little information is available. The area is known to be important for passage and wintering shorebirds and Laridae, particularly *Numenius phaeopus* and *Sterna hirundo*, and *Netta erythrophthalma erythrophthalma* has been recorded on the lagoons behind the beach.

Other fauna: No information.

Threats: No information.

Source: Paulo de Tarso Zuquim Antas.

Criteria for inclusion: 0.

Wetlands in Brasilia National Park (19)

Location: 15°40'S, 47°50'W; 10 km west of Brasilia, Distrito Federal.

Area: c.1,000 ha of wetlands.

Altitude: 1,350m.

Province and type: 8.30.10; 10, 13 & 15.

Site description: The Santa Maria Dam, a dam of 625 ha constructed in 1970, with a widely fluctuating water level, muddy margins, and aquatic vegetation restricted to the mouths of streams entering the dam; and numerous springs, streams and associated freshwater marshes on an undulating plateau. There is a well marked rainy season from October to April.

Principal vegetation: In a region of upland savanna and cerrado, with stands of *Mauritia flexuosa* and gallery forest along the water courses.

Land tenure: Owned by IBDF.

Protection: Included within Brasilia National Park (28,000 ha) established in 1961.

Land use: Scientific research and tourism in the National Park; the Santa Maria Dam is a water supply for the nearby city of Brasilia.

Waterfowl: Over 40 species of waterfowl have been recorded, but most occur only in small numbers, and many only as occasional visitors. Breeding species include *Podilymbus podiceps*, *Aamazonetta brasiliensis* and a variety of Rallidae including the rare *Laterallus xenopterus* and *Micropygia schomburgkii*. Common visitors include *Phalacrocorax olivaceus*, *Dendrocygna viduata* and *D. autumnalis*. In recent years, *Netta erythrophthalma erythrophthalma* has become

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a regular visitor; 100-150 were observed in August and September 1980, and smaller numbers again in 1981 and 1983.

Other fauna: The Park is one of the few known localities of the Brasília Tapaculo *Scytalopus novacapitalis* which occurs in dense riverine thickets and gallery forest. Mammals in the Park include *Chrysocyon brachyurus* and *Ozotoceros bezoarticus*.

Threats: None; the National Park is well protected.

Research and conservation: A considerable amount of research has been conducted on the fauna and flora of the National Park.

References: IUCN (1982); Antas & Lara-Resende (1983a); Negret & Teixeira (1984).

Source: See references.

Criteria for inclusion: 2a & 3a.

The floodplain of the Rio Araguaia and Ilha do Bananal (20)

Location: 9°15'-15°30'S, 49°35'-51°55'W; the middle Rio Araguaia, from Araguaia in the south 750 km downstream to Barreira do Campo, Goiás and Mato Grosso.

Area: c.3,800,000 ha of wetlands in a total area of 5,435,000 ha.

Altitude: 180-240m.

Province and type: 8.30.10; 09, 11, 12, 16 & 18.

Site description: The vast floodplain and lacustrine system of the middle Rio Araguaia, Rio Formosa and Rio das Mortes, including Ilha do Bananal between the Rio Araguaia and Rio Formosa. Ilha do Bananal, with an area of about 2,000,000 ha, is the largest fluvial island in the world. The whole system stretches for 750 km and is up to 100 km wide. During the period of flooding, from December to mid June, large areas of grassland, palm savanna and forest are inundated in vast shallow lakes; during the dry season, extensive sand banks and muddy areas are exposed. There are many permanent lakes with surrounding marshes, the largest of which is about 4,500 ha.

Principal vegetation: In the transition zone between the humid tropical forest of the Amazon Basin and woody savannas (cerrados) of central Brazil, with gallery forest along the main water courses.

Land tenure: Ilha do Bananal is owned by the Federal Government; the remainder is privately owned.

Protection: The northern part of Ilha do Bananal is included within the Araguaia National Park (562,312 ha) established in 1959; the northeastern portion of the floodplain is included within the Coco-Javaes Ecological Station (37,000 ha); and the southern part of Ilha do Bananal is in an Indian Reservation.

Land use: Extensive cattle ranching; fishing; and illegal hunting.

Waterfowl: An extremely rich area for waterfowl, with a wide variety of resident breeding species, and many Nearctic shorebirds occurring on migration. Resident species include *Phalacrocorax olivaceus*, *Anhinga anhinga*, *Ixobrychus exilis*, *Tigrisoma lineatum*, *Nycticorax nycticorax*, *Nyctanassa violacea*, *Pilherodius pileatus*, *Cochlearius cochlearius*, all three Ciconiidae, *Theristicus caudatus*, *Ajaia ajaia*, *Anhima cornuta*, all three *Dendrocygna* spp, *Amazonetta brasiliensis*, *Sarkidiornis melanotos*, *Cairina moschata*, *Opisthocomus hoazin*, *Porphyryla martinica*, *Eurypyga helias*, *Jacana jacana* and *Vanellus chilensis*. There are large breeding colonies of Ardeidae, *Ajaia ajaia* and *Mycteria americana*.

Other fauna: Mammals include *Chrysocyon brachyurus*, *Pteronura brasiliensis*, *Lutra enudris*, *Leo onca*, *Tapirus terrestris*, *Hydrochoerus hydrochaeris*, *Blastocerus dichotomus*, *Ozotoceros bezoarticus* and *Inia geoffrensis*. Reptiles include *Melanosuchus niger*, *Caiman crocodilus*, *Podocnemis expansa* and *Eunectes murinus*. Fishes include *Arapaima gigas*, *Cichla* spp, *Salminus hilarii*, *Serrasalmus* spp, *Electrophorus electricus*, various Pimelodidae, and many others.

Threats: Wardening in the National Park is reported to be poor; a major highway is being constructed through the Park; illegal grazing of domestic livestock and poaching occur; and there is some illegal settlement. Outside the protected areas there is overgrazing by domestic livestock, drainage of wetlands for rice cultivation, modifications in the water courses for irrigation purposes, and pollution from pesticide runoff. There are reports of the use of pesticides to kill *Dendrocygna* spp along the Rio Formosa, to reduce the numbers feeding in rice fields.

Research and conservation: Preliminary faunal and floral surveys have been conducted in the National Park and Ecological Station, and a detailed management plan has been prepared for the Park.

References: IBDF & FBCN (1981b); IUCN (1982); Antas (1983).

Source: Paulo de Tarso Zuquim Antas and Susana de Moura Lara-Resende.

Criteria for inclusion: 123.

The upper Rio Xingu (21)

Location: 10°05'-12°55'S, 51°55'-54°15'W; in northeastern Mato Grosso.

Area: 850,000 ha.

Altitude: 250-275m.

Province and type: 8.30.10; 09, 11, 12, 16 & 18.

Site description: Extensive tracts of riverine marshes, associated lakes, seasonally inundated grassland and swamp forest along the upper Rio Xingu and its tributaries including the Rio Suia-Micu, Rio Culuene, Rio Ronuro and Rio Steinen. Flooding occurs between October and April.

Principal vegetation: No information.

Land tenure: An Indian Reservation, owned by the Federal Government.

Protection: The area is afforded some protection by the local Indians.

Land use: Traditional activities of the local Indians.

Waterfowl: Very little information available; known to be an important area for both resident waterfowl and migratory shorebirds.

Other fauna: *Blastocerus dichotomus*, *Trichechus inunguis*, *Melanosuchus niger* and *Podocnemis expansa* are known to occur.

Threats: There is an increase in ranching and agriculture in the surrounding areas, and the Indians themselves are adopting modern farming practices.

Research and conservation: One of the most important and least disturbed wetland areas in central Brazil; identified as a priority area for conservation by Wetterberg *et al* (1976).

References: Wetterberg *et al* (1976).

Source: Paulo de Tarso Zuquim Antas and Susana de Moura Lara-Resende.

Criteria for inclusion: 123.

The Rio Guapore and Rio Cautario marshes (22)

Location: 12°00'S, 64°50'W to 15°10'S, 59°30'W; along the Bolivian border from Mato Grosso to the region of Principe da Beira, Mato Grosso and Rondonia.

Area: 1,400,000 ha.

Altitude: 150-230m.

Province and type: 8.6.1/8.30.10; 09, 11, 12, 16 & 18.

Site description: Extensive freshwater marshes and swamps along the Rio Guapore from its headwaters near the town of Mato Grosso 700 km downstream along the Bolivian border to near its confluence with the Rio Mamore; and swamps and riverine marshes along the lower Rio Cautario to its confluence with the Guapore. There are large tracts of seasonally flooded gallery forest and humid palm savanna with "islands" of forest. The dry season is from May to September. This wetland is contiguous with the Bolivian site 23.

Principal vegetation: No information.

Land tenure: Mainly private ownership; the Biological Reserve is owned by the Federal Government.

Protection: The western part is included in the Alto Guapore Biological Reserve (600,000 ha) established in 1982; the southeastern part is included in the recently established Alto Guapore Ecological Station.

Land use: Some hunting, fishing, cattle ranching and agriculture, but much of the area remains almost undisturbed.

Brazil

Waterfowl: Very little information available, but known to be very rich in breeding waterfowl, and important for Nearctic shorebirds on migration. Species recorded include *Pluvialis dominica*, *Limosa haemastica*, *Calidris melanotos*, *Micropalama himantopus* and *Steganopus tricolor*.

Other fauna: *Blastocerus dichotomus*, *Melanosuchus niger*, *Caiman crocodilus* and *Podocnemis expansa* are known to occur.

Threats: Ranching activities are being expanded in the area, and there is a considerable amount of illegal hunting, particularly of crocodilians. There are some small farms in the Biological Reserve.

References: Antas (1983).

Source: Paulo de Tarso Zuquim Antas.

Criteria for inclusion: 123.

Pantanal do Mato Grosso (23)

Location: 15°30'-21°30'S, 55°00'-59°00'W; northwestern Mato Grosso do Sul and southern Mato Grosso, on the Bolivian and Paraguayan borders.

Area: 11,000,000 ha of wetlands in a total region of 15,000,000 ha.

Altitude: 80-150m; (isolated peaks southeast of Corumba to 1,065m).

Province and type: 8.30.10; 09, 11, 12, 13, 16 & 18.

Site description: A vast region of seasonally flooded savannas in the upper drainage of the Rio Paraguay and tributaries; with many slow-flowing, meandering rivers and streams, numerous small permanent freshwater lakes and marshes, areas of higher dry savanna, and belts and islands of xerophytic scrub (matorral) and humid deciduous forest. The region is bounded by the Serra dos Coroados ou S. Lourenco to the north, the Planalto de Mato Grosso to the east, and the Serra da Bodoquena and Serra de Maracaju to the south. The wetlands drain west, through a gap 50 km wide between the Corumba and Ladario hills and the Serra da Bodoquena. The natural drainage is very slow, rivers falling by as little as 3 cm per km, and the soils are poor and badly aerated. The annual rainfall is 1,200-1,400 mm, 80% of which falls between December and March. The main flooding occurs from the end of December to mid June. There are great seasonal fluctuations in the extent of flooding. The largest permanent wetlands, including lakes up to 10,000 ha in extent, are in the northwest on the Bolivian border. Although the greater part of the Pantanal lies in Brazil, 1,235,000 ha along the western edge lie in Bolivia, and 400,000 ha in the south lie in northern Paraguay (see Bolivia sites 19 and 20, and Paraguay site 1).

Principal vegetation: Vast tracts of seasonally inundated savanna with scattered palms *Copernicia australis*; patches of humid deciduous forest and gallery forest with species of *Jacaranda*, *Caryocar*, *Vochysia* and *Tecoma*; and marshes with species of *Eichhornia*, *Azolla*, *Pistia* and Cyperaceae.

Land tenure: Mainly privately owned in large ranches. The Ecological Station is owned by SEMA.

Protection: 137,000 ha are protected in the Pantanal Matogrossense National Park, established in 1981, and 12,000 ha in Taiama Ecological Station, also established in 1981. The remainder of the area is unprotected.

Land use: The principal activity throughout the region is cattle ranching, which was introduced at the end of the 19th century. The region supports an important fishery, and there is a considerable amount of illegal hunting of crocodilians and fur-bearers for their hides, and live animals for the zoo and pet trade. There is a little agriculture, industry and mining, and in recent years some nature tourism.

Waterfowl: Probably the most important wetland area in South America in terms of waterfowl populations, with huge resident breeding populations of a wide variety of species typical of open freshwater marshes and wet savanna. Characteristic species include *Phalacrocorax olivaceus*, *Anhinga anhinga*, *Tigrisoma lineatum*, *Pilherodius pileatus*, *Syrigma sibilatrix*, *Bubulcus ibis*, *Butorides striatus*, *Egretta thula*, *E. alba*, *Ardea cocoi*, *Mycteria americana*, *Euxenura maguari*, *Jabiru mycteria*, *Harpiprion caerulescens*, *Theristicus caudatus*, *Phimosus infuscatus*, *Ajaia ajaja*, *Chauna torquata*, *Dendrocygna viduata*, *D. autumnalis*, *Amazonetta brasiliensis*, *Sarkidiornis melanotos*, *Cairina moschata*, *Aramus guarana*, a wide variety of Rallidae, *Jacana jacana*, *Vanellus chilensis*, *Himantopus himantopus*, *Phaetusa simplex* and *Sterna superciliaris*. The Pantanal is also very important for Nearctic shorebirds, particularly on passage to and from wintering areas further south. The commoner species are *Pluvialis dominica*, *Bartramia longicauda*, *Tringa* spp, *Calidris fuscicollis*, *C. melanotos* and *Tryngites subruficollis*.

Other fauna: The region is rich in birds of prey including *Cathartes burrovianus*, *Rostrhamus sociabilis*, *Circus buffoni*, *Buteogallus urubitinga*, *Busarellus nigricollis* and *Polyborus plancus*. Mammals include *Pteronura brasiliensis*, *Hydrochoerus hydrochaeris* and *Blastocerus dichotomus*. Reptiles include *Caiman crocodilus yacare* and *C. latirostris*.

Threats: Large tracts of the Pantanal remain remote and only slightly modified by man. However, there has recently been a great acceleration in development, and in many areas wetlands are threatened. The principal threats are: watershed deforestation resulting in increased turbidity and increased siltation rates; modifications to water courses and construction of dams and canals for irrigation projects; construction of hydroelectric dams; expansion of agriculture; introduction of domestic buffalo; pollution of rivers from industries, mines and pesticide runoff; increase in mining activities; overfishing; and extensive illegal hunting, particularly of *Caiman crocodilus* and Anatidae. The alcohol industry is being developed along the Rio Cuiaba, and is likely to cause serious pollution in that river in the future.

Research and conservation: In recent years, a considerable amount of attention has been focused on the Pantanal, and a variety of faunal and floral investigations and bird banding programmes have been conducted or are in progress. The Instituto de Preservacao e Controle Ambiental in Mato Grosso do Sul has been particularly active in this regard. The region has tremendous potential for nature tourism, recreation and sport hunting, and there is a great need to establish a rational and integrated management plan for the entire area. It is essential that additional areas be protected; attempts are being made to enlarge the National Park to over 200,000 ha, but ideally a protected area should cover a complete watershed as a corridor, in order to ensure the survival of the complete spectrum of natural processes, ecosystems and species.

References: Hueck (1978); Dourojeanni (1980); Mercedes-Benz do Brasil S.A. (1980); IUCN (1982).

Source: Marlise Becker, Carlos Yamashita and references.

Criteria for inclusion: 123.

Floodplain of the Rio Parana (24)

Location: 21°00'S, 51°45'W to 24°10'S, 54°25'W; between Tres Lagoas and the Paraguayan border, Sao Paulo, Parana and Mato Grosso do Sul.

Area: Formerly c.625,000 ha.

Altitude: 240-265m.

Province and type: 8.8.2; 09, 11, 16 & 18.

Site description: The extensive floodplain of the 440 km stretch of the Rio Parana downstream from Tres Lagoas, formerly 10-20 km wide, but now much reduced following the construction of huge hydroelectric dams on the Paranaiba (upper Parana) above Tres Lagoas.

Principal vegetation: No information.

Land tenure: No information.

Protection: None.

Land use: No information.

Waterfowl: No information.

Other fauna: No information.

Brazil

Threats: The Itaipu Hydroelectric Dam 60 km downstream on the Rio Parana, on the Brazil/Paraguay border, has flooded 146,000 ha of the valley and extends back to the lower portion of the present site.

Criteria for inclusion: 0.

Wetlands in Serra da Canastra National Park (25)

Location: 20°15'S, 46°40'W; 50 km north of Passos, Minas Gerais.

Area: Area of wetlands unknown; National Park 73,000 ha.

Altitude: 900-1,400m.

Province and type: 8.8.2; 10 & 13.

Site description: Cold clear highland springs, streams and associated bogs at the headwaters of several large rivers including the Rio Sao Francisco; on a high plateau of rolling grassland with steep escarpments. There are numerous waterfalls, rapids and pools up to 2m deep; water levels remain fairly constant throughout the year except during occasional flash floods in December and January. The annual rainfall is 1,300-1,700 mm.

Principal vegetation: *Sphagnum* bogs; rolling grassland (campos limpios); open woodland (cerrado); and riparian forest.

Land tenure: Owned by IBDF.

Protection: Within the Serra da Canastra National Park (73,000 ha) established in 1972; the protection is excellent.

Land use: Formerly a single large ranch with low density cattle grazing; now undisturbed except for some nature tourism and research activities.

Waterfowl: The larger streams and bogs support small populations of *Podiceps dominicus*, *Theristicus caudatus*, *Gallinago (g) paraguayiae* and *G. undulata*. The area is of major importance for its resident population of the extremely rare *Mergus octosetaceus*. J. M. Dietz estimated the population in the Park and surrounding areas at about 50 birds in 1980. This species is dependent on clear, fast-flowing rivers and streams which have now become extremely rare outside protected areas as a result of watershed degradation and extensive soil erosion.

Other fauna: The Brasilia Tapaculo *Scytalopus novacapitalis* was discovered in riverine thickets in the Park in October 1983; this species was previously thought to occur only in the vicinity of Brasilia. The Park has large populations of a variety of birds typical of tall grassland, a habitat becoming very rare in central Brazil. Mammals include *Chrysocyon brachyurus* and *Ozotoceros bezoarticus*.

Threats: None, other than fires which destroy large areas of grassland each year.

Research and conservation: Dietz (1980) conducted a study on *Chrysocyon brachyurus*, and IBDF has prepared a management plan for the Park. The Park contains one of the few remaining upland grassland areas with clear rivers and streams in central Brazil.

References: Dietz (1980); IUCN (1982).

Source: James M. Dietz, Helmut Sick and Derek A. Scott.

Criteria for inclusion: 2a, 2b & 3a.

Ninhal do Barreiro (26)

Location: 20°05'S, 45°38'W; 45 km NNW of Formiga, Minas Gerais.

Area: 1,000 ha.

Altitude: 650m.

Province and type: 8.8.2; 09, 12, 16, 17 & 18.

Site description: A complex of slow-flowing rivers, marshes, freshwater lakes, and seasonally flooded grassland, arable land and patches of forest; in the upper basin of the Rio Sao Francisco.

Principal vegetation: In a region of campos and cerrado.

Land tenure: Privately owned.

Protection: No legal protection, but the owners afford the area some protection and restrict hunting.

Land use: Cattle ranching, and some illegal hunting.

Waterfowl: A very important breeding area for waterfowl of the upper Rio Sao Francisco, with large colonies of *Egretta alba*, *Ardea cocoi* and *Ajaia ajaja*. Other resident species include *Nycticorax nycticorax*, *Bubulcus ibis*, *Egretta thula* and *Jabiru mycteria*. Many other species of waterfowl occur on migration.

Other fauna: *Chrysocyon brachyurus* and *Caiman latirostris* occur.

Threats: Illegal hunting poses the only threat at present.

Research and conservation: M. A. de Andrade is currently conducting a study of the avifauna, and banding nesting birds.

Source: Marco Antonio de Andrade.

Criteria for inclusion: 2c & 3a.

The Rio Doce Estuary, Juparana lakes and Linhares marshes (27)

Location: 18°35'-19°45'S, 39°41'-40°25'W; between Linhares and Sao Mateus, Espirito Santo.

Area: 191,500 ha (180,000 ha of coastal marshes; 11,500 ha of inland lakes).

Altitude: 0-30m.

Province and type: 8.8.2; 02, 05, 07, 08, 09, 12 & 18.

Site description: The estuarine system of the Rio Doce and 140 km of coastal marshes from Conceicao da Barra in the north to 30 km south of the Rio Doce in the south; with mangrove swamps, ocean beaches, fresh to brackish lakes and marshes, and areas of swamp forest; also inland a series of eight freshwater lakes with some fringing marshes in rolling hill country, the largest being Lagoa Juparana (5,500 ha).

Principal vegetation: In the humid tropical forest zone, although most of the forest has now been cleared for ranching and agriculture. The 44,000 ha of Atlantic forest protected in Sooretama Biological Reserve and Reserva Florestal de Linhares (contiguous reserves) represent almost 50% of the primary forest remaining in the State of Espirito Santo.

Land tenure: Mainly privately owned; Sooretama Biological Reserve is owned by IBDF, the Reserva Florestal de Linhares is owned by Companhia Vale do Rio Doce, and the beaches at the mouth of the Rio Doce are owned by Espirito Santo State.

Protection: Some freshwater lakes, swamps and swamp forest are included in the Sooretama Biological Reserve (24,000 ha) established in 1943, and in Reserva Florestal de Linhares (20,000 ha); the beaches at the mouth of the Rio Doce (Comboios) are protected by IBDF during the turtle nesting season. The remainder is unprotected.

Land use: Fishing and recreation along the coast; extensive cattle ranching and agriculture in surrounding areas; illegal hunting.

Waterfowl: Resident species include *Podilymbus podiceps*, *Phalacrocorax olivaceus*, *Ixobrychus exilis*, *Tigrisoma lineatum*, *Nycticorax nycticorax*, *Pilherodius pileatus*, *Butorides striatus*, *Egretta alba*, *Amazonetta brasiliensis*, *Cairina moschata*, *Aramus guarauna*, *Aramides cajanea*, *Porphyryla martinica*, *Jacana jacana* and *Vanellus chilensis*. A number of migrant Nearctic shorebirds occur along the coast, and *Sterna hirundinacea* occurs at the limit of its non-breeding range during the austral winter.

Other fauna: The beaches at the mouth of the Rio Doce are the only known regular nesting site of *Dermochelys coriacea* in Brazil.

Threats: Beach development for recreation and exploration for oil along the coast; and illegal hunting.

Research and conservation: Tundisi (1983a) has conducted limnological studies in the freshwater lakes of the Rio Doce valley. Research at Sooretama Biological Reserve has concentrated on the endangered forest fauna and flora.

References: IUCN (1982); Tundisi (1983a).

Source: Paulo de Tarso Zuquim Antas and Derek A. Scott.

Criteria for inclusion: 2c & 3a.

Lagoa Feia and the Paraiba do Sul marshes (28)

Location: 21°25'-22°10'S, 41°00'-41°35'W; south and east of Campos, Rio de Janeiro.

Area: 68,000 ha.

Altitude: 0-5m.

Province and type: 8.8.2; 02, 05, 07, 08, 09 & 12.

Site description: The estuarine/delta system of the Rio Paraiba do Sul, with extensive mangrove swamps; sandy beaches along the coast; a complex of relatively shallow freshwater lakes and marshes in the delta area; and a chain of small brackish lagoons stretching along the coast to the south. Lagoa Feia in the southern part of the delta is much the largest lake; drainage schemes had reduced its area from 30,000 ha in 1933 to 17,000 in 1978, and eliminated many smaller lakes nearby. The water level in the lake is now controlled and there are only slight seasonal fluctuations.

Principal vegetation: The aquatic vegetation includes Cyperaceae and species of *Eichhornia*, *Pistia*, *Eleocharis*, *Chara*, *Elodea*, *Cabomba*, *Potamogeton*, *Lemna*, *Salvinia*, *Typha*, *Schoenoplectus* and *Echinochloa*.

Land tenure: Mainly private, with some state ownership.

Protection: No legal protection, but some landowners prohibit hunting.

Land use: Fishing; cattle ranching; cultivation of sugar cane for the alcohol industry; and exploration for oil.

Waterfowl: A very important area for both resident and migratory waterfowl. Resident species include *Podilymbus podiceps*, *Podiceps dominicus*, *Phalacrocorax olivaceus*, *Bubulcus ibis*, *Butorides striatus*, *Egretta caerulea*, *E. thula*, *E. alba*, *Ardea cocoi*, *Dendrocygna bicolor*, *D. viduata*, *D. autumnalis*, *Anas bahamensis*, *Amazonetta brasiliensis*, *Oxyura dominica*, *Aramus guarana*, *Rallus nigricans*, *Porzana flaviventer*, *Laterallus melanophaius*, *Porphyriops melanops*, *Gallinula chloropus*, *Porphyryla martinica*, *Jacana jacana*, *Charadrius collaris* and *Sterna superciliaris*. *Netta erythrophthalma erythrophthalma* occurs in significant numbers; *Ixobrychus involucris* and *Rallus sanguinolentus* occur at the northern limit of their range in southeastern Brazil; and *Nycticryphes semicollaris* has been recorded as a winter visitor. Common Nearctic migrants include *Charadrius semipalmatus*, *Tringa melanoleuca*, *T. flavipes*, *T. solitaria* and *Actitis macularia*, and *Anas discors* has occurred as a vagrant.

Other fauna: *Lutra* sp, *Hydrochoerus hydrochaeris* and *Caiman latirostris* occur. Sick (1967) describes an interesting case of local speciation in the seed-eater *Sporophila bouvreuil*, which demonstrates the zoogeographic isolation of this wetland. The subspecies confined to the Lagoa Feia swamps differs from other forms of the species in lacking a distinctive male plumage.

Threats: The wetland is under serious threat from continuing drainage for agriculture, particularly the cultivation of sugar cane; land reclamation for urban and industrial development; pollution; disturbance from recreation; intensive illegal hunting; and the deliberate burning of marsh vegetation.

Research and conservation: A variety of faunal and floral investigations have been carried out by the Museu Nacional and Fundacao Estadual de Engenharia do Meio Ambiente (FEEMA).

References: Sick (1962, 1967 & 1968); Schneider & Sick (1962); Coimbra-Filho (1969a); Maciel & Araujo (1979); FEEMA (1980).

Source: Luiz A. Pedreira Gonzaga, Norma Crud Maciel, Helmut Sick and Dante Luiz Martins Teixeira.

Criteria for inclusion: 2a, 2b & 3a.

Rio de Janeiro lagoons (29)

Location: 22°50'-23°00'S, 42°00'-43°25'W; between Rio de Janeiro and Cabo Frio, Rio de Janeiro.

Area: 26,000 ha.

Altitude: 0-1m.

Province and type: 8.8.2; 05, 07, 08 & 12.

Site description: A chain of eleven large fresh to brackish coastal lagoons behind a sea beach from Lagoa Jacarepagua (1,400 ha) in the west to Lagoa de Araruama (15,000 ha) in the east; and a complex of salt pans, shallow saline lagoons and marshes south of Cabo Frio. Several of

the brackish lagoons have fringing mangroves and are influenced by the tides. Jacarepagua, Marapendi, Itaipu and Piratininga are in the outskirts of Rio de Janeiro and Niteroi.

Principal vegetation: Mangrove swamps with *Rhizophora mangle*, *Laguncularia racemosa*, *Conocarpus erectus* and *Avicennia* sp; marshes with Cyperaceae, *Paspalum vaginatum*, *Typha* sp and *Acrostichum* sp.

Land tenure: A mixture of state, municipal and private ownership.

Protection: None.

Land use: Fishing; conch fishing; extraction of salt; recreation; and some illegal hunting. In a region of extensive urban and suburban development, with the large cities of Rio de Janeiro and Niteroi in the west.

Waterfowl: Surprisingly rich in waterfowl in view of the proximity of the wetlands to large urban centres. Common residents include *Podilymbus podiceps*, *Phalacrocorax olivaceus*, *Nycticorax nycticorax*, *Butorides striatus*, *Egretta thula*, *E. alba*, *Ardea cocoi*, *Dendrocygna viduata*, *Anas bahamensis*, *Amazonetta brasiliensis*, *Gallinula chloropus*, *Jacana jacana* and *Charadrius collaris*. Other species recorded include *Botaurus pinnatus*, *Ixobrychus involucris*, *Cochlearius cochlearius*, *Oxyura dominica* and *Porphyriops melanops*. *Netta erythrophthalma erythrophthalma* is fairly common and known to breed; flocks of up to 80 have been recorded on Jacarepagua, Marapendi, Itaipu and Piratininga in recent years. A variety of Nearctic shorebirds occur on migration and in the austral summer, particularly on the salt pans and coastal lagoons near Cabo Frio. The commoner species include *Charadrius semipalmatus*, *Tringa melanoleuca*, *T. flavipes*, *Calidris alba*, *C. pusilla* and *C. fuscicollis*. *Nycticryphes semicollaris* has occurred as a winter visitor from the south.

Other fauna: No information.

Threats: The wetlands are under considerable pressure from urban expansion, the reclamation of land for industry and residential areas, and development for water sports and beach recreation. There is also a serious pollution problem from domestic and industrial waste, and some illegal hunting.

Research and conservation: Various faunal and floral studies, including bird banding projects, have been carried out by the Museu Nacional and local universities.

References: Sick & Pabst (1968); Sick & Teixeira (1979); Teixeira & Nacinovic (1981).

Source: Susana de Moura Lara-Resende, Norma Crud Maciel and Dante Luiz Martins Teixeira.

Criteria for inclusion: 2a, 2b & 3a.

Guanabara Bay (30)

Location: 22°40'-22°55'S, 42°58'-43°16'W; northeast of the city of Rio de Janeiro, Rio de Janeiro.

Area: 45,000 ha including 5,000 ha of mangroves.

Altitude: 0-2m.

Province and type: 8.8.2; 01, 07 & 08.

Site description: A large sea bay with narrow entrance to the sea between the cities of Rio de Janeiro and Niteroi; there are extensive mangrove swamps at Reconcavo in the northeast, and fringing fresh to brackish marshes and wet arable land.

Principal vegetation: Mangrove swamps with *Rhizophora mangle*, *Laguncularia racemosa* and *Avicennia* sp; salt marshes with *Spartina alterniflora*; and marshes with *Typha domingensis*, *Hibiscus pernambucensis* and *Acrostichum aureum*.

Land tenure: The bay is under Federal ownership (Marine Territory); the surrounding areas are mainly private.

Protection: An Environmental Protection Area has recently been established to protect 5,000 ha of mangroves at Reconcavo. The remainder of the area is unprotected.

Land use: Fishing; harvesting of crabs; exploitation of mangroves; and recreation. The city and port of Rio de Janeiro lie along the west shore of the Bay; other neighbouring areas are under cultivation.

Brazil

Waterfowl: A wide variety of resident and migratory waterfowl occur, although in much smaller numbers than in former times. Common residents include *Phalacrocorax olivaceus*, *Anhinga anhinga*, *Egretta caerulea*, *E. thula*, *E. alba*, *Dendrocygna viduata*, *Amazonetta brasiliensis*, *Aramides cajanea*, *Gallinula chloropus*, *Porphyryla martinica*, *Jacana jacana* and *Charadrius collaris*.

Other fauna: *Hydrochoerus hydrochaeris*, *Caiman latirostris* and *Paleosuchus niger* occur.

Threats: The shore of the bay is under intense pressure from urban and agricultural expansion, and only the large tracts of mangroves and swamp in the northeast remain relatively undisturbed. Here the principal threats are the destruction of mangroves for fuel and timber, drainage for agriculture, and pollution from pesticide runoff.

Research and conservation: Faunal and floral studies have been carried out by the Museu Nacional, and FEEMA has conducted a study of the mangroves at Reconcavo.

References: Araujo & Maciel (1979).

Source: Norma Crud Maciel.

Criteria for inclusion: 2b & 3a.

Guaratiba Bay (31)

Location: 23°02'S, 43°37'W; west of Rio de Janeiro city, Rio de Janeiro.

Area: 1,413 ha.

Altitude: 0m.

Province and type: 8.8.2; 02, 06, 07 & 08.

Site description: An area of mangrove swamps, brackish marshes and intertidal mudflats at the eastern end of a large sea bay.

Principal vegetation: Mangrove swamps with *Rhizophora mangle*, *Laguncularia racemosa* and *Avicennia* sp; marshes with *Paspalum vaginatum*.

Land tenure: A mixture of federal and state ownership.

Protection: Within the Guaratiba Biological and Archeological Reserve, a state reserve.

Land use: Fishing and recreation.

Waterfowl: A variety of resident waterfowl and migrant Nearctic shorebirds occur, the residents including *Phalacrocorax olivaceus*, *Anhinga anhinga*, *Egretta caerulea*, *E. thula*, *E. alba*, *Ardea cocoi*, *Ajaia ajaja*, *Jacana jacana* and *Charadrius collaris*.

Other fauna: No information.

Threats: Pollution, and encroachment of residential areas; the reserve is not clearly defined.

References: Maia & Penna (1982).

Source: Norma Crud Maciel.

Criteria for inclusion: 3a.

The lower Rio Ribeira, Iguape and Lagunas de Cananeia (32)

Location: 24°25'-25°15'S, 47°15'-48°05'W; near Registro and Iguape, Sao Paulo.

Area: 120,000 ha.

Altitude: 0-10m.

Province and type: 8.7.1; 02, 05, 06, 07, 08, 09, 11 & 12.

Site description: The extensive riverine marshes of the lower Rio Ribeira and tributaries; a complex of narrow coastal inlets, fresh to brackish lagoons, mangrove swamps and intertidal mudflats around Ilha Comprida and Ilha do Cardoso; and 100 km of ocean beach with coastal dunes.

Principal vegetation: Mangrove swamps with *Rhizophora mangle*, *Avicennia germinans* and *Laguncularia racemosa*; sandy areas and marshes with *Ipomoea pescaprae*, *Spartina ciliata*, *Philoxerus portulacoides*, *Canavalia obtusifolia*, *Remirea maritima* and *Hydrocotyle umbellata*. In a region of humid tropical forest (Atlantic forest).

Land tenure: The Ecological Station is owned by SEMA; Ilha do Cardoso is owned by the state; other areas are mainly private.

Protection: The northeastern portion is included within the Jureia Ecological Station (30,000 ha); Ilha do Cardoso State Park includes 1,100 ha of Atlantic beach and 1,800 ha of mangroves; other areas are unprotected.

Land use: Subsistence agriculture, and commercial fishing on a small scale.

Waterfowl: An important area for both breeding and migrant waterfowl. Resident species include *Phalacrocorax olivaceus*, *Egretta caerulea*, *E. thula*, *E. alba*, *Ardea cocoi*, *Dendrocygna* spp, *Amazonetta brasiliensis*, *Aramides cajanea* and *Vanellus chilensis*. Passage migrants include *Charadrius semipalmatus*, *Tringa* spp, *Calidris fuscicollis* and Laridae.

Other fauna: *Procyon cancrivorus*, *Hydrochoerus hydrochaeris* and *Tapirus terrestris* occur.

Threats: Destruction of mangroves, and excessive disturbance from recreation at weekends.

Research and conservation: A management plan has been prepared for Ilha do Cardoso State Park; and the Lagunas de Cananeia-Iguape area is under study for the creation of a protected area.

References: Negreiros *et al* (1974); Noffs & Baptista-Noffs (1982).

Source: Susana de Moura Lara-Resende and Marcos da Silva Noffs.

Criteria for inclusion: 3a.

Baia de Laranjeiras and Baia de Paranagua (33)

Location: 25°15'-25°35'S, 48°10'-48°45'W; between Paranagua and Guaraquecaba, Parana.

Area: 76,000 ha.

Altitude: 0m.

Province and type: 8.7.1; 01, 02, 03, 07, 08 & 10.

Site description: A large sea bay complex with deeply indented shoreline, numerous small islands, and the estuaries of several small fast-flowing rivers; there are some estuarine marshes and mangrove swamps. The bay is up to 10m deep, and has a tidal rise and fall of about 1m.

Principal vegetation: In a region of humid tropical forest (Atlantic forest).

Land tenure: No information.

Protection: The northeastern portion is included within the recently established Guaraquecaba Ecological Station (73,640 ha); the remainder is unprotected.

Land use: Fishing. The area is little disturbed.

Waterfowl: Little information is available, but the area is known to be rich in Ardeidae and Rallidae.

Other fauna: There is a large breeding colony of *Sula leucogaster* and *Fregata magnificens* on an island in Paranagua Bay. The area is particularly important for its population of the endangered parrot *Amazona brasiliensis*.

Threats: The surrounding forests are being destroyed, and there is some trapping of birds for the pet trade.

Source: Pedro Scherer Neto.

Criteria for inclusion: 2a & 3a.

Rio Iguacu and Iguacu Falls (34)

Location: 25°05'-25°41'S, 53°40'-54°38'W; 20 km southeast of Foz do Iguacu, on the Argentinian border, Parana.

Area: Unknown.

Altitude: 150-275m.

Province and type: 8.8.2; 10.

Site description: Approximately 170 km of the Rio Iguacu, a large, relatively fast-flowing river with spectacular falls which drop 80m over a distance of 2,700m. The flow in the river has recently been affected by the construction of a large hydroelectric dam 300 km upstream at Osorio. Contiguous with Argentina site 14.

Principal vegetation: In relatively undisturbed humid subtropical forest with some *Araucaria angustifolia* and the palms *Euterpe edulis* and *Cocos romanzoffiana*.

Land tenure: The greater part of the National Park is owned by IBDF.

Protection: Included within the Iguacu National Park (170,086 ha), established in 1939 and modified in 1944.

Land use: Tourism in the National Park.

Waterfowl: A variety of waterfowl breed in the Park, including *Anhinga anhinga*, *Mesembrinibis cayennensis*, *Cairina moschata*, *Heliornis fulica* and *Charadrius collaris*. The rare *Mergus octosetaceus* was recorded as an occasional visitor until at least the 1970s, and the endangered nominate race of *Tigrisoma fasciatum* may still occur.

Other fauna: There is a large roost of the rather local swift *Cypseloides senex* at the falls, and the endangered piping-guan *Pipile jacutinga* occurs in the surrounding forests. Mammals include *Pteronura brasiliensis*, *Lutra platensis*, *Hydrochoerus hydrochaeris* and *Tapirus terrestris*; reptiles include *Caiman latirostris* and *Paleosuchus palpebrosus*.

Threats: Increasing turbidity of the Rio Iguacu and its tributaries as a result of watershed degradation outside the park, and alterations in flow caused by the hydroelectric dam at Osorio are the main problems. There is some encroachment by settlers, forest clearance and hunting in the Park, and tourists cause a considerable amount of disturbance, particularly in low-flying helicopters.

Research and conservation: A variety of faunal and floral investigations have been conducted in the Park.

References: IUCN (1982).

Source: Derek A. Scott.

Criteria for inclusion: 2a, 3a & 3b.

Tubarao Lagoons (35)

Location: 28°02'-28°40'S, 48°40'-49°03'W; east of Tubarao, Santa Catarina.

Area: 50,000 ha.

Altitude: 0-5m.

Province and type: 8.8.2; 02, 07 & 08.

Site description: Lagoa do Mirim (18,000 ha), Lagoa Garopaba (3,500 ha), and about ten smaller brackish coastal lagoons with extensive marshes between Garopaba in the north and Jaguaruna in the south. There are some mangrove swamps, here at the extreme southern limit of their occurrence on the Atlantic coast.

Principal vegetation: No information.

Land tenure: No information.

Protection: None.

Land use: No information.

Waterfowl: No information.

Other fauna: No information.

Threats: No information.

Source: Paulo de Tarso Zuquim Antas.

Criteria for inclusion: 0.

Lagoa do Sombrio (36)

Location: 29°10'S, 49°40'W; 60 km southwest of Criciuma, Santa Catarina.

Area: 5,060 ha.

Altitude: 0m.

Province and type: 8.32.11; 07.

Site description: A large brackish coastal lagoon, up to 3m deep, and several small lagoons nearby, with brackish marshes and surrounding sandy areas. Water levels fluctuate with the local rainfall.

Principal vegetation: Marshes with Cyperaceae and *Typha* sp; in a region of open grassland and scrub.

Land tenure: A mixture of state and municipal ownership.

Protection: None.

Land use: Cattle ranching in surrounding areas.

Waterfowl: Resident breeding species include *Podilymbus podiceps*, *Gallinula chloropus*, *Fulica armillata* and *F. rufifrons*. The wetland is of chief importance as a wintering area for waterfowl breeding further south; these include *Phalacrocorax olivaceus*, *Egretta alba*, *Ardea cocoi*, *Dendrocygna bicolor*, *D. viduata*, *Cygnus melancoryphus* and *Netta peposaca*.

Other fauna: The area is rich in passerines associated with wetland habitats.

Threats: Drainage canals have been dug to reclaim land for cattle grazing.

Research and conservation: Preliminary avifaunal surveys have been conducted in the area.

Source: Lenir Alda do Rosario Bege and Selma Mattos Diniz.

Criteria for inclusion: 2b & 3a.

Tramandai Lagoons (37)

Location: 29°22'S, 49°48'W to 30°23'S, 50°20'W; from Torres south along the coast to 50 km south of Tramandai, Rio Grande do Sul.

Area: 42,000 ha.

Altitude: 0-5m.

Province and type: 8.32.11; 07 & 12.

Site description: A chain of lakes and lagoons with associated marshes stretching for 125 km along the coast of northern Rio Grande do Sul, separated from the sea by a belt of sand dunes 3-5 km wide. The great majority are fresh, but four lagoons near Tramandai (Tramandai, Armazem, Custodia and Gentil) are brackish with salinities ranging up to 30 p.p.t. The largest lakes are Itapeva (9,516 ha), dos Quadros (11,900 ha), Malvas (1,500 ha), Palmital (1,172 ha), Pinguela (2,908 ha), Tramandai (1,286 ha), Fortaleza (1,854 ha) and Porteira (1,868 ha). The maximum depth varies from about 1.5m to 3.5m, and the levels fluctuate seasonally by 50 cm to 1m.

Principal vegetation: Freshwater lakes and marshes with *Scirpus californicus*, *S. giganteus*, *Paspalidium paludivagum*, *Eichhornia crassipes*, *E. azurea*, *Pistia stratiotes*, *Potamogeton* sp, *Salvinia* sp, *Elodea densa*, *Fuerena robusta*, *Nymphoides indica* and *Cabomba australis*; brackish lagoons with *Scirpus californicus*, *S. olneyi*, *Ruppia maritima*, *Trapa* sp, *Potamogeton pectinatus*, *Ceratophyllum demersum* and *Chara* sp. Surrounding areas with dune vegetation, pastureland and rice cultivation.

Land tenure: Mainly private ownership; some lakes are partly owned by the state or local municipalities.

Protection: None.

Land use: Cattle ranching, traditional fishing and recreation. There is commercial fishing at some lakes, and pisciculture at Lagoa dos Quadros. The waters of Lagoa Rincao das Eguas and Lagoa Porteira are used to irrigate rice cultivation.

Waterfowl: An important area for a wide variety of breeding waterfowl and migrants from both the north and the south. Belton records over 65 species including *Rollandia rolland*, *Podiceps major*, *Botaurus pinnatus*, *Ixobrychus involucris*, *Mycteria americana*, *Euxenura maguari*, *Chauna torquata*, *Anas georgica*, *A. versicolor*, *Netta peposaca* (mainly a winter visitor), *Cairina moschata*, *Oxyura dominica*, *Rallus sanguinolentus*, *R. nigricans*, *R. maculatus*, *Aramides saracura*, *Fulica armillata*, *F. leucoptera*, *Gallinago (g.) paraguayiae* and *Larus maculipennis*. Migrant shorebirds include *Charadrius falklandicus*, *C. modestus* and *Eudromias ruficollis* from southern South America, and 13 regular visitors from the Nearctic.

Other fauna: No information.

Threats: There is some pollution from domestic sewage at Lagoa Marcelino, Laguna Tramandai and Lagoa Armazem.

Research and conservation: Limnological studies have been conducted at all the lakes by Chomenko (1981) and Schwarzbald (1982), and the avifauna has been studied by Belton (1984). Priority areas for protection include Lagoa Malvas, Lagoa Rincao I, Lagoa Rincao II and Lagoa Pombas.

References: Chomenko (1981); Schwarzbald (1982); Belton (1984).

Source: Walter A. Voss.

Criteria for inclusion: 3a.

Lagoa do Peixe and nearby lakes (38)

Location: 30°24'S, 50°20'W to 31°55'S, 51°54'W; along the coast east of Lagoa dos Patos, Rio Grande do Sul.

Area: 11,300 ha of lakes and lagoons.

Altitude: 0-4m.

Province and type: 8.32.11; 05, 07 & 12.

Site description: A chain of 23 small freshwater lakes and marshes, and the large shallow brackish to saline Lagoa do Peixe (4,370 ha), stretching for 240 km along the inland side of the coastal sand dunes between Lagoa dos Patos and the Atlantic; the seaward side of the dunes is a continuous ocean beach. Lagoa do Peixe varies in depth from 10-80 cm, and the salinity ranges from 1-40 p.p.t.; the lagoon is connected to the sea by a channel during the rainy season (winter and spring). The shores are muddy and sandy, and there is little aquatic vegetation. Most of the freshwater lakes are under 500 ha in area, but Lagoa Quintao, Lagoa dos Barros and Lagoa Figueira in the north exceed 700 ha, and the southernmost lake, Lagoa Tuneira, is 1,760 ha. The maximum depths range from under 1m to 11m, and levels fluctuate seasonally by about 50 cm. Lagoa Moleques and Lagoa Figueira are exceptional in being oligotrophic.

Principal vegetation: Some sparse halophytic vegetation and *Paspalum vaginatum* at Lagoa do Peixe; freshwater lakes and marshes with *Scirpus californicus*, *S. giganteus*, *Paspalidium paludivagum*, *Potamogeton illinoensis*, *Eichhornia azurea*, *Zizaniopsis bonariensis*, *Pontederia lanceolata*, *Echinodorus grandiflorus*, *Nymphoides indica*, *Ceratophyllum demersum* and *Chara* sp. Sand dune vegetation to the east and grassland to the west, with some plantations of *Pinus* and *Eucalyptus* spp in northern areas, and native coastal scrub in the south.

Land tenure: Private and public (Navy) ownership.

Protection: None.

Land use: Cattle ranching throughout; some recreation at lakes in the north; a little traditional fishing; commercial shrimp fishing at Lagoa do Peixe; sport hunting; and rice cultivation and forestry in surrounding areas. The waters of several lakes are used for irrigation in rice cultivation, particularly in the north.

Waterfowl: A very important area for a wide variety of waterfowl. Lagoa do Peixe is particularly important as a staging area and wintering area for migrant waterfowl breeding further south and for Nearctic shorebirds. The southern migrants include *Phoenicopterus chilensis* (up to 200), *Coscoroba coscoroba*, *Cygnus melancoryphus*, *Anas flavirostris*, *A. sibilatrix*, *A. georgica*, *Netta peposaca*, *Charadrius falklandicus* (over 5,000), *C. modestus* (over 1,000) and *Larus maculipennis*. Nearctic migrants include *Pluvialis dominica*, *Limosa haemastica* (up to 1,000 on passage in April/May and October), *Tringa melanoleuca*, *T. flavipes*, *Calidris canutus* (up to 20,000 on passage in April and May), *C. alba*, *C. fuscicollis* (many thousands), *C. melanotos* and *Sterna hirundo* (up to 8,000 in April and May). Common resident shorebirds include *Haematopus palliatus*, *Vanellus chilensis* and *Himantopus himantopus*.

Other fauna: No information.

Threats: Drainage of marshes at Lagoa do Fundo and Lagoa Pai Joao for forestry; fish farming with exotic species at Lagoa do Peixe; and destruction of coastal habitat for tourist recreation, particularly in the north. Forestry projects are affecting wind patterns and hence the movement of sand dunes, which has had a detrimental effect on some lakes. Proposals have been made to alter water levels in Lagoa do Peixe to improve fishing.

Research and conservation: Some shorebird censuses and banding programmes have been carried out by CEMAVE, the Fundacao Zoobotanica do Rio Grande do Sul, and the University of Porto Alegre. Chomenko (1981) and Schwarzbald (1982) have conducted limnological studies at all the lakes; and a research project on the importance of Lagoa do Peixe for waterfowl has recently been initiated by Susana de Moura Lara-Resende. Areas particularly worthy of protection include Lagoa do Peixe and surrounding areas; Lagoa Tuneira in the south; Lagoa Rebeca, Lagoa Cinza, Lagoa Papagaio I and II, and Lagoa Ponche in the north; and the oligotrophic lakes Moleques and Figueira.

References: Chomenko (1981); Schwarzbald (1982); Morrison (1983a); Belton (1984).

Source: Paulo de Tarso Zuquim Antas, Susana de Moura Lara-Resende, Flavio Silva and Walter A. Voss.

Criteria for inclusion: 123.

Lagoa dos Patos (39)

Location: 29°55'-32°00'S, 50°20'-52°15'W; south of Porto Alegre, Rio Grande do Sul.

Area: 1,567,000 ha (Lagoa dos Patos 985,000 ha; other lakes and marshes 582,000 ha).

Altitude: 0-10m.

Province and type: 8.32.11; 09, 12, 13, 16 & 17.

Site description: Lagoa dos Patos, the largest lake in Brazil, is a deep freshwater lake 250 km long by 50 km wide with a wide connection with the sea at Rio Grande in the south which enables shipping to enter the lake and service a large port at Porto Alegre in the extreme north. In the surrounding low-lying areas there are some 135 freshwater lakes of 100 to 2,000 ha in extent, extensive marshes, and large areas of seasonally flooded grassland and rice cultivation. Two of the most important areas for wildlife are the Lagoa do Capivari marshes (500 ha) and Pontal dos Gateados complex of lakes, marshes and wet grassland (5,000 ha) to the northeast of the main lake.

Principal vegetation: Freshwater marshes with *Scirpus* spp, *Zizaniopsis* sp, *Eichhornia crassipes*, *E. azurea* and *Salvinia* sp; and woodland and shrubbery with *Salix* sp, *Mimosa bimocronata*, *Cephalanthum glabratus* and *Erythrina cristagalli*. Pastureland and rice cultivation in surrounding areas.

Land tenure: Mainly private ownership.

Protection: None.

Land use: Fishing, cattle and horse ranching, rice cultivation and sport hunting.

Waterfowl: An extremely important area for waterfowl, with large breeding populations of Ardeidae, Threskiornithidae and Anatidae, particularly in the extensive marshes to the northeast of Lagoa dos Patos. There are several large mixed breeding colonies in the Lagoa do Capivari and Pontal dos Gateados areas, the largest with some 15,000 pairs. The principal species are *Phalacrocorax olivaceus*, *Nycticorax nycticorax*, *Bubulcus ibis*, *Butorides striatus*, *Egretta thula*, *E. alba*, *Ardea cocoi*, *Euxenura maguari*, *Phimosus infuscatus*, *Plegadis chihi* and *Ajaia ajaja*. Other breeding species include *Botaurus pinnatus*, *Harpiprion caerulescens*, *Chauna torquata*, *Dendrocygna bicolor*, *D. viduata*, *Anas versicolor*, *Amazonetta brasiliensis*, *Aramus guarauna*, *Rallus sanguinolentus*, *Gallinula chloropus*, *Porphyryla martinica*, three species of *Fulica*, *Jacana jacana*, *Vanellus chilensis*, *Himantopus himantopus* and *Larus maculipennis*. *Coscoroba coscoroba* breeds at Pontal dos Gateados at the northern limit of its range in Brazil. The area is also important for wintering Anatidae from southern South America, and Nearctic shorebirds, particularly *Pluvialis dominica*, *Tringa* spp, *Calidris melanotos* and *Tryngites subruficollis*.

Other fauna: The marshes support a very large breeding population of *Rostrhamus sociabilis*. Mammals include *Hydrochoerus hydrochaeris* and *Myocastor coypus*; and reptiles include *Caiman latirostris* and *Platemys spixii*. The whole system supports an extremely important fishery.

Threats: There is a considerable amount of pollution in Lagoa dos Patos from the city, port and industrial areas of Porto Alegre in the north and Rio Grande in the south. Petrochemical installations and a cellulose factory near Porto Alegre are particularly harmful. In the surrounding wetlands, the principal threat is drainage for pastureland and rice cultivation. Hunting is inadequately controlled, and the breeding colonies of Ciconiiformes are heavily persecuted by egg collectors.

Research and conservation: The Federal University of Rio Grande do Sul has conducted limnological studies, and biologists from IBDF and the Fundacao Zoobotanica do Rio Grande do Sul have banded waterfowl, particularly Ardeidae and Threskiornithidae.

References: Belton (1984).

Source: Flavio Silva.

Criteria for inclusion: 123.

Lagoa Mirim, Lagoa Mangueira and the Taim marshes (40)

Location: 32°10'-33°40'S, 52°30'-53°30'W; near the Uruguayan border in extreme southeastern Brazil, Rio Grande do Sul.

Area: 850,000 ha (Lagoa Mirim 230,000 ha; Lagoa Mangueira 80,200 ha).

Brazil

Altitude: 0-5m.

Province and type: 8.32.11; 05, 07, 12, 13, 16 & 17.

Site description: Lagoa Mirim is a brackish lake with a hard sand and mud shoreline, and relatively little aquatic vegetation; its total area is approximately 330,000 ha, of which 230,000 lie in Brazil and the remainder in Uruguay (see Uruguay site 9). Lagoa Mangueira (80,200 ha) is a long narrow freshwater lake, up to 4m deep, paralleling the coast to the east of Lagoa Mirim. The rest of the area is a vast complex of some 120 shallow freshwater lakes and marshes, seasonally flooded grassland, rice cultivation, and higher areas of dry savanna and native woodland, with a broad strip of coastal sand dunes and ocean beach in the east. The larger lakes include Lagoa Caiuba (1,750 ha), Lagoa da Flores (1,130 ha), Lagoa Nicola (258 ha) and Lagoa Jacare (145 ha).

Principal vegetation: Freshwater lakes and marshes with *Scirpus californicus*, *Zizaniopsis bonariensis*, *Paspalidium paludivagum*, *Myriophyllum brasiliensis*, *Ceratophyllum demersum*, *Cabomba australis*, *Eichhornia crassipes*, *E. azurea*, *Pistia stratiotes*, *Echinodorus grandiflorus* and *Salvinia* sp; scattered shrubs of *Cephalatum*, *Mimosa* and *Salix*; patches of native woodland with *Ficus enormis*, *Erythrina cristagalli* and bromeliads; and sand dune vegetation in the east. Also plantations of *Pinus* and *Eucalyptus*.

Land tenure: Mainly under private ownership in large ranches; the Ecological Station is owned by SEMA.

Protection: 32,038 ha of lakes, marshes and wet grassland, including Lagoa Nicola, Lagoa Jacare and the northern end of Lagoa Mangueira, are protected in the Taim Ecological Station. The remainder of the area is unprotected.

Land use: Cattle, sheep and horse ranching; cultivation of rice and soya beans; fishing; sport hunting; and some forestry. Water is taken from some of the lakes for rice cultivation, and there is commercial fishing in Lagoa Mangueira. An international highway passes through the middle of the area (and the Ecological Station).

Waterfowl: One of the richest areas for waterfowl in South America, with a great diversity of resident breeding species, winter visitors from southern breeding areas, and passage and "wintering" Nearctic shorebirds. Over sixty species of waterfowl were observed during a three day visit to the Taim area in January 1982. Common breeding species include *Podilymbus podiceps*, *Rollandia rolland*, *Podiceps major*, *Phalacrocorax olivaceus*, *Nycticorax nycticorax*, *Syrigma sibilatrix*, *Butorides striatus*, *Egretta thula*, *E. alba*, *Ardea cocoi*, *Mycteria americana*, *Euxenura maguari*, *Harpiprion caerulescens*, *Phimosus infuscatus*, *Plegadis chihi*, *Ajaia ajaja*, *Chauna torquata*, *Dendrocygna viduata*, *Coscoroba coscoroba*, *Cygnus melancoryphus*, *Anas flavirostris*, *A. georgica*, *A. versicolor*, *Netta peposaca*, *Amazonetta brasiliensis*, *Heteronetta atricapilla*, *Aramus guaranauna*, *Aramides ypecaha*, *Porphyriops melanops*, *Gallinula chloropus*, *Fulica armillata*, *F. leucoptera*, *F. rufifrons*, *Jacana jacana*, *Haematopus palliatus*, *Vanellus chilensis*, *Charadrius collaris*, *Gallinago (g) paraguayiae*, *Himantopus himantopus*, *Larus maculipennis*, *Phaetusa simplex*, *Sterna superciliaris* and *Rynchops niger*.

Large numbers of southern Anatidae and shorebirds visit the area in the austral winter, including *Anas sibilatrix*, *Charadrius falklandicus* and *C. modestus*. *Phoenicopterus chilensis* occurs in small numbers, and *Nycticryphes semicollaris* has been recorded. Common Nearctic migrants during the migration seasons and in the austral summer include *Pluvialis dominica*, *Limosa haemastica*, *Tringa melanoleuca*, *T. flavipes*, *Calidris alba*, *C. fuscicollis*, *C. melanotos*, *Micropalama himantopus* and *Tryngites subruficollis*.

Other fauna: Birds of prey are common, and include *Rostrhamus sociabilis*, *Circus cinereus*, *C. buffoni* and *Falco peregrinus*. Mammals include *Hydrochoerus hydrochaeris*, *Myocastor coypus* and *Blastocerus dichotomus*; and reptiles include *Caiman latirostris* and *Platemys* sp.

Threats: The principal threats are drainage of wetlands for pastureland and cultivation, and the extensive use of pesticides on agricultural land. Grasslands are heavily overgrazed; there is a considerable amount of illegal hunting; and breeding colonies of Ardeidae and Threskiornithidae are persecuted by egg collectors. Wardening in the Ecological Station is reported to be inadequate.

Research and conservation: There are excellent facilities for research at Taim Ecological Station, and a number of faunal and floral surveys have been carried out there. The Fundacao Zoobotanica do Rio Grande do Sul and CEMAVE have banded waterfowl, and Schwarzbald (1982) has conducted limnological studies of some lakes.

References: Marigo (1977); MINTER & SEMA (1977); Schwarzbald (1982); Morrison (1983a); Belton (1984).

Source: Susana de Moura Lara-Resende, Flavio Silva and Walter A. Voss.

Criteria for inclusion: 123.

The lower Rio Ibicui and Rio Uruguay marshes (41)

Location: 28°40'-29°40'S, 56°05'-56°55'W; between Sao Borja and Uruguaiana, Rio Grande do Sul.

Area: 107,500 ha.

Altitude: 60m.

Province and type: 8.32.11; 09, 11, 12, 16 & 17.

Site description: A complex of freshwater lakes and seasonally inundated alluvial plains along the Rio Ibicui and its tributaries, with extensive areas of rice cultivation. Much of the natural wetland habitat has been converted into rice fields.

Principal vegetation: No information.

Land tenure: Privately owned.

Protection: None.

Land use: Rice cultivation and grazing.

Waterfowl: Belton records over 55 species of waterfowl typical of the basin of the Rio de La Plata. Residents include *Anhinga anhinga*, *Botaurus pinnatus*, *Ixobrychus involucris*, *Tigrisoma lineatum*, *Euxenura maguari*, *Phimosus infuscatus*, *Chauna torquata*, *Dendrocygna bicolor*, *D. viduata*, *Amazonetta brasiliensis*, *Cairina moschata*, *Oxyura dominica*, *Aramus guarana*, *Aramides ypecaha*, *Porphyriops melanops*, *Gallinago (g.) paraguayiae*, *Phaetusa simplex*, *Sterna superciliaris* and *Rynchops niger*. Migrant include a variety of Anatidae and *Charadrius modestus* from the south, and *Pluvialis dominica*, *Bartramia longicauda*, *Tringa* spp, *Calidris fuscicollis* and *C. melanotos* from the Nearctic.

Other fauna: No information.

Threats: Continuing drainage of wetlands for agriculture.

Research and conservation: The avifauna of the region has been studied by Belton (1984).

References: Belton (1984).

Criteria for inclusion: 0.

Dams in Brazil (42)

Type: 15.

Site description: In recent decades, a number of enormous dams have been constructed in Brazil for hydroelectricity, irrigation and water supply to urban centres. Many others are under construction or in the planning stages, and within the next twenty years virtually every major river in the country will have been dammed, sometimes in several places. Some of the principal dams already completed are as follows:

Boa Esperanza Dam: 6°40'7"30'S, 43°30'45"00'W; on the upper Rio Parnaiba, Maranhao and Piaui; 155,000 ha; 110m above sea level.

Abras Dam: 4°20'S, 40°27'W; on the upper Rio Acarau, Ceara; 28,500 ha; 200m.

Oros Dam: 6°15'S, 39°00'W; on the upper Rio Jaguaribe, Ceara; 32,500 ha; 200m.

Sao Francisco Dam: 9°00'11"20'S, 40°50'43"10'W; on the Rio Sao Francisco, Bahia; 900,000 ha; 380m.

Parnaiba Dams: 19°35'20"48'S, 50°40'51"38'W; two contiguous dams on the Rio Parnaiba, Mato Grosso do Sul, Sao Paulo and Minas Gerais; 150,000 ha; 305m.

Tres Marias Dam: 18°30'S, 45°15'W; on the upper Rio Sao Francisco, Minas Gerais; 120,000 ha; 595m.

Furnas Dam: 20°30'21"30'S, 45°15'46"20'W; on the Rio Grande and lower Rio Sapucaí, Minas Gerais; 180,000 ha; 745m.

Rio Tiete Dams: 21°25'S, 49°30'W; a chain of dams on the Rio Tiete, Sao Paulo; over 100,000 ha; 400m.

Paranapanema Dam: 23°15'S, 49°00'W; on the Rio Paranapanema, Sao Paulo; 60,000 ha; 570m.

Brazil

Itarare Dam: 23°20'S, 49°40'W; on the Rio Itarare, Sao Paulo and Parana; 65,000 ha; 550m.

Passo Fundo Dam: 27°40'S, 52°45'W; on a tributary of the Rio Uruguay, Rio Grande do Sul; 15,000 ha; 550m.

Rincao da Estrela Dam: 28°55'S, 53°10'W; on the upper Rio Jacui, Rio Grande do Sul; 35,000 ha; 300m.

Itaipu Hydroelectric Dam: 24°30'S, 54°20'W; on the Rio Parana on the Paraguayan border, Parana; 146,000 ha; 195m.

Large dams completed, under construction, or in the planning stages in the Amazon Basin are listed under site 1.

Most of the dams have deeply indented shorelines, widely fluctuating water levels, and little aquatic vegetation, except at river mouths. In general, they are of little importance for native wildlife, although some have developed important fisheries following the introduction of exotic species. Several dams are known to be of importance for Nearctic shorebirds on migration (e.g. the Parnaiba, Rio Tiete and Paranapanema dams), and some resident waterfowl have adapted well to the new conditions, particularly *Phalacrocorax olivaceus*, several Ardeidae and *Dendrocygna viduata*. In the east and northeast, the rare *Netta erythrophthalma* has recently begun to occur in significant numbers on dams.

Tundisi (1981) has conducted limnological studies at 35 dams in Sao Paulo State, and researchers elsewhere are increasingly taking an interest in these new water bodies, but on the whole, the importance of the dams for wildlife and their ecological effects on neighbouring and downstream areas remain poorly known.