World Heritage Sites

Protected Areas and World Heritage

CENTRAL AMAZON CONSERVATION COMPLEX
BRAZIL

This immense 4.9 million square hectare complex of tropical rainforest protects one of the most biodiverse regions in the world. In Jaú National Park it includes one of the best examples of a blackwater (igapó) flooded ecosystem. In Mamiraua Reserve it includes one of the best examples of a whitewater (várzea) seasonally flooded forest with undisturbed dry tropical (terra-firme) forest between them. The site protects the largest array of electric fish in the world and key threatened species such as the giant arapaima fish, Amazonian manatee, black caiman and two species of river dolphin. The biodiversity includes examples of speciation accelerated by the extreme conditions which has resulted in a high degree of endemism. The area is a constantly changing mosaic of habitats extensive enough to contain processes such as wind-blows, floods and burns, providing opportunities to study their effect on the biodiversity of natural ecosystems on a large scale.

COUNTRY
Brazil

NAME
Central Amazon Conservation Complex

NATURAL WORLD HERITAGE SERIAL SITE
2000: Jaú National Park inscribed on the World Heritage List under Natural Criteria ix and x:
2003: Mamirauá Sustainable Development Reserve Focal Zone, Amanã Sustainable Development Reserve and Anavilhanas Ecological Station inscribed on the World Heritage List as extensions to Jau National Park under Natural Criteria ix and x.
Designation of the remainder of Mamirauá Reserve was deferred and may be included later.

STATEMENT OF OUTSTANDING UNIVERSAL VALUE [pending]
The UNESCO World Heritage Committee issued the following statement at the time of inscription:

Justification for Inscription

Criterion (ix): The varzea and igapó forests, lakes, rivers, and islands of the proposed site together constitute physical and biological formations and demonstrate ongoing ecological processes in the development of terrestrial and freshwater ecosystems. They include a constantly changing and evolving mosaic of river channels, lakes, and landforms. The floating (and constantly moving and changing) mats of vegetation typical of the varzea watercourses include a significant number of endemic species, including the largest array of electric fishes in the world. Anavilhanas contains the second largest archipelago of river islands in the Brazilian Amazon.

Criterion (x): The expanded property substantially increases the already impressive protection offered by Jaú National Park to the biological diversity, habitats, and endangered species found in the Central Amazon region. The area is one of the Endemic Bird Areas of the World, is considered as one of the World Wildlife Fund's 200 Priority Ecoregion for Conservation, and it is also a Centre of Plant Diversity. The expansion of Jaú National Park to include an important sample of Varzea ecosystems, igapó forests, lakes and channels significantly increases the representation of the aquatic biodiversity of the Central Amazon region. Expansion of the site also enhance the protection of key threatened species including giant arapaima fish, the Amazonian manatee, the black caiman, and two species of river dolphins.

INTERNATIONAL DESIGNATION
1993: Mamirauá designated a Wetland of International Importance under the Ramsar Convention (1,124,000 ha).

2001: The Complex designated the core area of the Central Amazon Biosphere Reserve (20,859,987 ha) under the UNESCO Man & Biosphere Programme.

IUCN MANAGEMENT CATEGORIES

Jaú National Park:	II National Park
Mamirauá Sustainable Development Reserve:	VI Managed Resource Protected Area
Amanã Sustainable Development Reserve:	V Protected Landscape
Anavilhanas Ecological Station:	Ia Strict Nature Reserve

BIOGEOGRAPHICAL PROVINCE

Amazonian (8.5.1)

GEOGRAPHICAL LOCATION

The four Reserves lie west and northwest of Manaus between the Rio Solimões/Amazon & Rio Negro.

Jaú National Park is 200 km northwest of Manaus, It covers the Rio Jau watershed, extending 340 km west of the confluence of the Jaú and Negro rivers between 1°40' to 3°00'S and 61°26' to 64°00'W.

Mamirauá Reserve lies on the north bank of the Solimões/Amazon river 540-800 km west of Manaus. The core lies between the Rio Solimões and the Rio Japurá, centred on 3º 33'S by 64º 68'W.

Amanã Reserve lies between Jaú National Park and the east bank of the Rio Japura adjoining the

Mamirauá Reserve, 350 to 620 km west of Manaus, centred on 3º 48'S by 63º 52'W.
Anavilhanas Ecological Station lies along the east bank of the Rio Negro 50-170km northwest of centred on 3º25'S / 60º50'W.

DATES AND HISTORY OF ESTABLISHMENT

1980: Jaú National Park established;

1981: Anavilhanas Ecological Station on the Rio Negro established by Federal decree 86.061;

1990: Mamirauá State Ecological Station established with a core area of 260,000 ha;

1993: Mamirauá designated a Ramsar Wetland site;

1996: Mamirauá decreed a Sustainable Development Reserve *(Reserve de Desenvolvimento Sustentável Mamirauá)* by Amazonas state government (1,124,000 ha);

1997: Amanã decreed a Sustainable Development Reserve by the Amazonas state government; Jaú National Park Management Plan published;

1999: Anavilhanas Ecological Station management plan published;

2000: Jaú National Park inscribed as a Natural World Heritage site;

2001: The three Reserves designated the UNESCO Central Amazon Biosphere Reserve and the core area of the UNESCO Central Amazon Ecological Corridor;

2001: Mamairauá Reserve won a UNESCO award in the 'Science and Environment' category;

2003: The four Reserves inscribed as the WH Central Amazon Conservation Complex;

2004: The NGO *Sociedade Civil Mamirauá* awarded a UNDP Equator Prize for establishing two Sustainable Development Reserves.

LAND TENURE

State of Amazonas. The Federal government owns 98.3% of Jaú National Park; 1.7% (almost 39,000 ha) is comprised of 31 legally held properties which are to be repossessed by the state by incorporation into the patrimony of *the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renovaveis* (IBAMA); a further 1.5% of government land on the Unini River is settled by 175 families without ownership title (*posseiros*) which the government is seeking funds to repossess (Pinheiro, 1999).

Jau is administered by the Brazilian Institute of the Environment and Natural Resources (IBAMA) assisted by the Vitória Amazônica Foundation (FVA). Mamirauá is administered by the *Sociedade Civil Mamirauá* (SCM) and the Mamirauá Institute for Sustainable Development *(Instituto de Desenvolvimento*

Sustentável Mamirauá, (IDSM) which sponsors conservation with participatory sustainable development. Amanã is also administered by the IDSM. Anavilhanas is managed by IBAMA with the Institute for Ecological Research (*Instituto de Pesquisas Ecologicas,* IPE).

AREAS

Total area: 5,323,018 ha (UNESCO, 2011) with a proposed 20 km buffer strip around the whole periphery.
The areas given in the nomination documents total 5,232,086 ha:

Amanã Sustainable Development Reserve:	2,350,000 ha
Jau National Park:	2,272,000 ha
Anavilhanas Ecological Station:	350,086 ha
Mamirauá State Ecological Station:	260,000 ha (Focal or Demonstration zone only)

Mamirauá Sustainable Development Reserve beyond the focal zone (864,000 ha) is not included within the World Heritage site. The total Complex area cited by WDPA (6,096,000 ha) includes this.

ALTITUDE

Mamirauá, below 80m; Amanã and Jaú, 200m and below; Anavilhanas, 30-600m.

PHYSICAL FEATURES

Jaú: The National Park includes the whole 1,000,000 ha watershed of the 300 km-long Rio Jaú which has some 1500 sources and a total length of tributaries of about 5,700 km. The Park extends to the Carabinani river to its south and to the Unini river and its tributary the Paunini on its north. It is geographically intermediate between the oldest and the most recent sedimentary formations of the Amazon Basin. Nearly 65% is part of the Palaeocene and Pleistocene Solimões Formation, a very extensive sedimentary deposit composed of table uplands which form barriers to the drainage. Other formations within the Park include the older Palaeocene Prosperança and Trombetas formations, which underlie 17% and 8% of the Park respectively. Here there are more flat-topped hills 150 to 200m high with often deep sharply dissected V-shaped valleys. Quaternary sediments formed part of glacial period marine regressions which resulted in the carving of valleys later filled by sediments, which are the basis of the present drainage pattern. The dry forest soils are yellow laterite and latosols.

The rivers of the Park are lined with beaches of white sand and white nutrient-poor kaolinic hydromorphic soils during the dry season and flood over the surrounding forest during the wet season. There are secondary waterways of differing sizes: *igarapés* (streams), *paranás* (braided channels separated from a river by strips of unflooded land) and *ria* lakes, typical of large rivers in the Amazon region. There is also a nine-tier waterfall on the tributary Carabinani river. The Park contains quite a large area of black-water drainage, which originates in the Guyana Shield, and gives Rio Negro its name. Its dark colour results from organic acids released by the decomposition of organic matter and the lack of terrestrial sediments. Flooding is highest during June and July when lakes can flood between 5.7-10.5 meters. Streams flood only up to 3 meters and have less biomass but a greater diversity of species. pH levels are low: highest during the dry season in late fall and at 2.7 are near the limit for many aquatic organisms. The *terra-firme* streams are clear, cool and acidic, the lakes clear but warmer.

Mamirauá: The Reserve is in the flooded forests of the Amazonian lowlands between the Rio Solimões (upper Rio Amazonas), the Rio Japurá and the Auti channel connecting them. It is in the *várzea* or white-water flood forest where the nutrient-rich water is ochreous with suspended sediment and is very fertile. The forested floodplain of lakes and channels, former channels, pools and backwaters, beaches and levees is annually modified by 10-12 meter floods; a regime in constant fluctuation between high and low water which is continually forming and dissolving land. These create two major habitats: *restingas* - forested levees flooded 4-5 months a year, which are banks of higher sedimentation and stabilised rich alluvial soils, and *chavascais* - low-lying open shrubby swamp woodland flooded 8-9 months a year, with grey-brown or red-yellow hydromorphic soils. Water levels can vary up to 15m over 5-6 year period, flooding over a million hectares, covering nearly all of the Reserve, and dominating the biological and ecological processes of the region. The area of *restinga* is about 44.3% of the reserve, *chavascai* covers about 14.2%, open water 10.2% and other areas 31.3%.

Amanã: The Reserve extends from the east bank of the Rio Japurá to the headwaters of the upper Unini and Paunini rivers which flow east bordering the Jaú National Park, connecting it with Mamairauá. Near its western edge is the 40 x 5 km Lake Amanã, one of the largest lakes of the Amazon region. The main

western access is via channels to Lake Amanã, the eastern access is via the Unini, Paunini and Preta rivers. There are four terrestrial ecosystems: *várzea* forest, flooded by white water from the Rio Japurá (20%), *igapó* forest, flooded by black water in the lake (10%), *campina* of dry shrub grasslands, and *terra-firme* forest of tall dry unflooded forest on rather poor soils, both lowland and sub-montane, which covers the most of the reserve. Near the Jaú National Park there are flat-topped hills 150 to 200m high with often deep sharply dissected V-shaped valleys.

Anavilhanas: A unique 1,000,000 ha riverine archipelago of elongated islands shifting over time with the annual floods of the Rio Negro, the largest tributary of the Amazon. Blackwater rivers, known as 'hunger rivers' are colored by their high dissolved humus content and have low nutrient levels and biomass. The river here is 1- 3km wide and flood levels can fluctuate by 10 meters. There are also 250,000 ha of dry forest. There are many channels of differing sizes, *paranás* (braided channels separated from the main river by strips of unflooded land) and *ria* lakes. The islands form from parallel banks of sediment washed from the Guyanan Shield and from intense flocculation with decomposing organic matter in the acidic water of the Rio Negro (pH, 3.2 - 5.5). The river is bordered by silt and white nutrient-poor kaolinic hydromorphic soils. The *terra-firme* streams are clear, cool and acidic, the lakes clear but warmer. The dry forest soils are yellow laterite and latosols

CLIMATE

The area has a hot humid tropical climate where the seasons are defined by the rainfall which ranges between 1,750 and 2,500mm per year. At Anavilhanas Ecological Station on the Rio Negro, southeast of Jau, an average annual rainfall of 2,075mm is recorded. Temperatures can vary more diurnally than seasonally. The annual average temperature is 26ºC, ranging between an average maximum of 30ºC and 33ºC in November when rainfall and water levels are lowest, and an average minimum of 21ºC - 23ºC as rainfall and water levels rise to a maximum in June. Higher land in Amanã Reserve is slightly cooler

VEGETATION

Jaú: The tall dry forest cover of the Park is part of the continuous forest of the Amazon central plain. Its landscape is typical of the lower Rio Negro, characterised in a 1978 survey by Radam Brasil as: a) dense tropical forest, mainly on unflooded *terra firme*, generally very stratified, with a layer of large emergent trees and averaging 180 plant species per hectare (Ferreira *et al*., 1996); b) open tropical *igapó* blackwater flooded forest, associated with wide soil and climatic transitions. This is characterised by low trees with thin trunks, with many bromeliad and orchid epiphytes; it grows on sandy nutrient-poor soils and averages 108 plant species per hectare (Ferreira *et al*., 1996); and c) *campinarana* or Rio Negro *caatinga*, a tall dry shrub-woodland mosaic restricted to the Rio Negro region which grows primarily in well drained uplands. It is dominated by tall trees; epiphytes and lianas are very rare. Within each of these macrohabitats is a variety of vegetation types including *chavascai* swamp and grassland. Dominant families at the Jaú river mouth are *Palmae, Leguminosae* and *Chrysobalanaceae*, and of the middle reaches, *Leguminosae, Burseraceae, Palmae, Myristicaceae* and *Moraceae. Protium grandiflorum* is a common dominant along the river. Palms exist in both canopy and understorey of all types of forest, the predominant palms in non-flooded areas being *Mauritia miriti* and *M. carana*.

Mamirauá: *Várzea* white-water flood-forest is characterised by a series of successional sequences due to regular flooding; also by secondary growth along settled watercourses. Its waterlogged forests are formed of three main communities: tall forested *restinga*, flooded no more than 2.5m deep, more open low *restinga* flooded deeper than 2.5m, and *chavascai* shrub-swamp. These are all adapted to a regime with extremes of change between continual flooding and drought. The high *restingas* have the greatest density and diversity of botanical species - almost 200 species of trees and lianas - though this is barely more than half the number found in *terra-firme* forest. The dominant plant families are *Annonaceae* (16.4%), *Euphorbiaceae* (10.5%), *Leguminosae* (7.8%), *Apocynaceae* (7.4%), *Lecythidaceae* (6.0%) and *Lauraceae* (5.2%). Some of the largest trees in the Amazon are abundant in this community. These include the buttress-trunked *Ceiba pentandra, Hura crepitans,* and *Parinari excelsa. Ceiba pentandra* found on the high edge of the *várzea* is an important timber species as are *Manilkara amazonica*, *Carapa guianensis*, *Iryanthera surinamensis;* also baboonwood *Virola surinamensis* (EN) and *Calycophyllum spruceanum,* which are restricted to wetland.

Other trees characteristic of the *várzea* forest are *Parkia inundabilis*, *Septotheca tessmannii*, *Coumarouna micrantha*, *Ceiba burchellii*, *Ochroma lagopus*, and *Manilkara inundata* and the locally threatened species *Cedrela odorata, Platymiscium ulei, Calophyllum brasiliense,* and *Xylopia frutescens.* There is often a dense understory of large-leaved herbaceous plants of the *Zingiberaceae, Maranthaceae* and *Heliconiaceae* families. The low *restingas*, with clear understories and good visibility, are dominated

by *Euphorbiaceae* (18.8%), *Leguminosae* (16.0%), *Lecythidaceae* (7.0%), *Annonaceae* (5.5%), and *Myrtaceae* (5.8%). The most abundant species are *Pterocarpus amazonicus, Piranhea trifoliata, Eschweilera albiflora* and *Neoxythece elegans.*

The *chavascais* are sparsely forested and inaccessible, with many lianas, briars, shrubs and grasses. These include shrubs such as *Palicouria fustigiata, Bauhinia* co*rniculata, Bonafonsia juruana,* the grass *Oryza grandiglumis* and lianas like *Cayaponia amazonica* and *Mimosa pelliata* which are abundant. *Chavascais* have lower species diversity but higher basal areas. The most frequent trees are pioneer species such as *Cecropia latiloba*, *Pseudobombax munguba, Nectandra amazonum, Symmeria paniculata,* and the palm *Astrocaryum jauari*. *Ficus* spp. though not frequent, provide most of the basal area of the habitat. There are clumps of Columbian thorny bamboo such as *Guadua* angustifolia, much used for construction.

Other small or seasonal plant communities are found in Mamirauá. Palm groves are dominated by *Astrocaryum murumuru, A. jauari,* the endemic *Bactris tefensis, Mauritia flexuosa, Attalea* sp.and the wetland cabbage palm *Euterpe oleracea.* They are always close to the high *restingas* where they are less subject to flooding. Grasslands appear in the dry months as enclaves in the *chavascais* or other land previously under water. The aquatic flora overlaps the terrestrial flora. Its diversity is relatively high: with 30 species of submerged and floating aquatic macrophytes. There are over 10 species of rooted plants with water-borne leaves and stems, generally *Gramineae* that are terrestrial when floodwater is absent, plus opportunistic *Cyperaceae*. Almost 20 species of trees and shrubs adapted to flooding are counted as aquatic flora, part of the floating grasslands which compose the habitat richest in biomass of the *várzea*. The most significant macrophytes are *Paspalum* sp., *Salvinia* sp., *Eichnochola* sp., *Pistia* sp., *Azola* sp., *Eichornia* sp.and *Utricularia* sp. Fruit trees, such as the yellow mombim, are critical to the survival of fruit-eating fish that enter the forest understorey during the flood. *Spondias mombim*, jauari palm *Astrocaryum jauari*, *Rollinia deliciosa*, *Vitex cymosa* and *Ficus* spp.

In **Amanã** the tall dry *terra-firme* forest both lowland and sub-montane, is part of the continuous forest of the Amazon central plain. It is interrupted only along the *várzea* whitewater flooded margins of Rio Japurá (20%), the *igapó* blackwater flooded upper Lake Amana (10%), and by areas of *campina* dry grassy shrub-woodlands. Amanã Reserve offers a wide array of aquatic habitats, with both white and black waters and the clear waters of the *terra-firme* streams (*igarapés*) and lakes. The forests have a medium-high, 25 to 30m open canopy or a dense canopy with emergent trees of up to 40m. Leading tree families are *Leguminosae, Sapotaceae, Rubiaceae, Chrysobalanaceae, Lauraceae,* and *Annonaceae.* In the high forest there are many valuable timber trees including the *várzea* species *Ceiba pentandra, Hura crepitans* and *Calophyllum brasiliense* and *terra-firme* tree species *Mezilaurus itauba* and *Virola surinamensis.* Economically important trees on the *terra-firme* are the Brazil nut *Bertholletia excelsa*, *Bowdichia virgilioides*, and rubber *Hevea spruceana*. All these trees have been drastically reduced elsewhere in the Amazon and, where accessible near Lake Amanã, have already begun to suffer unregulated exploitation.

Anavilhanas has a landscape typical of the lower Rio Negro valley, which has some of the highest biodiversity in the world. In 1996 it was described by Ferreira *et al.* as: a) dense *terra-firme* forest, mainly lowland (<100m) and submontane (100-600m), dense and very stratified, with a 30-40m canopy broken by isolated 50m emergent trees and 185 plant species per hectare; b) *igapó* seasonally flooded blackwater forest adapted to flooding by aerial root systems and fast growth, having dense low tree growth with thin trunks, many epiphytes and locally abundant palm-trees. It grows on sandy nutrient-poor soils and averages 108 plant species per hectare; c) *campinaranas arbóreas*, or Rio Negro *caatinga-gapo*, a tall dry grassland to shrub-woodland mosaic on some islands and dry lands bordering pristine forests. Adaptation to poor soils has resulted in low diversity but high endemism and there an abundance of bromeliad and orchid epiphytes. Leading families are *Fabaceae* eg: *Aldina heterophylla, Arecaceae* eg: *Euterper catingae* and *Manicaria martiana* and *Caesalpinaceae* eg: *Peltogyne catingae;* and d) *campinas* shrub-woodlands on quartzitic sands, covered by grasses and *Cyperaceae* such as *Lagenocarpus sabanensis* in most areas, with open undergrowth and low trees of the *Melastomataceae, Chrysobalanaceae, Lauraceae, Ochnaceae* and *Rubiaceae.* There are also some *chavascai* shrub-woodland rainwater swamps. The wide range of terrestrial and aquatic habitats is well suited to its function as a research station.

FAUNA

Jaú: The Park protects an impressive range of fauna, with many species associated with blackwater river systems. There is high diversity with 120 species of mammals, including 20 species of rodents and

marsupials, 455 birds, said to be 60% of the birds recorded from the Central Amazon, 150 reptiles and 282 fishes which are approximately 60% of the fish species recorded in the Rio Negro watershed.

Mammal species considered locally threatened include white-bellied spider monkey *Ateles belzebuth* (EN), golden-backed black uakari *Cacajao melanocephalus*, Humboldt's woolly monkey *Lagothrix lagothricha* (VU), giant anteater *Myrmecophaga tridactyla* (VU), giant armadillo *Priodontes maximus* (VU), bush dog *Speothos venaticus* (VU), short-eared dog *Atelocynus microtis,* giant otter *Pteronura brasiliensis* (EN), long-tailed otter *Lontra longicauda,* jaguar *Panthera onca*, puma *Puma concolor*, ocelot *Leopardus pardalis,* South American manatee *Trichechus inunguis* (VU). Threatened reptiles are terrestrial yellow-footed tortoise *Geochelone denticulata* (VU), ten freshwater turtles including the six-tubercled Amazon River turtle *Podocnemis sextuberculata* (VU), yellow-spotted river turtle *P.unifilis* (VU) and South American river turtle *P. expansa.* Rio Jau also has four alligators: black caiman *Melanosuchus niger*, yellow caiman *Caiman crocodilus,* dwarf caiman *Palaeosuchus palpebrosus* and the *jacaretinga, P. trigonatus,* which is locally found only in this river.

Bird species in the *terra-firme* forest number 247 of which 121 are restricted to it. Among these are the harpy eagle *Harpia harpiya,* white-plumed antbird *Pithys albifrons* and black-faced antbird *Myrmoborus myotherinus.* The *igapó* forest has 194 species, 58 being restricted to it. And there are 38 aquatic species including the black-chinned antbird *Hypocnemoides melanopogon* and festive and orange-winged amazon parrots *Amazona festiva* and *A.amazonica.* Invertebrates include 87 families of insects, with 21 families each of the *Coleoptera* and *Ledidoptera,* and 8 species of shrimp.

Mamirauá: Because of flooding, much of the wildlife, except for the ichthyofauna, is higher in endemism than diversity, especially in the *restingas*. The middle to large size vertebrate fauna is similar to that of the surrounding *terra-firme* forests, but less diverse since only tree-dwelling or swimming animals are able to survive the floods. Animals in the *várzea* also suffer from hunting and the habitat loss and fragmentation increasingly found throughout the settled Amazon. The mammals include Ega long-tongued bat *Scleronycteris ega*, two endemic primates, the red-and-white uakari monkey *Cacajao calvus calvus* (VU) which is found only within the Reserve and the black-headed squirrel monkey *Saimiri vanzolinii* (VU). It contains white saki *Pithecia albicans* (VU), endemic emperor tamarin *Saguinus imperator*, mustached tamarin *S. mystax,* Nancy Ma's night monkey *Aotus nancymaae*, doubtful titi monkey *Callicebus dubius*, all of which have narrow distribution. There are also capybara *Hydrochoeris hydrochaeris,* black agouti *Dasyprocta fuliginosa* and spotted paca *Cuniculus paca, Felix* spp.,jaguar and lowland tapir *Tapirus terrestris*. (VU). White-lipped peccaries *Tayassu pecari* and probably brocket deer *Mazama americana* enter to feed when it is possible. Two freshwater mammals are endemic to the region: the South American manatee (VU) and the boto or pink dolphin *Inia geoffrensis* forage over the flooded land. Other aquatic mammals include the tucuxi or grey dolphin *Sotalia fluviatilis*, giant otter (EN) and long-tailed otter *Lontra longicaudis.*

About 340 species of birds are found in Mamirauá, among them the recently discovered Klage's antwren, *Mirmutherula klagesi*. The diversity increases from east to west but is only moderately rich as there is no *terra-firme* forest. There are bird species with restricted distribution such as the wattled curassow *Crax globulosa* (EN), and the horned screamer *Anhima cornuta*. Other birds that stand out include the macaws *Ara* spp., tinamous *Crypturellus* spp., parrots *Amazona* spp. and *Piona* spp. There are many aquatic birds such as herons *Egretta, Ardea* and *Bulbulcus* species, sharptailed and buffnecked ibis *Cercibis oxycerca* and *Theristicus caudatus,* roseate spoonbill *Ajaia ajaia* and ducks *Dendrocygna* spp.

The lack of terra firme also limits the diversity of the herpetofauna. Even at 72 species this is relatively low compared with other areas of the Amazon. In the core area there have been recorded 34 species of frogs and toads, 3 worm-salamanders, 15 lizards, 10 snakes, yellow-footed tortoise (VU) which lives there year-round, 6 freshwater turtles including six-tubercled Amazon River turtle (VU), yellow-spotted river turtle (VU) and South American river turtle and at least two caimans, black and yellow. The snakes include the anaconda *Eunectes murinus*, fer-de-lance *Bothrops asper*, palm pit-vipers *Bothriechis* spp., coral snakes *Micrurus* spp., the bushmaster *Lachesis muta* and boa constrictor *Boa constrictor.*

To date, about 300 species of fish have been recorded in the reserve and adjacent waters, for many of which they are spawning and nursery grounds. This fauna is exceptionally diverse, with the greatest number of species ever recorded for a *várzea* ecosystem, because of the range of aquatic habitats and the wide environmental fluctuations of the hydrologic regime. Very large fish live in these whitewater rivers and during the flood season roam through the flooded forest eating and dispersing fruits from the floodplain trees. They include the giant pirarucu fish *Arapaima gigas,* red-bellied pacu *Piaractus*

brachypomus, Metynnis and *Mylossoma* species, *tambaqui* or black pacu *Colossoma macropomum*, sardinha *Triportheus angulatus* which are all hunted, and the smaller carnivorous piranha *Serrasalmus* spp. Many beautiful ornamental fish are taken from the blackwater tributaries and lakes in this region for aquaria: the discus *Symphysodon discus* and *S. aequifasciata*, hundreds of cichlids in the genus *Cichlasoma*, assorted characins, *Anostomidae,* tetras in the genera *Hemigrammus* and *Aequifasciata,* and *Hyphessobrycon* spp., and many catfish of the families *Aspredinidae, Corydoradinae, Doradidae* and *Loricariidae.*

The richest habitat, with the highest biomass values found in any *várzea* environment, is the floating grasslands, harboring about 100 species during some part of the year with an invertebrate fauna dominated by micro- and macrocrustacea, mollusks, annelids, flatworms, sponges, adult and larval insects, and arachnids. The dominant groups of insects are the *Coleoptera, Hemiptera, Odonata, Ephemeroptera,* and the *Diptera (Chironomideae).* The dominant groups of crustaceans are the *Ostrachoda, Conchostraca* and the *Malacostraca*. In some areas, *Amphipoda* are also common. Macro-crustaceans include four species of crabs, one newly found which is new to science, and two species of shrimp, dominant in the invertebrate fauna of the floating sedges and the flooded forest. Molluscs are common, but not very diverse. Large *Pomaceae* snails are characteristic; *Ostrachoda* are common and *Mysideos* live on the litter of leaves at the bottom. In some places, colonies of *Spongiae* grow in the branches of trees submerged during several months each year.

Amanã: There are many rare and endangered animal species in this reserve which have been drastically reduced elsewhere in the Amazon. These include the golden-backed black uakari monkey, pink dolphin grey dolphin, giant otter (EN), jaguar and harpy eagle, What may be the largest population of South American manatees (VU) inhabits the black waters of Amanã Lake during the dry season, migrating during the flood season to *várzea* forest in Mamirauá, where its preferred foods are abundant. There must be many other species both terrestrial and aquatic that depend on *várzea* and *terra-firme* at different times of the year in search of food or to escape floods. The combination of Mamirauá and Amanã as an ecological unit is therefore important.

There are 25 species of amphibians and 42 species of reptiles, a comparatively small number for the Amazon Basin, but the yellow-spotted river turtle (VU), six-tubercled river turtle (VU) and South American river turtle are found as are the yellow-footed tortoise (VU), black and yellow caiman. Fish species diversity is high but abundance is low. The huge pirarucu fish *Arapaima gigas* is notable. So far 334 species were recorded in the various environments, lakes, rivers and small streams. At the Anavilhanas Ecological Station on the Rio Negro downstream from Jau only 13 of the 53 families found in the Amazon basin were not found: it has approximately 60% of the fish species recorded in the Rio Negro watershed.

60% of the birds recorded from the Central Amazon have been observed in the site area (Borges *et al.*, 1996). Out of 178 species recorded, ninety-six (54%) were passeriforms, eighty-two (46%) non-passerine. Three of the more important families are the *Tyrannidae* (23 species, 13%), *Formicariidae* (22 species, 12%) and *Thraupidae* (13 species, 7.3%). 72% were observed in *terra-firme* environments, 15% on islands and 13% in both. Notable are horned screamer *Anhima cornuta*, Orinoco goose *Neochen jubata*, harpy eagle, black-and-white hawk-eagle *Spizaetus melanoleucus* and wattled curassow (EN).

Anavilhanas also protects an impressive range of fauna, with many species associated with the blackwater ecosystem, the dry forests and the intervening flooded and dry margins. The islands have almost no terrestrial fauna but much of the fauna is adapted to seasonal flooding, migrating horizontally and/or vertically, with life cycles synchronised with the seasonal fruit production. There is a high diversity of vertebrates including a great number of bat species. About 12 species of mammals are listed as threatened in Brazil: Guiana spider monkey *Ateles paniscus* (VU), giant anteater (VU), giant armadillo (VU), many carnivores - jaguar, puma, ocelot, short-eared dog, bush dog (VU), giant otter (EN) and long-tailed otter, South American manatee (VU), grey dolphin *Sotalia fluviatilis* and the boto or pink dolphin *Inia geoffrensis* are abundant.

60% of the birds recorded from the Central Amazon have been observed in the site area (Borges *et al.*, 1996). Out of 178 species recorded ninety-six (54%) were passeriforms, eighty-two (46%) of other orders. Three of the more important families are the *Tyrannidae* (23 species,13%), *Formicariidae* (22 species, 12,5%) and *Thraupidae* (13 species, 7.3%). 72% were observed in *terra-firme* environments, 15% on islands and 13% in both. There are 25 species of amphibians and 42 species of reptiles, a comparatively small number for the Amazon Basin but South American river turtle *Podocnemis expansa* and black caiman are abundant. Anavilhanas has approximately 60% of the fish species recorded in the Rio Negro

watershed. Species diversity is high but abundance is low. So far, 334 species were recorded in the various environments, lakes, rivers and small streams and only 13 of the 53 families found in the Amazon basin were not found in Anavilhanas.

CONSERVATION VALUE

The Complex is the largest protected tropical rainforest in the world and the World Heritage protected area alone is larger than Switzerland. It forms the core of the UNESCO MAB Central Amazon Biosphere Reserve and harbors a unique assemblage of exceptional ecosystems and great biodiversity. It is one of the World Wildlife Fund's 200 Priority Regions for Conservation, a Centre of Plant Diversity and one of the BirdLife-designated Endemic Bird Areas of the World. Jau is located primarily on *terra-firme* with a large portion of the flora and fauna of an *igapo* blackwater river system. Mamirauá Reserve protects one of the best examples of a *várzea* whitewater seasonally flooded forest where speciation is accelerated by the extreme continually changing conditions and there is a resulting high degree of endemism. Maimirauá is designated a Ramsar Wetland. Amanã protects areas of both whitewater seasonally flooded forest and a blackwater flood ecosystem along with a huge area of undisturbed *terra-firme* dry tropical forest. Terrestrial species not adapted to water are not found in the *várzea* The biota is protected in an area vast enough to contain major ecological and biological processes such as wind-blows, floods and burns, providing unequalled large-scale opportunities to study their effects on biodiversity in natural ecosystems. Mamirauá and Amanã are also managed to include the human cultures living in the Reserves. The sites lie within a WWF Global 200 freshwater eco-region.

CULTURAL HERITAGE

Jaú: There are no indigenous inhabitants in the area today but the recent survey identified 17 archaeological sites at the river mouth on the Rio Negro, with undated material suggesting the past existence of a corridor between the Solimões and Negro rivers. Numerous stone carvings were found on the river margins. Detailed studies of these sites could help to explain the history of human occupation of the lower Rio Negro (FVA, 1997). The nearby city of Airão, founded near the end of the 17th century, is in the Park's buffer zone and was the first Portuguese settlement on the river. Nowadays, the *Instituto do Patrimonio Histórico Brasileiro* is working on official preservation of the Airão ruins previously abandoned in the 1950s (FVA, 1997).

Mamirauá: The region has long been settled because of its productiveness and accessibility by river. It was originally inhabited by native groups, among which the Omágua predominated, but the Amerindian population was largely decimated by war and introduced disease. The remaining indigenous peoples were incorporated into colonial society by government-sponsored miscegenation and the remaining indigenous communities in the area have a high number of people of mixed blood. At the beginning of the 20th century, after rubber-collecting declined, succeeding settlements were built on trade in firewood for steamships, fish, manatees, and turtles. They were concentrated around the trading posts of *patrons*, who controlled the markets of an extractive economy based on a system of debt-slavery and barter.

Amanã: There are no indigenous inhabitants in the area today but a recent survey on the north shores of Lake Amanã unearthed material suggesting that the area was probably part of a corridor between the Solimões and Negro rivers used by tribesmen in pre-Columbian times.

The area of Anavilhanas in the late 17th century when the city of Airão, the first Portuguese settlement on the river, was founded, was inhabited by Cauauri Indians, also the Arauaque who later traded via other regional groups with settlers of European descent. There are several archeological sites left by these groups and their ancestors which are yet to be excavated and recorded. The Instituto do Patrimonio Histórico Brasileiro (IPHAN) is working on official preservation of the Airão ruins (FVA, 1997).

LOCAL HUMAN POPULATION

Jaú: There are no indigenes. The rural population of *caboclos* are descendents of Portuguese originally attracted by rubber collecting, and the indigenous people. In 2002 112 families lived along the Unini river, 56 families on the Rio Jaú and 7 families on the Carabinani river (FVA, 1998). Most were born in the region or in the state, and still live in traditional ways, on manioc cultivation, hunting, fishing, gathering turtles and ornamental fish and the collection of timber, rubber, nuts, oils, resins and gum.

Mamirauá: Decline in the system of barter trading during the 1960s accelerated urbanisation and reduced the number of settlements in the area. In 2002 there were about 5,300 people in 23 settlements: 1,668 in the core area and 3,609 in neighboring communities. Sixty-five percent of the dwellings are sited along the Solimões, 30% are along the Japurá. The economy is based on manioc cultivation and small farms,

fishing for *pirarucu* and *tambaqui*, forest products and some hunting. Smallholdings are usually farmed as biologically diverse ecosystems including trees, a traditional practice in the tropics which does not degrade the land. Difficult economic conditions are mitigated by migration, especially in years of high floods. Illiteracy is 38% but environmental education is being successfully introduced within the core area of the Reserve.

Amanã: The total population of the Reserve in 2002 was about 2,000 people, 45% along the Rio Japurá in 14 communities, 18% around Lake Amanã in 5 main communities and 5% in two villages on the connecting channels between them. There are a few other communities scattered in the channels off the Rio Japurá, but there is no information on the population. The inhabitants live by subsistence fishing, hunting and small-scale agriculture: manioc, banana, tobacco, corn and some fruit trees. Monkeys, peccaries, agoutis, tapirs and especially manatees are hunted and probably some birds. Other products include liana for basketry, forest fruits, edible oils, high-value hardwoods such as *Mezilaurus itauba* from the *terra-firme* forest, and marketable *várzea* timber species such as *Ceiba pentandra, Hura crepitans* and *Calophyllum brasiliense.*

Anavilhanas: The local population except for four families has been displaced and financially compensated by the Federal government. They lived on small scale agriculture and artisanal fishing, and hunting. People from the town of Airão across the river and from Manaus (a city of more than one million people), 50 km to the south, pursue both traditional and commercial fishing, small scale logging and hunting. Until recently sand and stone was extracted along the river by companies from Manaus. The Rio Negro which crosses the area, bears heavy river traffic, which brings the risk of pollution and illegal activities, but does not otherwise disturb the ecology.

VISITORS AND VISITOR FACILITIES

There is no road access to the Jau National Park beyond Novo Airão, 100 km downstream and it is only accessible by river, so rented boats are the usual means of access. The journey from Manaus to the Park entrance takes up to 18 hours, or 8 hours by speedboat. Visitors need prior authorisation from the Park Director at IBAMA headquarters in Manaus. At the entrance, there is a recently-built visitors' centre, a houseboat for the Park guards and housing for researchers and visitors. At present there is no registered tourist agency arranging trips to the Park, but in 1998 there were 885 visitors, mostly foreigners who concentrated on the Carabinani waterfalls and the extensive beaches of the Rio Negro. There is a guard post at the mouth of the Rio Jaú and one is planned for the mouth of the Rio Unini which is much visited by fishermen.

Mamirauá and especially Amanã are not yet much known to tourists though there is through traffic on the rivers. Short tours using speedboats and canoes are planned based on a 30-person lodge at Uakari, and some 300 visitors a year are expected. The Rio Negro landscape of Anavilhanas attracts river excursions from Manaus en route to Jaú which have little environmental impact and provide an income. 80% of the county of Novo Ayrão is natural or Indian reserves, and might come to depend on tourism to enhance local incomes. There are houseboats for official visitors. Anavilhanas Ecological Station is closed to tourism. The landscape of Anavilhanas attracts river excursions from Manaus and en route to Jaú which have little environmental impact and provide an income. 80% of the county of Novo Ayrão is natural or Indian reserves, and might come to depend on tourism to enhance local incomes. However, the Station is closed to tourism. There are houseboats for official visitors.

SCIENTIFIC RESEARCH AND FACILITIES

The management plans for the four protected areas have been the mainspring of research about them. Plans were published for Mamirauá (1996), Jaú National Park (1997), Anavilhanas Ecological Station (1999), and that for Amanã should be published soon. An aerial survey of the central Amazon was published in 1978. In 1985 there was a satellite survey of water levels and a scientist researching the endemic white uakari suggested an ecological station in Mamirauá which developed into the IDSM Mamirauá Institute at Tefé with a small basic laboratory and where from 1992 research has been ongoing into *várzea* ecology and local social and economic conditions. For this reason Mamirauá has been the most completely studied of the three areas. It ws only in the 1980s, Lake Amanã was discovered to scientists following the manatee, and there have been many subsequent studies there.

By agreement with IBAMA, the Vitória Amazônica Foundation (FVA) has carried out multidisciplinary research in Jau National Park since 1992, inventorying the fauna and flora, soils and landscape and in general for protection, education and administration. Research on the resident population is focussed on analysis of large-scale trends in demography, subsistence and environmental impacts. FVA stores the

data in a computerised database, building up an information centre about the Reserve. Geographic Information Systems are used to generate landscape maps, land-use maps and other images.

MANAGEMENT

Jaú is one of the few conservation units in the Brazilian Amazon with a management plan that is both complete and being implemented. This evolved between IBAMA, the Vitória Amazônica Foundation, local municipal governments, research institutions and members of the extraction and tourism industries following guidelines prepared by IBAMA. Nearly 60 expert researchers from 13 different institutions contributed. To integrate local residents with conservation initiatives within the Park there are periodic meetings with residents to disseminate planning decisions and to provide training for environmental education professionals and research on the economic valuation of natural resources. In Novo Airão, one example is the Fibrarte Project, set up to stimulate the use of natural fibres such as *aruma*, *Schynosiphon* sp. to produce high quality handicrafts. Since 1993 the main body supervising research, planning and management and education in the Park has been the Vitória Amazônica Foundation.

The Management Plan has three phases: I: Protection, minimising impacts and integrating with neighbors; II: Research into and protection of biodiversity; III: Specific activities. It describes programs for the regulation of the use of Park resources, such as turtles and ornamental fish, survey, research and monitoring, public use, recreation and education about the natural processes of the area, public relations, encouragement of crafts, management training for local people, political integration local and regional, administration and maintenance, and sources of sponsorship. A zoning plan defines four management zones: Primitive: of great natural value, with minimum intervention and maximum protection; Extensive use: some human activity; Intensive use: already altered by man, and Especial use: the Park services core. Key indicators to be used to monitor the state of conservation will include the biological resources, the hydro-climatic cycle, critical habitats, human use and quality of life, park use and effectiveness of the management plan. Indicators for the effectiveness of monitoring are also in place.

Mamirauá: The Mamirauá Sustainable Development Reserve was the first Brazilian protected area to attempt to combine the preservation of natural ecosystems with sustainable development. To achieve this, starting in 1992, plans were evolved between IBAMA, local municipal governments, research institutions and the representatives of the mining and tourism industries following guidelines prepared by IBAMA. They embody the work of expert researchers from many different institutions. This was done with the participation of 60 riverine communities who continue to take part in monitoring, management, protection and research. Representatives of groups of villages and of resource-user communities meet every two months with local governmental and non-governmental organisations, and there are annual General Assemblies at which management decisions are discussed and voted on.

In Mamirauá, except for the purpose of local subsistence, hunting and logging of small and endemic trees is prohibited. Zoning and protection has increased animal populations and the productivity of both forest and aquatic resources, especially of the 650,000ha of lakes which form 25% of the focal area. This is 250,000 ha in size, 23.2% of the whole Reserve. Here, Special Management and Protected zones cover about 73,000 ha (35%) of the area. Monitoring of the fauna and local living conditions is done by volunteer inspectors from local communities. This supports management and research, notes and corrects problems and promotes understanding and sustainable use of the ecosystem. Dissemination of planning decisions, political integration, public health, training for environmental education and increased economic production from the natural resources are all promoted within the core zones of the protected areas. The work in these areas of the *Sociedade Civil Mamiraua* through the Mamirauá Institute for Sustainable Development (IDSM) to ensure a sustainable future for local livelihoods and the resources of the forest was awarded a UNDP Equator Prize in 2004.

Amanã is managed with Mamirauá. Protection and research is all done within the core zone near and around Lake Amanã and Rio Japura where the different lakes are zoned for protection, sustainable use and commercial use. The rest of the Reserve is a Total Protection zone, feasible because it is virtually uninhabited. The Reserves are among the few conservation areas in the Brazilian Amazon with management plans that are both complete and being implemented though Amana does not yet have a separate Plan.

The Brazilian Ministry of the Environment with IBAMA, the National Indian Foundation and state environmental institutions, has launched a project called 'Ecological Corridors for the Tropical Brazilian Forest' (PPG7-PPR), part of the Pilot Program for the Protection of Brazilian Tropical Forests, to support conservation projects and help to regulate the use of natural resources. The three protected reserves

form the core of the Central Amazon Corridor and, since 2001, form UNESCO's MAB Central Amazon Biosphere Reserve. Decisions to include Anavilhanas Ecological Station (350,018 ha) on the Rio Negro and the whole Mamirauá Reserve (1,124,000 ha) within the Complex were deferred.

Anavilhanas is also zoned into areas of Total Protection, Buffer, Sustainable Use, Rehabilitation and Experimental Use but is totally protected and monitored only within the 'Experimental Interference zone' (for research and education), which is 10% of the area,

The Brazilian Ministry of the Environment with IBAMA, the National Indian Foundation (FUNAI) and state environmental institutions, has launched a project called 'Ecological Corridors for the Tropical Brazilian Forest' (PPG7-PPR), part of the Pilot Program for the Protection of Brazilian Tropical Forests, to support conservation projects and help to regulate the use of natural resources. The four protected reserves form the core of the Central Amazon Corridor and, since 2001, are a part of UNESCO's MAB Central Amazon Biosphere Reserve. The increase in good management and tourism has begun to improve the health and education of the local people (WCS, 2005).

MANAGEMENT CONSTRAINTS

Deforestation is currently the main threat in the Amazon region. Some 13% of the original rainforest is already been lost to the ever-increasing economic pressure on the region's resources fuelled by inadequate government policies, inappropriate land use systems and unsustainable resource use. Only 3.5% of the total area of 3.5 million square kilometers of the Brazilian Amazon is officially designated federal indirect-use protected areas. These include national parks, biological reserves and ecological stations within which people are not allowed to live. However, this law is unenforceable, and all protected areas in the Amazon region have people living in them. Development along rivers and roads is a major threat to native habitats and to species which are degraded by logging of valuable timber, farming, hunting, mining and intensive commercial fishing.

The Complex suffers from being both very productive and relatively accessible. Jaú National Park is in good condition. The grass fires, blow-downs and floods which do occur being part of the natural order of the forest. But there are around 250 families who fish in the Unini river quite intensively. The Park has also been invaded from the surrounding area and is in great need of a better infrastructure. For instance, there are only two Park rangers at the entrance, making it easily invaded by outsiders who remove fish and turtles which may affect future stocks. However, in the surrounding region no development projects such as hydroelectric dams, gas pipelines, power lines, highways, logging or mining exist or are foreseen. In Mamirauá the core area of the Reserve is well guarded, but in the surrounding area effective measures are still to be taken. There is generally fairly intensive use of monkeys, fish and manatees for meat near communities. Amanã, except in the core area of the Reserve near the lake and riverside villages, is virtually undisturbed by development and exploitation and is not expected in the near future. In Anavilhanas there is a little logging, and hunting, intensive fishing and heavy but not disruptive through river traffic. These threats are monitored, though for lack of funds, only within the focal area. Again, flooding, windblow and grass fires are the main natural hazards in the reserves.

STAFF

Jaú National Park has a staff of four: Head of Conservation and three rangers, which is very inadequate although 26 volunteer guards have received training. The rangers live with their families and are employed by a private company *(Empresa de Segurança).* FVA has a staff of 23 people, including two ecologists and three sociologist researchers, three IT experts, two educators, two technical staff responsible for alternative economic activities such as the Fibrarte Project, ten in administration and one developing the Foundation.

In Amanã and Mamirauá the IDSM employs 150 people under a Director and two Adjunct Directors. IBAMA trained 100 volunteer guards from the local communities but 50 more are needed. Mamirauá has ten houseboat-guard posts at entry points, supported by the use of speedboats and radio. In the past the Institute has received advice on the management plan and training from 12 state and national and 8 foreign institutions and universities. Amanã shares these resources. A few volunteers have been trained there and a ranger service is planned. 5 Brazilian and 4 foreign institutions have assisted its development. In Anavilhanas IBAMA has one Director (in Manaus) with 6 employees, but no security guards and the station is understaffed. There are speedboats and radios but no monitoring, administration or other activities outside the research area.

BUDGET

In Jaú, IBAMA invested around R$1,383,480 (approximately US$780,000) in the Park between 1993 and 1997, of which R$378,000 (US$211,000) were spent on the management plan. From 1992 to 1997, FVA also channelled about R$1,600,000 (US$894,000) into the preparation of the plan, excluding researchers' salaries and the expenses of collaborating organisations. The primary sources of funding were: IBAMA through its National Programme for the Environment (PNMA-IBAMA), the World Wildlife Fund, the European Union, the W. Alton Jones Foundation, the Government of Austria and 14 other institutions. The funding available to the PP-G7PPR project amounts to nearly US$47 million. About US$3.8 million has been allocated for Phase 1.

In the Reserves, Mamirauá has an average annual budget of USD$2,100,000, contributed by the Ministry of Science & Technology, 5 federal and state institutions, 6 Brazilian NGOs and 7 foreign organisations (WWF, UNICEF, EU, DFID, CI, WCS, and the Netherlands). Amanã has an average annual budget of USD$1,200,000, contributed by Federal and State governments, DFID and WCS. The funds for the PPG-7 PPR project are nearly US$47 million of which US$3.8 million has been allocated for Phase 1. For Anavilhanas there is little funding or information. However, the funds available to the PPG-7 PPR project are nearly US$47 million of which US$3.8 million has been allocated for Phase 1.

ADDRESSES

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