ECOSYSTEMS OF SOUTH AMERICA: STATUS AND THREATS

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GLOSSARY

Ecosystem: A set of interacting living and nonliving components in a defined geographic space. Ecosystems include both plant and animal communities and the soil, water and other physical elements of their environment.

Bioregion: One of six biogeographic divisions of South America consisting of contiguous ecoregions. Bioregions are delimited to better address the biogeographic distinctiveness of ecoregions.

Ecoregion: A geographically distinct assemblage of natural communities that share a large majority of their species and ecological dynamics, share similar environmental conditions, and interact ecologically in ways that are critical for their long-term persistence.

Major Ecosystem Type: Groups of ecoregions that share minimum area requirements for conservation, response characteristics to major disturbance, and similar levels of beta diversity (i.e., the rate of species turnover with distance).

Major Habitat Type: Groups of ecoregions that have similar general structure, climatic regimes, major ecological processes, beta diversity, and flora and fauna with similar guild structures and life histories.

The term "ecoregion," as used in this article, refers to "natural" ecological systems, or terrestrial and aquatic areas as they were when Europeans first arrived in the New World. The original extent of natural ecoregions is presented, grouped by bioregion, major habitat type and major ecosystem type. The definitions of these terms, given in the glossary above, are taken from Dinerstein et al. (1995); the rating codes are given in the footnotes to the table. Indications of the extent of remaining natural ecosystems, the threats to their continued existence, and the status of protected areas are discussed, together with priorities for conservation.

I. ORIGINAL EXTENT OF TERRESTRIAL ECOSYSTEMS

Ecosystems can be classified in many ways, making the number of categories vary widely depending on the use intended. Here, the system adopted by Dinerstein et al. (1995) is used. This divides the continent into 95 terrestrial "ecoregions," exclusive of mangroves. These are grouped into four "major ecosystem types:" tropical broadleaf forests, conifer/temperate broadleaf forests, grasslands/savannas/shrublands, and xeric formations. Within each of these categories are varying numbers of "major habitat types," such as tropical moist broadleaf forests. These are further divided into nine "bioregions" Amazonian tropical moist forests, for example, is a bioregion.

The 95 ecoregions, with their hierarchical groupings, are presented in Table I. Also included are the ratings for conservation status, biological distinctiveness and biodiversity priority derived by Dinerstein et al. (1995). This study made a systematic survey of the status of natural ecosystems in Latin America and the Caribbean (LAC) and applied a uniform methodology to assigning priorities to these ecosystems for conservation efforts. The work was done for the United States Agency for International Development (USAID) by the WWF-US Biodiversity Support Program (BSP). The document is based on three workshops, plus consultations with relevant organizations and individual experts (the list of contributors contains 178 names).

[Table I here]

The classification system is hierarchical, starting with four "major ecosystem types" (eg. Tropical Broadleaf Forests), which are divided into 10 "major habitat types" (eg. Tropical

Moist Broadleaf Forests). These are crossed with six bioregions (eg. Amazonia) and divided into 95 ecoregions (eg. Rondônia/Mato Grosso moist forests). The system allows the priority of some ecoregions to be promoted upward based on uniqueness and regional representation, even if indicators of diversity and vulnerability are not so high.

The effort was unusual in emphasizing protection of areas with high beta diversity (a measure of the turnover of species along ecological gradients), as well as the more commonly used alpha diversity (species diversity within a habitat). In the case of mangroves, the diversity assessed is ecosystem diversity, including aquatic animal life. This avoids mangroves receiving the unjustly low diversity ratings that tend to result when assessments are restrained to terrestrial organisms, especially trees.

Although the ecoregions identified in Table I refer to "natural" (pre-Colombian) ecosystems, it should be emphasized that these had already been subject to millenia of influence by indigenous peoples prior to the arrival of Europeans. This influence continues today, together with much more rapid alterations from such activities as deforestation and logging done by non-indigenous residents. "South America" is taken to include the three Guianas (different from usage by the Food and Agriculture Organization of the United Nations-FAO) and to exclude Panama (however, in the case of ecoregions that extend into Panama, the area estimates in Table 1 include the Panamanian portions). The ecoregions are mapped in Figure 1. The ecoregion numbering corresponds to Table 1, and also to the report by Dinerstein et al. (1995); the numbering presented here is not continuous, since the report also includes ecoregions in Mexico, Central America and the Caribbean. Extensive bibliographic material on the delimitation of the ecoregions and on the state of knowledge about them can be found in Dinerstein et al. (1995).

[Figure 1 here]

Mangroves occur along the coasts of Brazil, the three Guianas, Venezuela, Colombia, Ecuador and northern Peru. Dinerstein et al. (1995) divide them into five complexes: Pacific South America, Continental Caribbean, Amazon-Orinoco-Maranhão, Northeast Brazil and Southeast Brazil. Each complex is further subdivided into 2-5 units, corresponding to distinct segments of coastline. Mangroves are essential to maintaining populations and ecological processes in surrounding marine, freshwater and terrestrial ecosystems.

II. PRESENT EXTENT OF TERRESTRIAL ECOSYSTEMS

Unfortunately, information is not available on the present extent of each of the 95 ecoregions listed in Table I. Information on the extent of tropical forests in approximately 1990 is available from the FAO Tropical Forest Resources Survey (FAO, 1993). Non-tropical areas are covered by a variety of national surveys (Harcourt and Sayer, 1996). These data are tabulated by country in Table II. National data are important because decisions regarding land-use policies and conservation are taken at the national level – not at the levels of bioregions or ecosystem types. Over half of the South American continent is represented by a single country: Brazil (Fig. 2).

[Table II and Figure 2 here]

An idea of the extent of existing ecosystems can be gained from measurements of land cover in 1988 made using 1 × 1 km-resolution data from the AVHRR sensor on the NOAA satellite series (Stone et al., 1994). These are given in Figure 3 and are tabulated in Table III.

[Figure 3 and Table III here]

It should be emphasized that many ecosystems can be heavily disturbed by logging and other activities without the change being evident on satellite imagery. This is true for LANDSAT-TM imagery (30 × 30-m resolution) used for deforestation estimates in Brazil, and the limitations are much greater for 1 × 1-km AVHRR data.

Brazil is the country with the most extensive satellite information on forest cover and its loss. Unfortunately, information on non-forest vegetation types such as cerrado is much less complete. Considerable confusion arises between the FAO (1993) classification and others such as the one adopted here because FAO classifies cerrado, caatinga and chaco as "forests."

Brazil's Legal Amazon region originally had 4 million km^2 of forests, the rest being cerrado and other types of savannas. Agricultural advance was slow until recent decades because of human diseases (especially yellow fever and malaria), infertile soil and vast distances to markets. These barriers have progressively crumbled, although a range of limiting factors restricts the extent and the duration over which many uses of deforested areas can be maintained (Fearnside, 1997a). Deforestation in the region has been predominantly for cattle pasture, with critical contributions to the motivations for the transformation coming from the role of clearing as a means of establishing land tenure and in allowing land to be held and sold for speculative purposes (Fearnside, 1993).

The Atlantic forests of Brazil (ecoregions 54 and 55) have been almost completely (>95%) destroyed, mainly for agriculture, silviculture and real-estate development. Most of what remains of this extraordinarily rich ecosystem is in protected areas, but unprotected areas continue in rapid retreat. These forests are recognized as major "hotspots" of biodiversity (Heywood and Watson, 1995; Stotz et al., 1996).

In Andean countries, clearing by small farmers has predominated in driving deforestation, in contrast to the predominant role of medium and large cattle ranchers in Brazil. Migration from densely populated areas in the Andean highlands (altiplano) has led to settlement in lowland forests areas, with consequent upsurges in clearing (eg., Rudel and Horowitz, 1993).

Savanna ecosystems have suffered heavy human pressure. The pampas of Argentina, and the Uruguayan savannas of Uruguay and southern Brazil (ecoregions 120 and 121) have largely been converted to agriculture. The Brazilian cerrado, originally covering 2 million km^2, is the largest ecoregion in South America, as well as holding the largest number of species of any of the world's savannas. The cerrado was largely intact until the mid-1970s. Clearing, especially for soybeans and planted pasture, reduced the cerrado to 65% of its original area by 1993 according to LANDSAT imagery interpreted by Brazil's National Institute for Space Research (INPE). The advance of clearing has proceeded at an accelerating pace, speeded by infrastructure projects and an array of government subsidies.

The temperate and coniferous forests of the Southern Cone have been under severe pressure from logging. These forests are usually logged by clearcutting in a manner similar to their counterparts in the North American temperate zone. This contrasts with the "selective" logging (highgrading for a few species) that characterizes timber extraction from the diverse forests of the tropical region.

III. HUMAN USE OF CONVERTED AREAS

Conversion of natural ecosystems to agroecosystems and secondary forests creates landscapes that maintain biodiversity to varying degrees. "Shifting cultivation" as practiced by indigenous peoples and by traditional non-indigenous residents (caboclos) in Amazonian forests maintains a substantial part of the original biodiversity. This contrasts with the effect of the vast expanses of cattle pasture that have replaced this, either directly or following a phase of use in pioneer agriculture by small farmers who have recently arrived from other places.

In densely settled areas along the coast of Brazil and in the southern portions of the country, agricultural use has gone through a series of "cycles," such as sugarcane and coffee. The productivity of many areas has been damaged by soil erosion and other forms of degradation. Cattle pasture is often the land use replacing these crops. Since the 1970s, plantation silviculture (which now covers over 70,000 km^2) and soybeans (130,000 km^2) have made large advances.

In Argentina and Uruguay, cattle ranching and wheat and rice farming are major land uses. Natural vegetation is better represented in areas with little agricultural potential, such as mountain and polar areas and arid and semiarid zones.

IV. HUMAN USE OF REMAINING NATURAL HABITATS

Areas that remain under natural vegetation cover, rather than being converted to other land uses through clearing, are also subject to human use and alteration. Selective logging in tropical forests, for example, leaves much of the basic structure of the ecosystem intact, but also can lead to significant changes that can set in motion a sequence of events leading to complete destruction of the ecosystem. Logging leaves a substantial amount of dead biomass in the forest, including the crowns and stumps of harvested trees and all of the biomass of the many additional trees that are killed by damage sustained during the logging process. Openings created in the canopy allow sunlight and heat to penetrate to the forest floor, drying out the fuel bed more quickly than in unlogged forests. Climatic variations such as those provoked by the El Niño phenomenon make logged forests especially susceptible to entry of fires. Ample opportunities for fires are provided as fields are burned to prepare land for planting and as cattle pastures are burned to control invading weeds. The fires burn slowly through the understory, charring the bases of trees as they go. Many of these trees then die, leading to a positive-feedback process whereby more dead biomass and canopy openings are provided and subsequent fires begin with greater ease, killing still more trees. This can degrade the entire forest within a few years (Nepstad et al., 1999).

Tropical forests are also used for "extractivism," or the collection of non-timber forest products (NTFPs) such as rubber and Brazilnuts. This does relatively little damage to the forest, although extractivists do have an impact through hunting and through clearing for subsistence crops. The extractivist population can also play a protective role in defending the forest against encroachment by more aggressive actors such as ranchers and loggers. This is the basis of the extractive reserve system in Brazil (see Anderson, 1990).

Savannas are often grazed by cattle without cutting trees. Cerrado (ecoregion 114), "lavrado" or Guianan savannas (ecoregion 111) the Pantanal wetlands (ecoregion 133) and the llanos of Venezuela (ecoregion 110) are among the savannas often used in this way. Increasing fire frequency, virtually all a result of human-initiated burning, can lead to shifts in species composition and to a drain of nutrients.

Aquatic ecosystems are traditionally exploited by fisheries. This alters the relative abundance of the species present. Use of watercourses as recipients for sewage and other pollutants also affects aquatic life in many ways.

V. THREATS TO REMAINING NATURAL HABITATS

A. Terrestrial Ecosystems

1. Deforestation

Deforestation is the dominant transformation of forested ecosystems that threatens biodiversity. In Brazil, which holds most of the continent's remaining forests, ranching is the dominant use for land once deforested. In the 1990s, soybeans began to enter forested regions, representing a new force in this process (they had already been a major factor in transformation of the cerrado since the 1970s). The most important effect of soybeans is not loss of forest directly planted to the crop, but the extensive infrastructure of waterways, railways and highways that are built to transport soybeans and the inputs needed to grow them. The cycle of deforestation that has repeatedly occurred along Amazonian highways can be expected to accompany these new access routes.

Population growth is a fundamental contributor to deforestation and other forms of natural habitat loss. In recent years, however, the redistribution of population through migration that has overshadowed the impact of absolute growth in population size. These include migrations from the semi-arid Northeast of Brazil to Amazonia, from Paraná to Rondônia, from the highlands of Bolivia, Peru and Ecuador to the Amazonian lowlands and, in the case of Ecuador, to the Pacific lowlands as well.

2. Logging and Charcoal Manufacture

Logging is an increasingly important factor in Amazonia, and the catalytic role of this activity in increasing the flammability of the logged forest gives it potential impact far beyond its direct damage. So far, logging in Brazil has been dominated by domestic demand for sawnwood, plywood and particle board, which is almost entirely supplied from tropical forests rather than from silvicultural plantations plantations (which produce wood for pulp and, to a lesser extent, charcoal). However, global markets for tropical timber are presently dependent on supplies from Asian forests that will soon come to an end if current rates of exploitation continue. In the 1990s, Asian logging companies began buying land and/or obtaining concessions in such countries as Brazil, Guyana and Suriname, and pressure from global timber markets can be expected to increase in the future. Asian loggers are also the principal forces in clearcutting the Valdivian and Nothofagus forests of Chile (ecoregions 88 and 89).

In eastern Amazonia, demand for charcoal for pig-iron smelting in the Carajás area is a potential threat to forests. Carajás, with the world’s largest deposit of high-grade iron ore, is expected to be mined for 400 years at the present rate of exploitation. Wood from native forests is inherently cheaper as a source of biomass for charcoal production as compared to plantation-grown sources. Charcoal manufacture has an impact on the forest both through direct

removals (including officially sanctioned forestry management systems) and by increasing the profitability of logging and deforestation (see Anderson, 1990)
.

Deforestation impacts are magnified by fragmentation and edge effects (Laurance and Bierregaard, 1997). This division of the remaining natural habitat into many small islands surrounded by cattle pastures or other highly modified land uses, together with forming edges with increased entry of light, wind and foreign organisms, result in many changes in the remaining natural ecosystems. Most of these changes are forms of degradation, such as greatly increased mortality in the trees that provide the dominant component of forest structure. Vine loads on trees near edges also increase, leading to further increase in mortality and susceptibility to windthrow.

3. Other Threats

Climate change represents a major long-term threat to many South American ecosystems. The Intergovernmental Panel on Climate Change (IPCC) has prepared detailed reviews of potential climatic impacts on South America in its 1998 Special Report on Regional Impacts (Chapter 6) and its 2000 Third Assessment Report (Working Group II, Chapter 14).

Removal of fauna through hunting is a virtually universal consequence of proximity of human settlements to natural habitats. The removal of fauna can affect seed dispersal, pollination, and other processes needed for maintaining plant and animal communities. Introduction of exotic species also represents a threat to natural ecosystems. Exotic species are a particularly severe problem in the Valdivian and Nothofagus forests of Chile (ecoregions 88 and 89).

Mangrove ecosystems are subject to some unique threats. Shrimp culture in mangrove areas has had severe impacts on the coast of Ecuador. Mangroves in Maranhão have been subject to pressure for charcoal manufacture. In São Paulo state mangroves have often suffered from oil spills, and are also losing ground to real-estate development. This has also affected restingas (ecoregions 176-178).

B. Aquatic Ecosystems

1. Dams

Hydroelectric dams have major impacts on river ecosystems by blocking fish migration, by eliminating rapids and replacing well oxygenated running water with reservoirs that usually have anoxic water in their lower layers. The composition of fish present changes radically, and undergoes a succession of changes as reservoirs age. Anoxic water released through the turbines severely reduce fish and freshwater shrimp productivity in the rivers downstream of the dams.

In Brazil, the 2010 Plan, released in 1987, listed over 300 dams for eventual construction in Brazil, independent of the expected date of completion. Of these, 65 dams were in the Amazon region. Economic difficulties have caused projected construction dates to be successively postponed, but the ultimate number of dams has not changed. Most contentious is the Babaquara Dam on the Xingu River, which would flood over 6000 km^2 of forest, much of it in indigenous areas. This has been renamed the "Altamira Dam," and appears in the current decennial plan for construction by 2013.

In Chile, the dams planned and under construction on the Bio-Bio River are expected to have major environmental impacts. The Ralco Dam is particularly contentious. In Uruguay, at least five major dams are planned for construction in the next few years.

2. Waterways

Industrial waterways, known as hidrovias in Brazil, greatly alter aquatic habitats. No less than seven waterways are under construction or planned for soybean transport on barges: the Paraguay-Paraná (Hidrovia do Pantanal), the Madeira River waterway, the Tocantins-Araguaia waterway, the Teles Pires-Tapajós waterway, the Capim River waterway, the Mamoré-Guaporé Waterway and the Rio Branco and Rio Negro-Orinoco Waterways. Waterway construction involves blasting rock obstructions, cutting sharp curves, and dredging sediment from the river beds. The Corumbá-Cáceres stretch of the Hidrovia do Pantanal, if built, would lower the water level in the Pantanal wetlands (ecoregion 133), threatening one of the world's most renowned concentrations of wildlife.

3. Other Threats

Other threats to aquatic habitats include sedimentation from soil erosion and landslides. This is severe, for example, in rivers draining steep areas of former Atlantic forest in the coastal mountains of Brazil. Mining for gold, tin and diamonds in Amazonia can also inject large amounts of sediment into streams and rivers.

Destruction of varzea forest (ecoregion 33) in Amazonia can affect aquatic life through loss of important fish breeding areas and food sources for fruit- and seed-eating fish. Destruction of varzea lakes and overfishing represent additional threats.

VI.) STATUS OF PROTECTED AREAS

The choice and design of reserves depends on the financial costs and biodiversity benefits of different strategies. In Brazil, rapid creation of lightly protected "paper parks" has been a means of keeping ahead of the advance of barriers to establishment of new conservation units, but emphasis must eventually shift to better protection of existing reserves (Fearnside, 1999).

Creating reserves that include human occupants has a variety of pros and cons (Kramer et al., 1997). Although the effect of humans is not always benign, much larger areas can be brought under protection regimes if human occupants are included. Additional considerations apply to buffer zones around protected areas. A “fortress approach,” whereby uninhabited reserves are guarded against encroachment by a hostile population in the surrounding area, is believed to be unworkable as a means of protecting biodiversity, in addition to causing injustices for many of the human populations involved

VII. PRIORITIES FOR CONSERVATION

Indigenous peoples have the best record of maintaining forest, but negotiation with these peoples is essential in order to ensure maintenance of the large areas of forest they inhabit (Fearnside and Ferraz, 1995). The benefits of environmental services provided by the forest must accrue to those who maintain these forests. Development of mechanisms to capture the value of these services will be a key factor affecting the long-term prospects of natural ecosystems.

In the case of deforestation in Amazonia, a variety of measures could be taken immediately through government action, including changing land tenure establishment procedures so as not to reward deforestation, revoking remaining incentives, restricting road building and improvement, strengthening requirements for environmental impact statements for proposed development projects, and creating employment alternatives, and, in the case of Brazil, levying and collecting taxes that discourage land speculation. A key need is for a better-informed process of making decisions on building roads and other infrastructure such that the full array of impacts is taken into account.

Environmental services represent a major value of natural ecosystems, and mechanisms that convert the value of these services into monetary flows that benefit the people who maintain natural habitats could significantly influence future events in the region (Fearnside, 1997b). Environmental services of tropical forests include maintenance of biodiversity, carbon stocks and water cycling. The water cycling function, although very important for countries in the region, does not affect other continents as the first two services do. At present, avoiding global warming by keeping carbon out of the atmosphere represents a service for which monetary flows are much more likely to result from international negotiations. Activities under the United Nations Framework Convention on Climate Change (UN-FCCC) are at a much more advanced stage of negotiation than is the case either for the Biodiversity Convention or for the "Non-Binding Statement of Principles" and possible future convention on forests.

In the case of carbon, major decisions regarding credits for tropical forest maintenance are likely to be taken at the sixth Conference of the Parties (COP-6) to the Kyoto Protocol, at the end of 2000 or early in 2001. This will be after the IPCC Special Report on Land-Use Change and Forestry (SR-LUCF) has been released in May 2000. Regardless of what is decided at COP-6, global warming is a permanent consideration that can be expected to receive increasing weight in decision making. The threats to natural ecosystems in South America are many, and recognition of the multiple environmental services provided by them is a key factor in insuring that substantial areas of each of these ecosystems continue to exist, thereby maintaining their biodiversity.

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Figure Legends

Figure 1 – Ecoregions for pre-Colombian vegetation of South America. Numbers correspond to Table I. (Adapted from: Dinerstein et al., 1995)

Figure 2 – Locations mentioned in the text.

Figure 3 – Extent of land-cover types in 1988 based on 1 × 1 km-resolution AVHRR imagery (source: http://www.whrc.org; see also: Stone et al., 1994).

Table I: Terrestrial Ecoregions of South America

Major Ecosystem type	Major Habitat type	Bioregion	Ecoregion Name	Ecoregion No.	Countries	Original area (km^2)
TROPICAL BROADLEAF FORESTS						
	Tropical Moist Broadleaf Forests					
		Orinoco Tropical Moist Forests				
			Cordillera La Costa montane forests	17	Venezuela	13,481
			Orinoco Delta swamp forests	18	Venezuela, Guyana	31,698
			Guianan Highlands moist forests	20	Venezuela, Brazil, Guyana	248,018
			Tepuis	21	Venezuela, Brazil, Guyana, Suriname, Colombia	49,157
			Napo moist forests	22	Peru, Ecuador, Colombia	369,847
		Amazonian Tropical Moist Forests				
			Macarena montane forests	23	Colombia	2,366
			Japurá/Negro moist forests	24	Colombia, Venezuela, Brazil	718,551
			Uatumã moist forests	25	Brazil, Venezuela, Guyana	288,128
			Amapá moist forests	26	Brazil, Suriname	195,120
			Guianan moist forests	27	Veneauela, Guyana, Suriname, Brazil, French Guiana	457,017
			Paramaribo swamp forests	28	Suriname	7,760
			Ucayali moist forests	29	Brazil, Peru	173,527
			Western	30	Peru,	8,315

Amazonian swamp forests		Colombia	
Southwestern Amazonian moist forests	31	Brazil, Peru, Bolivia	534,316
Juruá moist forests	32	Brazil	361,055
Várzea forests	33	Brazil, Peru, Colombia	193,129
Purús/Madeira moist forests	34	Brazil	561,765
Rondônia/Mato Grosso moist forests	35	Brazil, Bolivia	645,089
Beni swamp and gallery forests	36	Bolivia	31,329
Tapajós/Xingu moist forests	37	Brazil	630,905
Tocantins moist forests	38	Brazil	279,419
Northern Andean Tropical Moist Forests			
Chocó/Darién moist forests	39	Colombia, Panama, Ecuador	82,079
Eastern Panamanian montane forests	40	Panama, Colombia	2,905
Northwestern Andean montane forests	41	Colombia, Ecuador	52,937
Western Ecuador moist forests	42	Ecuador, Colombia	40,218
Cauca Valley montane forests	43	Colombia	32,412
Magdalena Valley montane forests	44	Colombia	49,322
Magdalena/Urabá moist forests	45	Colombia	73,660
Cordillera Oriental montane forests	46	Colombia	66,712
Eastern Cordillera Real montane forests	47	Ecuador, Colombia, Peru	84,442
Santa Marta montane forests	48	Colombia	4,707

Venezuelan Andes montane forests	49	Venezuela, Colombia	16,638
Catatumbo moist forests	50	Venezuela, Colombia	21,813
Central Andean Tropical Moist Forests			
Peruvian Yungas	51	Peru	188,735
Bolivian Yungas	52	Bolivia, Argentina	72,517
Andean Yungas	53	Argentina, Bolivia	55,457
Eastern South American Tropical Moist Forests			
Brazilian Coastal Atlantic forests	54	Brazil	233,266
Brazilian Interior Atlantic forests	55	Brazil	803,908
Tropical Dry Broadleaf Forests			
Orinoco Tropical Dry Forests			
Llanos dry forests	74	Venezuela	44,177
Amazonian Tropical Dry Forests			
Bolivian Lowland dry forests	76	Bolivia, Brazil	156,814
Northern Andean Tropical Dry Forests			
Cauca Valley dry forests	77	Colombia	5,130
Magdalena Valley dry forests	78	Colombia	13,837
Patía Valley dry forests	79	Colombia	1,291
Sinú Valley dry forests	80	Colombia	55,473
Ecuadorian dry forests	81	Ecuador	22,271
Tumbes/Piura dry forests	82	Ecuador, Peru	64,588
Marañon dry forests	83	Peru	14,921
Maracaibo dry forests	84	Venezuela	31,471
Lara/Falcón dry	85	Venezuela	16,178

forests			
Central Andean Tropical Dry Forests			
Bolivian montane dry forests	86	Bolivia	39,368
CONIFER/TEMPERATE BROADLEAF FORESTS			
Temperate Forests			
Southern South American Temperate Forests			
Chilean winter-rain forests	87	Chile	24,937
Valdivian temperate forests	88	Chile, Argentina	166,248
Subpollar *Nothofagus* forests	89	Chile, Argentina	141,120
Tropical and Subtropical Coniferous Forests			
Eastern South American Tropical and Subtropical Coniferous F			
Brazilian *Araucaria* forests	105	Brazil, Argentina	206,459
GRASSLANDS/SAVANNAS/SHRUBLANDS			
Grasslands, Savannas and Shrublands			
Orinoco Grasslands, Savannas and Shrublands			
Llanos	110	Venezuela, Colombia	355,112
Amazonian Grasslands, Savannas and Shrublands			
Guianan savannas	111	Suriname, Guyana, Brazil, Venezuela	128,375
Amazonian savannas	112	Brazil, Colombia, Venezuela	120,124
Beni savannas	113	Bolivia	165,445
Eastern South American Grasslands, Savannas and Shrublands			
Cerrado	114	Brazil, Paraguay, Bolivia	1,982,249
Chaco savannas	115	Argentina, Paraguay, Bolivia, Brazil	611,053
Humid Chaco	116	Argentina, Paraguay, Uruguay, Brazil	474,340

Córdoba montane savannas	117	Argentina	55,798
Southern South American Grasslands, Savannas and Shrublands			
Argentine Monte	118	Argentina	197,710
Argentine Espinal	119	Argentina	207,054
Pampas	120	Argentina	426,577
Uruguayan savannas	121	Uruguay, Brazil, Argentina	336,846
Flooded Grasslands			
Orinoco Flooded Grasslands			
Orinoco wetlands	128	Venezuela	6,403
Amazonian Flooded Grasslands			
Western Amazonian flooded grasslands	129	Peru, Bolivia,	10,111
Eastern Amazonian flooded grasslands	130	Brazil	69,533
São Luis flooded grasslands	131	Brazil	1,681
Northern Andean Flooded Graslands			
Guayaquil flooded grassland	132	Ecuador	3,617
Eastern South American Flooded Grasslands			
Pantanal	133	Brazil, Bolivia, Paraguay	140,927
Paraná flooded savannas	134	Argentina	36,452
Montane Grasslands			
Northen Andean Montane Grasslands			
Santa Marta paramo	137	Colombia	1,329
Cordillera de Mérida paramo	138	Venezuela	3,518
Northern Andean paramo	139	Ecuador	58,806
Central Andean Montane Grasslands			
Cordillera	140	Peru, Ecuador	14,128

Central paramo			
Central Andean puna	141	Bolivia, Argentina, Peru, Chile	183,868
Central Andean wet puna	142	Chile	188,911
Central Andean dry puna	143	Argentina, Bolivia, Chile	232,958
Southern South American Montane Grasslands			
Southern Andean steppe	144	Argentina, Chile	198,643
Patagonian steppe	145	Argentina, Chile	474,757
Patagonian grasslands	146	Argentina, Chile	59,585
XERIC FORMATIONS			
Mediterranean Scrub			
Central Andean Mediteranean Scrub			
Chilean matorral	148	Chile	141,643
Deserts and Xeric Shrublands			
Orinoco Deserts and Xeric Shrublans			
La Costa xeric Shrublands	168	Venezuela	64,379
Arayua and Paría xeric scrub	169	Venezuela	5,424
Northern Andean Deserts and Xeric Shrublands			
Galapagos Islands xeric scrub	170	Ecuador	9,122
Guajira/Barranquilla xeric scrub	171	Colombia, Venezuela	32,404
Paraguaná xeric scrub	172	Venezuela	15,987
Central Andean Deserts and Xeric Shrublands			
Sechura desert	173	Peru, Chile	189,928
Atacama desert	174	Chile	103,841
Eastern South American Deserts and Xeric Shrublands			
Caatinga	175	Brazil	752,606
Restingas			
Northern Andean Restingas			
Paranaguá restingas	176	Venezuela	15,987
Amazonian Restingas			

Northeastern Brazil restingas	177	Brazil	10,248
Eastern South American Restingas			
Brazilian Atlantic Coast restinga	178	Brazil	8,740

Data source: Dinerstein et al. (1995)

Conservation status codes: 1=critical, 2=endangered, 3=vulnerable, 4=relat
5=relatively intact

Biological distinctiveness codes: 1=globally outstanding, 2=regionally out
3=bioregionally outstanding, 4=locally important

Biodiversity priority codes: I=highest priority at regional scale, II=high
scale, III=moderate priority at regional scale, IV=important at national s

Table II: Area of Tropical Forest Present in 1990 (km^2)[a]

	Tropical rain forests	Moist decid-uous forest	Dry decid-uous forest[b]	Very dry forest	Desert	Hill and montane forest	All forests[b]
Bolivia	0	355,820	73,460	0	40	63,850	493,170
Brazil	2,915,970	1,970,820	288,630	0	0	435,650	5,611,070
Colombia	474,550	41,010	180	0	0	24,900	540,640
Ecuador	71,500	16,690	440	0	0	31,000	119,620
French Guiana	79,930	30	0	0	0	0	79,970
Guyana	133,370	31,670	0	0	0	19,120	184,160
Paraguay	0	60,370	67,940	0	0	270	128,590
Peru	403,580	122,990	190	2,690	1,840	147,770	679,060
Suriname	114,400	33,280	0	0	0	0	147,680
Venezuela	196,020	154,650	2,220	1	0	103,900	456,910
Total	4,389,320	2,787,330	433,060	2,691	1,880	826,460	8,440,870

(a) Data source: FAO (1993).
(b) Includes cerrado, caatinga and chaco.

Table III: Land-Cover in South America in 1988

	Closed Tropical Moist Forest	Recently Degraded TMF	Closed Forest	Degraded Closed Forest	Wood-lands	Degraded Wood-lands	Savanna, Grass-lands	Degraded Savanna, Grass-lands	Scrub lands, Shrub-lands
Argentina	1.2	0.0	96.8	0.6	645.4	15.7	755.4	232.8	894.a
Bolivia	323.5	12,7	409.2	24.6	345.1	102.2	87.7	86.2	4.8
Brazil	3,522.3	519.7	3,686.0	1,692.2	1,555.9	330.0	740.0	179.4	0.0
Chile	0.0	0.0	134.1	29.1	75.2	29.8	101.1	14.0	86.9
Colombia	581.6	5.4	622.5	11.4	116.3	14.5	255.5	64.0	0.0
Ecuador	115.5	1.7	121.0	1.7	33.7	4.3	41.9	13.3	3.2
French Guiana	78.8	0.0	79.8	2.4	0.6	0.0	0.2	0.0	0.0
Guyana	159.4	2.0	171.6	2.4	5.4	0.3	18.4	1.5	0.0
Paraguay	0.3	0.0	8.9	0.2	209.1	50.7	104.0	26.5	0.0
Peru	620.8	19.1	654.7	19.1	88.0	78.8	139.0	97.4	64.3
Suriname	126.0	2.5	128.5	10.0	0.5	0.3	1.2	0.4	0.0
Uruguay	1.4	0.0	2.1	0.0	0.9	0.0	154.1	11.0	0.0
Venezuela	379.1	0.2	415.5	9.9	33.9	40.2	243.3	82.0	27.2
Unclassified									
Total	5,909.9	563.4	6,530.7	1,803.7	3,109.8	666.9	2,642.0	808.5	1,080.6
Continent	33.4%	3..2%	36.9%	10.2%	17.6%	3.8%	14.9%	4.6%	6.1%
Category		8.7%		21.6%		17.7%		23.4%	

N.B. All values in thousands of km^2 or percent.
"TMF" includes Tropical Moist, Semi-deciduous and Gallery Forests
"Grasslands" includes those seasonally flooded
"Closed forest" includes TMF, Montane forests, Cool and Temperate Deciduous Forests and Tropical Seasonal Forests "Degraded grasslands" includes Agriculture
"Desert, Bare Soil" includes inland Salt Marsh Communities
"Other" includes wet vegetation and mangroves
Source: Stone et al., 1994.

Fig. 1 part 1

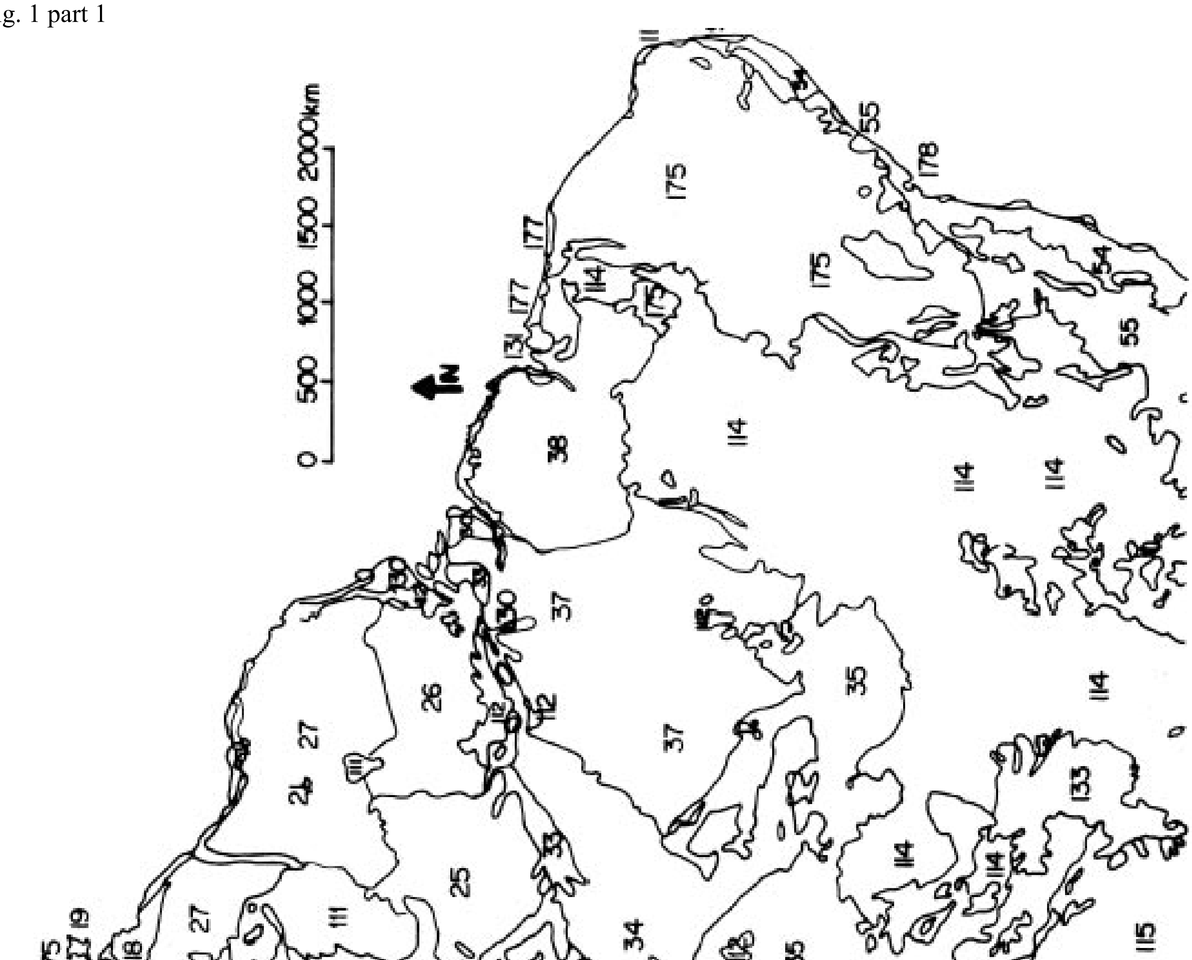

Fig. 1 part 2

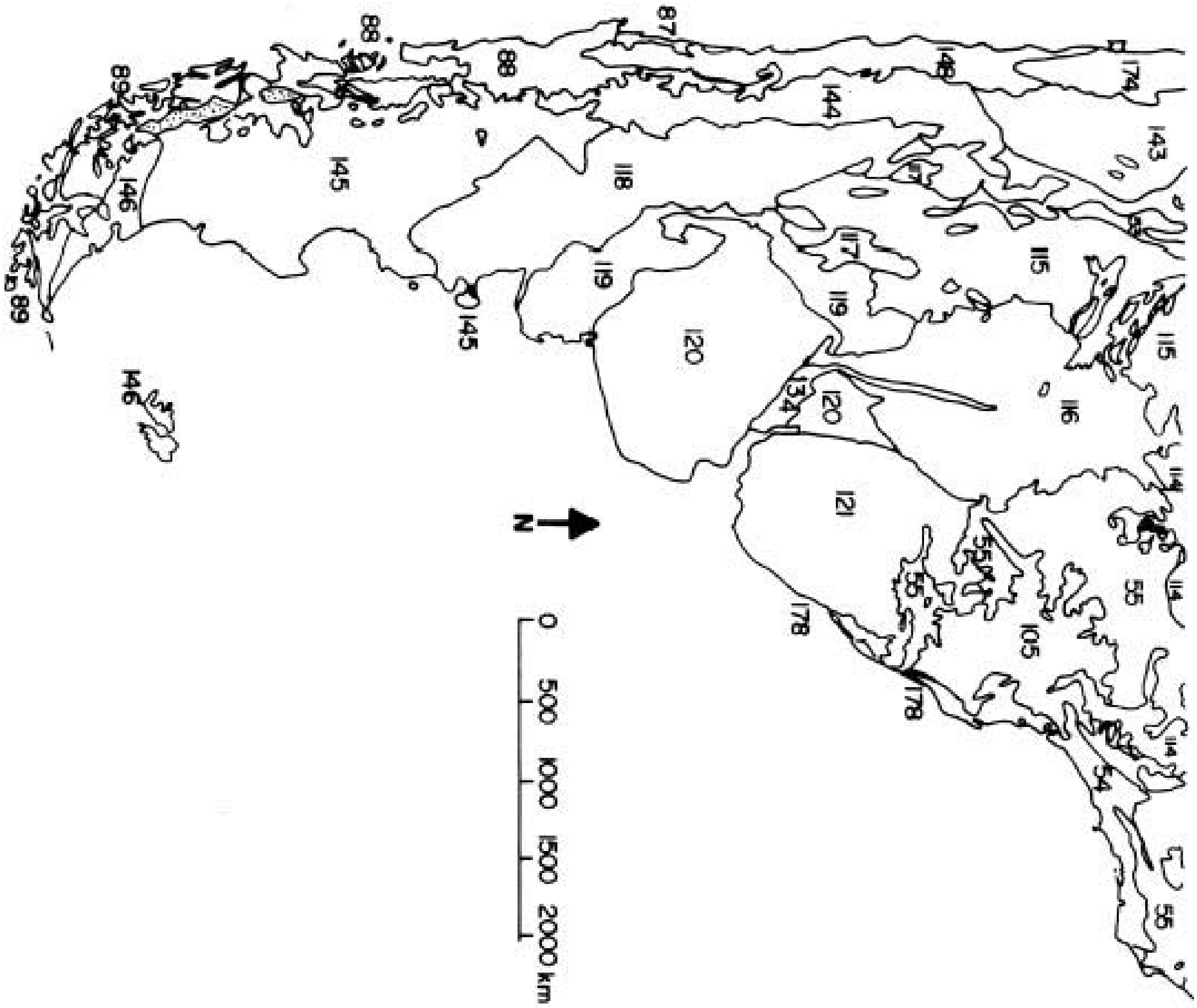
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Fig. 2

ORINOCO RIVER
VENEZUELA
GUYANA
SURINAME
FR. GUIANA
COLOMBIA
RIO BRANCO
RIO NEGRO
ECUADOR
AMAZON
RIVER
TAPAJOS R.
ALTAMIRA DAM
CAPIM R.
MARANHAO
CARAJAS
MINE
NORTHEAST
MADEIRA RIVER
TELES PIRES
XINGU R.
ARAGUAIA R.
TOCANTINS R.
RONDONIA
MAMORE
GUAPORE
BRAZIL
PERU
CACERES
BOLIVIA
CORUMBA
SÃO PAULO
PARAGUAY
PARANA
CHILE
PARANA-PARAGUAY
URUGUAY
ARGENTINA
RALCO DAM
0
500
1000
1500 km