

World Heritage Sites

Protected Areas and World Heritage



SANGAY NATIONAL PARK ECUADOR

This Park in the central Andes is the largest area of unaltered wild land in the country's eastern Cordilleras. It has outstanding natural beauty, two snow-capped active volcanoes and a range of ecosystems from the tropical rainforests of the Amazon basin to mountain glaciers. Its isolation has protected a great diversity of wildlife including indigenous species such as the mountain tapir and Andean condor.

Threats to the Site: The Park was inscribed as endangered between 1992 and 2005 because of poaching, illegal grazing, encroachment and road building. Measures have now been taken to strengthen protection of the Park.

COUNTRY Ecuador

NAME Sangay National Park (*Parque Nacional de Sangay*)

NATURAL WORLD HERITAGE SITE

1983: Inscribed on the World Heritage List under Natural Criteria vii, viii, ix and x.

1992-2005: Listed as a World Heritage site in Danger from poaching, roadbuilding and overgrazing .

IUCN MANAGEMENT CATEGORY

II National Park

BIOGEOGRAPHICAL PROVINCE

Amazonian / Yungas (8.05.01 / 8.35.12)

GEOGRAPHICAL LOCATION

In central Ecuador 160 km south of Quito on the eastern side of the Cordillera Oriental range of the Andes. The town of Riobamba lies 20 km west and Macas 15 km southeast: 1° 27' to 2° 15'S, 78° 04' to 78° 31'W.

DATES AND HISTORY OF ESTABLISHMENT

1975: Originally gazetted as a National Wildlife Reserve (271,925ha) under Interministry Agreement 190;

1979: Status changed to National Park under Interministry Agreement 322;

1992: The Park was almost doubled by a 245,840 ha extension to the south under Official Register 929 but this is not part of the World Heritage site; this was listed as endangered due to the impacts of road construction, also the heavy poaching of wildlife, illegal livestock grazing and encroachment along the Park's perimeter.

LAND TENURE

State, in Morono Santiago, Chimborazo and Tungurahua provinces. In the National Park extension, outside the World Heritage site, there are private properties. Administered by the Ministry of the Environment (M. de A. *in litt.* 2003), but formerly by the Sub-Secretariat of Forestry and Renewable Natural Resources (INEFAN).

AREA

World Heritage Site: 271,925 ha. Sangay National Park including southern extension: 517,765 ha.

ALTITUDE

800m to 5,319m (Altar).

PHYSICAL FEATURES

The Park comprises three geomorphic zones: the volcanic High Andes, the eastern foothills and alluvial fans. The highlands, of pre-Cretaceous metamorphic and plutonic rocks, rise from 2,000-5,000m and are dominated by three stratovolcanoes: Tungurahua (5,016m) and Altar (5,319m) in the northwest and Sangay (5,230m) in the west centre of the park. Tungurahua and Sangay are both still active: Sangay regularly ejects hot rocks and tephra and since 1934 has been one of the world's most continuously active volcanoes. Tungurahua last violently erupted between 1916 and 1925, erupted in 2002 and was the subject of a red alert in 2004. Altar has an eroded and glaciated caldera to the west, and is considered extinct (WWF & IUCN, 1997). The eastern foothills in the north-east and south-east are low irregular mountains between 1,000m and 2,000m in height formed of outcrops of sedimentary rocks. Large east-sloping alluvial fans dominate the east side of the Park between approximately 800m and 1,300m. Younger segments of these fans are only slightly dissected, but older parts are cut into by canyons up to 200m deep (Schuerholz *et al.*, 1980).

The High Andes zone and its volcanoes in Ecuador result from the subduction of the Nazca plate under the South American plate. It lies in the intermediate and upper Cordillera Oriental, an area of rugged topography with deep steep-sided valleys, abundant cliffs and many rocky jagged peaks. There are three subzones: subglacial, from 2,000m to 3,000m which is unglaciated; a glaciated subzone between 3,000m and 5,300m, with arêtes, cirques, and U-shaped valleys with meandering rivers, and a volcanic subzone dominated by lava and volcanic ash deposited during more recent times on the cones and flanks of the three volcanoes (Schuerholz *et al.*, 1980).

The major rivers drain east to the Amazon Basin. From north to south these are the Lushin and its tributary Shicoyocu; Palora and its tributaries: Collones, Santa Ana, Sangay and Namoqim; and Upano and its tributaries: Volcan and Sangan. They fall with rapid and dramatic variations in level. Run-off is extremely rapid due to high rainfall and steep slopes, and erosion is substantial, although controlled by thick forest vegetation. There are numerous waterfalls, especially in the hanging valleys of the glaciated zone and along the eastern edge of the Cordillera, and many lakes, including Laguna Pintada near Altar which is 5 km long (Schuerholz *et al.*, 1980).

Above 4,500m rocky lithosols are found in limited areas around the principal volcanoes. A thin layer of organic matter covers recent ash falls around and to the east of Sangay volcano. In the east between 3,000m and 4,500m are extensive black Andean soils of the *Páramo* (montane grassland) formed from volcanic base material. Black Andean soils of the cloud forest are found on the middle slopes of the Andes, in a variable north-south oriented band, particularly in areas of high rainfall and cloud cover. Moist reddish hydrolytic latosols cover much of the low eastern subtropical forest region. These are generally acid and heavily leached (Macey *et al.*, 1976).

CLIMATE

The Park is just south of the Equator, but being high, has a subtropical and temperate climate. Rainfall is strongly orographic. The eastern slopes of the Cordillera receive the most rainfall as moist warm air from the Amazon basin moves up over the Andes, creating a cloud forest belt. The mean annual rainfall at Pastaza, just to the northeast, is 4827mm; at Macas to the southeast, 2414mm. But the western boundary is in the rain shadow of the Western Cordillera and Penipe just beyond it has a mean annual rainfall of only 633mm. Seasonal variation is more marked to the west, with only 122 days of rain recorded in Riobamba. The wettest periods vary from site to site, generally occurring from November to February and April to October. Annual temperatures are relatively constant, although there is considerable diurnal variation. The mean annual temperature in the east is 20°C with a mean maximum and minimum of 25.4°C and 16.4°C and absolute recorded maximum and minimum of 31°C and 10°C. At the highest elevations, temperatures never rise above zero. A permanent snow line occurs at about 4,800m (Schuerholz *et al.*, 1980).

VEGETATION

Natural vegetation in very good condition covers 84.52% of Sangay. The Park has a high percentage of *páramo*, montane grassland, which has the greatest hydrological and soil carbon sequestration potential in Ecuador (IUCN, 2003). The Park lies within a WWF/IUCN Centre of Plant Diversity: at least 3,000 plant species are known to occur in the park. Some 93 families, 292 genera and 1,566 species have been identified in the Andean forests of Ecuador above 2,400m, and most of these genera are represented in Sangay (WWF & IUCN, 1997). The vegetation has three main zones: alpine and subalpine in the high *páramo*, montane cloud and wet forests, and subtropical and wet rain forests in the upper Amazon basin. (Nine life zones are detailed in the management plan.) It is principally influenced by altitude and rainfall, with the most luxuriant vegetation growing on the wetter eastern slopes.

Alpine rain tundra has formed between 4,500m and the snow line, dominated by lichens and bryophytes. A subalpine rain-*páramo* zone occurs between 3,400 and 4,000m, with three main vegetation types: *Festuca*

tussock grassland; areas of cushion plants and other low-growing species, and undisturbed stands of bamboo *Nuerolepis* sp. The edge of this zone has been lowered in the west by set fires. Below 3,750m montane rainforest grows on the wetter eastern slopes. The vegetation of the upper half of this zone grows about five metres high and is dominated by *Polylepis tomentella*, *Buddleia incana*, *Miconia salicifolia* and *Myrtus communis* associated with *Monnina crassifolia*, *Baccharis teindalensis*, *Disphostephium lavandulaefolium* and *Gnoxys* spp. Montane wet forest is found in the western valleys with pure stands of *Polylepis* sp. or *Gnoxys* sp. associated with *Buddleia incana* where undisturbed. At lower elevations, there is a greater variety of small trees and shrubs, including *Senecio vaccinoides*, *Diphostephium* sp., *Vaccinium* spp., *Miconia salicifolia*, *Brachyotum* spp., *Myrtus communis*, *Osteomeles* spp. and *Monnina crassifolia*.

Between 2,000m and 3,000m lower montane rainforest occurs on steep-sided valleys. Forests on its upper slopes are up to 12m high, dominated by *Weinmania* sp. and *Oreopanax* sp. Lower down, the canopy grows to 40m and includes *Podocarpus oleofolius*, red cedar *Cedrela odorata* (VU), *Oreopanax* sp., *Weinmania sryadifolia* and *Alnus jorullensis*, found in pure stands in disturbed areas. The understory layer is formed of small trees such as *Miconia* sp. and a third layer of *Piper ecuadorensis*, *Cyathea* sp. and *Bocconia* sp. Ferns, epiphytes and orchids are abundant and towards 2,000m, *Cecropia* sp., cedar *Cedrela odorata*, palms and *Rubiaceae* are present. Subtropical rainforest occurs below 2,000m where temperatures range between 18°C and 24°C and rainfall may reach 5000mm annually. Species diversity is very high and members of the *Lauraceae* and *Moraceae* such as *Ficus* spp. and *Chlorophora* spp., palms, *Cedrela odorata* and wild avocado *Persea* sp. occur. Undergrowth species such as *Selaginella sericea* and brightly coloured flowers of the *Gesneraceae* and *Lobeliaceae* are common. This formation receives less rainfall in the south, forming a subtropical wet forest, although there is no clear distinction with wetter areas. Species include *Cordia alliodora*, *Necandra* sp., *Ocotea* sp., *Cedrela rosei*, *Inga* sp. and *Ochroma lagopus*. *Centropogon trachyanthus* is endemic to this area. Macey *et al.* (1976) give partial species lists for the various formations.

FAUNA

The fauna is not well-studied, although it is known to be species rich. Species distributions correspond with vegetation zones and there is distinct altitudinal zonation. At the highest altitudes the guinea pig *Cavia aperea* and grey Andean small-eared shrew *Cryptotis montivaga*, Andean fox *Dusicyon culpaeus*, mountain tapir *Tapirus pinchaque* (EN)* and puma *Puma concolor* occur. Elsewhere in lower forests, spectacled bear *Tremarctos ornatus* (VU)*, giant otter *Pteronura brasiliensis* (EN), jaguar *Panthera onca*, ocelot *Leopardus pardalis*, margay *L. wiedii*, lowland tapir *Tapirus terrestris* (VU), white-tailed deer *Odocoileus virginianus clavium*, brocket deer *Mazama rufina* and northern pudu deer *Pudu mephistophiles*, are found. A partial species list is given in Macey *et al.* (1976). *indicator species

The Park lies within one of the world's Endemic Bird Areas (Stattersfield *et al.*, 1998). Some 400-500 bird species may be present, although comprehensive inventories have not yet been compiled. The Park contains two Endemic Bird Areas, the Central Andean Páramo, home to ten bird species of restricted range, and the Eastern Andes of Ecuador and northern Peru, home to 15 restricted-range species. Among these are listed the spot-winged parrotlet *Touit stictoptera* (VU), red-faced parrot *Hapalopsittaca pyrrhops* (VU), golden-plumed parakeet *Leptosittaca branickii* (VU), little woodstar *Acestrura bombus* (VU), coppery-chested jacamar *Galbula pastazae* (VU) and masked mountain tanager *Buthraupis wetmorei* (VU) (Wege & Long, 1995); also reported are the hummingbirds *Heliangelus viola* and *Campylopterus villaviscencio*, grey-breasted mountain toucan *Andigena hypoglauca*, turquoise jay *Cyanolyca turcosa* and red-hooded tanager *Piranga rubriceps* (IUCN, 2003). Other notable other species include condor *Vultur gryphus*, seen particularly around the mountain area of Altar, Cubillín and Quilimas, cock of the rock *Rupicola peruviana ecuatorialis*, in substantial populations in inaccessible upper forest areas of the eastern Andean slopes, giant hummingbird *Patagona gigas*, torrent duck *Marganetta armata*, king vulture *Sarcorhamphus papa* and swallow-tailed kite *Elanoides forficatus*. A preliminary species list is given in Macey *et al.* (1976).

CULTURAL HERITAGE

Prior to 1534, the area was inhabited by some 30,000 Indian Huamboyas, and Indian legends are still told about the volcanoes. In the following century, the Spanish prospected for gold, began to settle the country and put down a rebellion: 19th century explorers found no inhabitants in the area. Colonisation of the eastern side started in the early 20th century (M. de A. *in litt*, 2003).

LOCAL HUMAN POPULATION

Much of the Park area has been inaccessible and uninhabited. The resident Indian groups are the Quichuas- Puruháes in the northwest and centre, the Quichuas-Cañaris in the south and southwest and Shuar in the south and southeast. The Quichua populations practice a subsistence economy based upon access to and use of local resources. 17 archaeological sites and potential monuments (e.g. corrals) have been located. There is a need for more detailed archaeological fieldwork in the Park and around

(IUCN,2003). However, lands to both east and west have been populated for several years now, with a number of cooperative farms close to the eastern boundary which may edge closer (Macey *et al.*,1976). In 1987, there were approximately 400 people living at Atilio to the southwest, 70% of whom were permanent residents (J. Thorsell, pers.comm.1989). The area to the south added to the Park in 1992 had a resident population of about 1,000, adding to planning and management problems. There is also a noticeable increase in the presence of vaqueros and hunters in the western areas of Culebrillas and Plazapamba (INEFAN, pers comm.1995). The Alao area in the west is peopled by the indigenous Peruhá Amerindians (P.Catelan,1996).

VISITORS AND VISITOR FACILITIES

The areas attracting tourists include 327 lakes and three volcanoes, though since the recent eruptions of Tungurahua, only 300-400 visit the Park annually, down from approximately 3,000 a year in 1991, since most visitors tended to stay in the Tungurahua area - which had been starting to show signs of wear (M. de A. *in litt.*, 2003). Mountaineering on the major peaks of Tungurahua, Altar, Cubillin, Quilimas and Sangay is one of the Park's major attractions. Facilities include accommodation, hot springs, and trails (INEFAN, *in litt.*, 1995). A tourist information centre has been built in Macas (IUCN-SUR, 1993). Since 1989 the Peruhá Association of Indigenous Guides of the Volcanoes Altar and Sanguay (ASGUIAS) has operated from San Antonio de Alao and Guargualla, the easiest access to Sangay being from the Alao valley. This indigenous organisation has been awarded professional status by the Ecuadorian Government. It offers a guide service, a dormitory and tourist shop and promotes sustainable tourism. Difficult access has tended to limit public knowledge about the Park which could be promoted more widely (P.Catelan, 1996).

SCIENTIFIC RESEARCH AND FACILITIES

A study of management alternatives by Macey *et al.* in 1976 examined natural, social, cultural and historic resources in the area, and reviewed alternatives such as agriculture, forestry, economic potential of minerals and management as a wildland area. The results directly led to the establishment of Sangay National Park. The 1980 management plan (Schuerholz *et al.*1980) analysed biophysical, socio-economic, cultural and biological-ecological aspects of the Park to provide the foundation and justification for the different management programmes (Salazar & Huber, 1982). Research into the mountain tapir was undertaken in 1991-2, and among other subjects monitoring of the spectacled bear by the *Fundacion Natura Ecosciencia* is ongoing, but relatively little is known about the Park's natural resources which offer good opportunities for research (M.de A.*in litt.*,2003).

CONSERVATION VALUE

Sangay National Park is one of the world's most complex series of ecological habitats, and so far has been little altered. It lies within a C.I.-designated Conservation Hotspot, is a WWF Global 200 Freshwater Ecoregion, a WWF/IUCN Centre of Plant Diversity and lies in one of the world's Endemic Bird Areas. It received the highest resource analysis rating of any park in Ecuador. Its natural regions, terrestrial and aquatic ecosystems, physiographic formations, geology, history and other unique characteristics make it the most outstanding protected area in mainland Ecuador (FAO, 1976). It is an important protector of many watersheds, and has archaeological interest of unknown extent (WWF and IUCN, 1997).

CONSERVATION MANAGEMENT

The management plan by Schuerholz *et al.* in 1980 was to be implemented over five years from 1982. Its main objectives were to protect the site's integrity through zoning, to apply appropriate management to each zone, and to define zone boundaries and launch a program of education and awareness. The main primitive and scientific zones where no human activities are permitted comprise 90% of the area. Other zones are for ecological recuperation, extensive and intensive recreational use, and administrative use. The location and activities allowed and prohibited in these zones are detailed in Macey *et al.* (1976). However, these zones were drawn up without community input or checking in the field. Inventories are also lacking of the Park's biological and archaeological resources. Studies are lacking of the social-economic conditions of the local communities and stakeholder interests. And clarity over land tenure and budgetary allocations is lacking (IUCN, 2003a). A new management Plan was approved in 2005 (UNESCO,2005).

Until recently the difficulty of access made the Park relatively easy to protect and it was under the management of the Sub-Secretariat of Forestry and Renewable Natural Resources (INEFAN). Between 1990 and 1995, with financial aid from Fundacion Natura Ecuador and technical help from the US Peace Corps, numerous facilities were built, including a tourist information centre at Macas; guard posts at Atilio and San Juan (Alao) in the west, Palora, Macas, San Isidro, Pablo Sexto, VI Cooperativa, Sinai and 9 de Octubre in the east, and Rio Negro and Candelaria in the north; shelters at El Placer hot springs and at the base of Sangay volcano. 3 of the Amazon outposts were closed in 2005 and 4 were open once a week. Trails at Pondoá (Tungurahua) and Alao (El Placer) were modified, and signs were added to trails and at Park entrances. Management equipment includes four jeeps, 11 motorcycles and six horses (INEFAN,*in litt.*,1995). Due to decentralisation of the Ecuadorean public sector, the Park management is

headed by two managers whose offices are located at Riobamba and Macas (M.de A. *in litt.*,2003). The Association of Indigenous Guides of the Volcanoes Altar and Sangay, the indigenous co-operative, uses proceeds from tourism to finance projects to benefit their community. A new management plan is prepared, and WWF with the Ecuadorian conservation organisation *Fundacion Natura*, have implemented a five year conservation project funded by the Dutch government to deal with some of the issues faced by the Park such as assisting the State Party to avoid conflicts over land use and wildlife, and developing sustainable activities among the local people (UNESCO, 1999,2004).

One of UNDP's 2004 Equator prizes for the country went to the indigenous and campesino communities comprising the *Asociación de Trabajadores Autónomos San Rafael-Tres Cruces-Yurac Rumi* (ASARATY) which has, since 1999, been managing 8,000 ha of montane grassland (*páramos*) to counter the degradation of habitat adjacent to the Park. It has developed a participatory planning process to raise Alpacas sustainably and market products from Alpaca wool; also to increase food security, and develop income-generating ecotourism (UNDP,2004). The Amarzaga Project of the *Fundación Wanduk Yachai*, aided by the Tropical Rainforest Coalition (TRC) has bought 125 ha of primary premontane rainforest in the Llushin valley just east of the Park boundary to ensure its protection. The Wanduk family which manages the Foundation from the town of Puyo nearby have also been given permission to manage 50,000 ha of rainforest within the Park itself (TRC,2004).

MANAGEMENT CONSTRAINTS

The Park is most open to invasion on the east and south-east, and up the Alao valley in the west to hunters from Riobamba. Most of the subtropical lowland forest on the eastern boundary has been converted into cattle pasture and agricultural land. Overgrazing of the fragile *páramo* by cattle and sheep has occurred in the western areas of Filo de Plazapamba and Culebrillas Chico, resulting in extensive soil erosion and compaction. In 1987, fires burned approximately 300 ha in Naranjal Chico and 1,000 ha in Atilio destroying native vegetation (J.Thorsell, pers.comm. 1989) but the area has since recovered (M.de A. *in litt.*,2003).

Native animals do not yet seem to have been adversely effected by fire or introduced livestock, except in the Alao area northwest of Sangay volcano where urban poachers take mountain tapirs and deer, and the range of mountain tapir may be affected by increasing numbers of cattle. A 1996 report mentions the introduction of non-native species of trout into Rio Culebrillas which may subsequently colonise Rio Namaquim, one of the Sangay rivers, and the upper Rio Palora (P.Catelan, *in litt.*,1996). Subsistence poaching occurs in the areas around Filo de Plazapamba and Altar. There has been sporadic confrontation between the residents of Atilio and Park guards, the last in 1995 (INEFAN, *in litt.*,1995). Both spontaneous and organised colonisation of the lower slopes of the Andes around the edge of the Park is destroying the vegetation, contributing to erosion and could threaten important watersheds. Poaching by Shuar Indians who lost most of their land to colonists migrating from the Sierras, still occurs. There are incursions into the forests along the western and southern boundaries of the Park and into the Llushin River area in the north (J. Thorsell, pers. comm.,1989).

In 1992, the site was placed on the list of World Heritage in Danger mainly because of the construction of a road by the Ministry of Public Works across the south end of the Park from Guamote in the high Andes to Macas on the plain to the southeast which divides the World Heritage site from the southern half of the Park outside it. Although the site is only crossed by the road for 8km, it was severely affected by the construction impacts: pollution of the Upana River and nearby lakes, use of dynamite, destruction of biological corridors, microclimate changes and indirect effects: new settlements, cattle ranching, poaching and logging (Wunder,1995). However, since completion, the roadsides have begun to re-forest. This area has since been excluded from the World Heritage site. The construction also worried local people about their rights to land. The IUCN team and Park staff met opposition at the time but relations with the local people are now good (M.de A. *in litt.*,2003) and according to INEFAN, colonisation in the Guamboya valley and along Rio Palora and small scale mining activities have been stopped (UNESCO, 1998). There is also a potential threat of artisanal gold mining in the Llushin Grande and Huamboya areas. Effective management has been greatly hindered because of a lack of staff and too low a budget (INEFAN, *in litt.*,1995). Encroachment by hunters, farmers and herdsman and unresolved conflicts over land tenure are still common. But by 2001, a UNF-funded pilot project to test the effectiveness of monitoring and management tools developed by IUCN and WCPA led to the removal of the site from the danger list (UNESCO, 2002).

STAFF

Two park managers, at the Macas and Riobamba centres, three biologist/sub-superintendents, four technicians and 12 guard parks. In 1994 the Park staff was reduced by 30% because of government budgetary cuts (M.de A. *in litt.*,2003). Staff are still too few and ineffective to monitor the site and enforce regulations.

BUDGET

A budget of 120,000,000 sucres (US\$55,000) was proposed for 1995, US\$1.6 million was pledged by the government of the Netherlands, to be implemented by Fundacion Natura, the WWF, and the Nature Conservancy to help protect the Park (UNESCO,1999). In 2002 a UNF/IUCN/UNESCO pilot study *Enhancing Our Heritage* was started to improve conservation and monitoring of the area. But central government funding has been severely cut back in recent years (UNESCO,2005).

ADDRESSES

The Director, INEFAN, Junto al Ministerio de Agricultura y Ganaderia, Av. Eloy Alfonso y Amazonas, Quito, Ecuador.

The Director, INEFAN, Junto al Ministerio de Agricultura y Ganaderia, Riobamba, Ecuador.

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DATE December 1982. Updated 5-1989, 9-1989, 7-1995, 7-1997, 4-2002, October 2005.

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PHYSICAL FEATURES

The Park comprises three geomorphic zones: the volcanic High Andes, the eastern foothills and alluvial fans. The highlands, of pre-Cretaceous metamorphic and plutonic rocks, rise from 2,000-5,000m and are dominated by three stratovolcanoes: Tungurahua (5,016m) and Altar (5,319m) in the northwest and Sangay (5,230m) in the west centre of the park. Tungurahua and Sangay are both still active: Sangay regularly ejects hot rocks and tephra and since 1934 has been one of the world's most continuously active volcanoes. Tungurahua last violently erupted between 1916 and 1925, erupted in 2002 and was the subject of a red alert in 2004. Altar has an eroded and glaciated caldera to the west, and is considered extinct (WWF & IUCN, 1997). The eastern foothills in the north-east and south-east are low irregular mountains between 1,000m and 2,000m in height formed of outcrops of sedimentary rocks. Large east-sloping alluvial fans dominate the east side of the Park between approximately 800m and 1,300m. Younger segments of these fans are only slightly dissected, but older parts are cut into by canyons up to 200m deep (Schuerholz *et al.*, 1980).

The High Andes zone and its volcanoes in Ecuador result from the subduction of the Nazca plate under the South American plate. It lies in the intermediate and upper Cordillera Oriental, an area of rugged topography with deep steep-sided valleys, abundant cliffs and many rocky jagged peaks. There are three subzones: subglacial, from 2,000m to 3,000m which is unglaciated; a glaciated subzone between 3,000m and 5,300m, with arêtes, cirques, and U-shaped valleys with meandering rivers, and a volcanic subzone dominated by lava and volcanic ash deposited during more recent times on the cones and flanks of the three volcanoes (Schuerholz *et al.*, 1980).

The major rivers drain east to the Amazon Basin. From north to south these are the Lushin and its tributary Shicoyocu; Palora and its tributaries: Collones, Santa Ana, Sangay and Namoqim; and Upano and its tributaries: Volcan and Sangan. They fall with rapid and dramatic variations in level. Run-off is extremely rapid due to high rainfall and steep slopes, and erosion is substantial, although controlled by thick forest vegetation. There are numerous waterfalls, especially in the hanging valleys of the glaciated zone and along the eastern edge of the Cordillera, and many lakes, including Laguna Pintada near Altar which is 5 km long (Schuerholz *et al.*, 1980).

Above 4,500m rocky lithosols are found in limited areas around the principal volcanoes. A thin layer of organic matter covers recent ash falls around and to the east of Sangay volcano. In the east between 3,000m and 4,500m are extensive black Andean soils of the *Paramo* (montane grassland) formed from volcanic base material. Black Andean soils of the cloud forest are found on the middle slopes of the Andes, in a variable north-south oriented band, particularly in areas of high rainfall and cloud cover. Moist reddish hydrolytic latosols cover much of the low eastern subtropical forest region. These are generally acid and heavily leached (Macey *et al.*, 1976).

CLIMATE

The Park is just south of the Equator, but being high, has a subtropical and temperate climate. Rainfall is strongly orographic. The eastern slopes of the Cordillera receive the most rainfall as moist warm air from the Amazon basin moves up over the Andes, creating a cloud forest belt. The mean annual rainfall at Pastaza, just northeast of the Park, is 4827mm; at Macas to the southeast, 2414mm. But the western boundary is in the rain shadow of the Western Cordillera and Penipe just beyond it has a mean annual rainfall of only 633mm. Seasonal variation is more marked to the west, with only 122 days of rain recorded in Riobamba. The wettest periods vary from site to site, generally occurring from November to February and April to October. Annual temperatures are relatively constant, although there is considerable diurnal variation. The mean annual temperature in the east is 20° C with a mean maximum and minimum of 25.4° C and 16.4° C and absolute recorded maximum and minimum of 31°C and 10°C. At the highest elevations, temperatures never rise above zero. A permanent snow line occurs at about 4,800m (Schuerholz *et al.*, 1980).

VEGETATION

Natural vegetation in very good condition covers 84.52% of Sangay. The Park has a high percentage of *páramo*, montane grassland, which has the greatest hydrological and soil carbon sequestration potential in Ecuador (IUCN,2003). The Park lies within a WWF/IUCN Centre of Plant Diversity: at least 3,000 plant species are known to occur in the park. Some 93 families, 292 genera and 1,566 species have been identified in the Andean forests of Ecuador above 2,400m, and most of these genera are represented in Sangay (WWF & IUCN, 1997). The vegetation has three main zones: alpine and subalpine in the high *páramo*, montane cloud and wet forests, and subtropical and wet rain forests in the upper Amazon basin. (Nine life zones are detailed in the management plan.) It is principally influenced by altitude and rainfall, with the most luxuriant vegetation growing on the wetter eastern slopes.

Alpine rain tundra has formed between 4,500m and the snow line, dominated by lichens and bryophytes. A subalpine rain-*páramo* zone occurs between 3,400 and 4,000m, with three main vegetation types: *Festuca* tussock grassland; areas of cushion plants and other low-growing species, and undisturbed stands of bamboo *Nurolepis* sp. The edge of this zone has been lowered in the west by set fires. Below 3,750m montane rainforest grows on the wetter eastern slopes. The vegetation of the upper half of this zone grows about five metres high and is dominated by *Polylepis tomentella*, *Buddleia incana*, *Miconia salicifolia* and *Myrtus communis* associated with *Monnina crassifolia*, *Baccharis teindalensis*, *Disphostephium lavandulaefolium* and *Gnoxys* spp. Montane wet forest is found in the western valleys with pure stands of *Polylepis* sp. or *Gnoxys* sp. associated with *Buddleia incana* where undisturbed. At lower elevations, there is a greater variety of small trees and shrubs, including *Senecio vaccinooides*, *Diphostephium* sp., *Vaccinium* spp., *Miconia salicifolia*, *Brachyotum* spp., *Myrtus communis*, *Osteomeles* spp. and *Monnina crassifolia*.

Between 2,000m and 3,000m lower montane rainforest occurs on steep-sided valleys. Forests on its upper slopes are up to 12m high, dominated by *Weinmania* sp. and *Oreopanax* sp. Lower down, the canopy grows to 40m and includes *Podocarpus oleoifolius*, red cedar *Cedrela odorata* (VU), *Oreopanax* sp., *Weinmania sryadifolia* and *Alnus jorullensis*, found in pure stands in disturbed areas. The understorey layer is formed of small trees such as *Miconia* sp. and a third layer of *Piper ecuadorensis*, *Cyathea* sp. and *Bocconia* sp. Ferns, epiphytes and orchids are abundant and towards 2,000m, *Cecropia* sp., cedar *Cedrela odorata*, palms and *Rubiaceae* are present. Subtropical rainforest occurs below 2,000m where temperatures range between 18°C and 24°C and rainfall may reach 5000mm annually. Species diversity is very high and members of the *Lauraceae* and *Moraceae* such as *Ficus* spp. and *Chlorophora* spp., palms, *Cedrela odorata* and wild avocado *Persea* sp. occur. Undergrowth species such as *Selaginella sericea* and brightly coloured flowers of the *Gesneraceae* and *Lobeliaceae* are common. This formation receives less rainfall in the south, forming a subtropical wet forest, although there is no clear distinction with wetter areas. Species include *Cordia alliodora*, *Necandra* sp., *Ocotea* sp., *Cedrela rosei*, *Inga* sp. and *Ochroma lagopus*. *Centropogon trachyanthus* is endemic to this area. Macey *et al.* (1976) give partial species lists for the various formations.

FAUNA

The fauna is not well-studied, although it is known to be species rich. Species distributions correspond with vegetation zones and there is distinct altitudinal zonation. At the highest altitudes the guinea pig *Cavia aperea* and grey Andean small-eared shrew *Cryptotis montivaga*, Andean fox *Dusicyon culpaeus*, mountain tapir *Tapirus pinchaque* (EN)* and puma *Puma concolor* occur. Elsewhere in lower forests, spectacled bear *Tremarctos ornatus* (VU)*, giant otter *Pteronura brasiliensis* (EN), jaguar *Panthera onca*, ocelot *Leopardus pardalis*, margay *L. wiedii*, lowland tapir *Tapirus terrestris* (VU), white-tailed deer *Odocoileus virginianus clavium*, brocket deer *Mazama rufina* and northern pudu deer *Pudu mephistophiles*, are found. A partial species list is given in Macey *et al.* (1976).

*indicator species

The Park lies within one of the world's Endemic Bird Areas (Stattersfield *et al.*, 1998). Some 400-500 bird species may be present, although comprehensive inventories have not yet been compiled. The Park contains two Endemic Bird Areas, the Central Andean Páramo, home to ten bird species of restricted range, and the Eastern Andes of Ecuador and northern Peru, home to 15 restricted-range species. Among these are listed the spot-winged parrotlet *Touit stictoptera* (VU), redfaced parrot *Hapalopsittaca pyrrhops* (VU), golden-plumed parakeet *Leptosittaca branickii* (VU), little woodstar *Acestrura bombus* (VU), coppery-chested jacamar *Galbula pastazae* (VU) and masked mountain tanager *Buthraupis wetmorei* (VU) (Wege & Long, 1995); also reported are the hummingbirds *Heliangelus viola* and *Campylopterus villaviscencio*, greybreasted mountain toucan *Andigena hypoglauca*, turquoise jay *Cyanolyca turcosa* and red-hooded tanager *Piranga rubriceps* (IUCN,2003). Other notable other species include condor *Vultur gryphus*, seen particularly around the mountain area of Altar, Cubillín and Quilimas, cock of the rock *Rupicola peruviana ecuatorialis*, in substantial populations in inaccessible upper forest areas of the eastern Andean slopes, giant hummingbird *Patagona gigas*, torrent duck *Marganetta armata*, king vulture *Sarcoramphus papa* and swallow-tailed kite *Elanoides forficatus*. A preliminary species list is given in Macey *et al.* (1976).

CULTURAL HERITAGE

Prior to 1534, the area was inhabited by some 30,000 Indian Huamboyas, and Indian legends are still told about the volcanoes. In the following century, the Spanish prospected for gold, began to settle the country and put down a rebellion: 19th century explorers found no inhabitants in the area. Colonisation of the eastern side started in the early 20th century (M.de A. *in litt*, 2003).

LOCAL HUMAN POPULATION

Much of the Park area has been inaccessible and uninhabited. The resident Indian groups are the Quichuas-Puruháes in the northwest and centre, the Quichuas-Cañaris in the south and southwest and Shuar in the south and southeast. The Quichua populations practice a subsistence economy based upon access to and use of local resources. 17 archaeological sites and potential monuments (e.g. corrals) have been located. There is a need for more detailed archaeological fieldwork in the Park and around (IUCN,2003). However, lands to both east and west have been populated for several years now, with a number of cooperative farms close to the eastern boundary which may edge closer (Macey *et al.*,1976). In 1987, there were approximately 400 people living at Atilio to the southwest, 70% of whom were permanent residents (J. Thorsell, pers.comm.1989). The area to the south added to the Park in 1992 had a resident population of about 1,000, adding to planning and management problems. There is also a noticeable increase in the presence of vaqueros and hunters in the western areas of Culebrillas and Plazapamba (INEFAN, pers comm.1995). The Alao area in the west is peopled by the indigenous Peruhá Amerindians (P.Catelan,1996).

VISITORS AND VISITOR FACILITIES

The areas attracting tourists include 327 lakes and three volcanoes, though since the recent eruptions of Tungurahua, only 300-400 visit the Park annually, down from approximately 3,000 a year in 1991, since most visitors tended to stay in the Tungurahua area - which had been starting to show signs of wear (M. de A. *in litt*, 2003). Mountaineering on the major peaks of Tungurahua, Altar, Cubillin, Quilimas and Sangay is one of the Park's major attractions. Facilities include accommodation, hot springs, and trails (INEFAN, *in litt*, 1995). A tourist information centre has been built in Macas (IUCN-SUR, 1993). Since 1989 the Peruhá Association of Indigenous Guides of the Volcanoes Altar and Sanguay (ASGUIAS) has operated from San Antonio de Alao and Guargualla, the easiest access to Sangay being from the Alao valley. This indigenous organisation has been awarded professional status by the Ecuadorian Government. It offers a guide service, a dormitory and tourist shop and promotes sustainable tourism. Difficult access has tended to limit public knowledge about the Park which could be promoted more widely (P.Catelan, 1996).

SCIENTIFIC RESEARCH AND FACILITIES

A study of management alternatives by Macey *et al.* in 1976 examined natural, social, cultural and historic resources in the area, and reviewed alternatives such as agriculture, forestry, economic potential of minerals and management as a wildland area. The results directly led to the establishment of Sangay National Park. The 1980 management plan (Schuerholz *et al.*1980) analysed biophysical, socio-economic, cultural and biological-ecological aspects of the Park to provide the foundation and justification for the different management programmes (Salazar & Huber, 1982). Research into the mountain tapir was undertaken in 1991-2, and among other subjects monitoring of the spectacled bear by the *Fundacion Natura Ecosciencia* is ongoing, but relatively little is known about the Park's natural resources which offer good opportunities for research (M.de A. *in litt*,2003).

CONSERVATION VALUE

Sangay National Park is one of the world's most complex series of ecological habitats, and so far has been little altered. It lies within a C.I.-designated Conservation Hotspot, is a WWF Global 200 Freshwater Eco-region, a WWF/IUCN Centre of Plant Diversity and lies in one of the world's Endemic Bird Areas. It received the highest resource analysis rating of any park in Ecuador. Its natural regions, terrestrial and aquatic ecosystems, physiographic formations, geology, history and other unique characteristics make it the most outstanding protected area in mainland Ecuador (FAO, 1976). It is an important protector of many watersheds, and has archaeological interest of unknown extent (WWF and IUCN, 1997).

CONSERVATION MANAGEMENT

The management plan by Schuerholz *et al.* in 1980 was to be implemented over five years from 1982. Its main objectives were to protect the site's integrity through zoning, to apply appropriate management to each zone, and to define zone boundaries and launch a program of education and awareness. The main primitive and scientific zones where no human activities are permitted comprise 90% of the area. Other zones are for ecological recuperation, extensive and intensive recreational use, and administrative use. The location and activities allowed and prohibited in these zones are detailed in Macey *et al.* (1976). However, these zones were drawn up without community input or checking in the field. Inventories are also lacking of the Park's biological and archaeological resources. Studies are lacking of the social-economic conditions of the local communities and stakeholder interests. And clarity over land tenure and budgetary allocations is lacking (IUCN, 2003a). A new management Plan was approved in 2005 (UNESCO,2005).

Until recently the difficulty of access made the Park relatively easy to protect and it was under the management of the Sub-Secretariat of Forestry and Renewable Natural Resources (INEFAN). Between 1990 and 1995, with financial aid from Fundacion Natura Ecuador and technical help from the US Peace Corps, numerous facilities were built, including a tourist information centre at Macas; guard posts at Atilio and San Juan (Alao) in the west, Palora, Macas, San Isidro, Pablo Sexto, VI Cooperativa, Sinai and 9 de Octubre in the east, and Rio Negro and Candelaria in the north; shelters at El Placer hot springs and at the base of Sangay volcano. 3 of the Amazon outposts were closed in 2005 and 4 were open once a week. Trails at Pondoia (Tungurahua) and Alao (El Placer) were modified, and signs were added to trails and at Park entrances. Management equipment includes four jeeps, 11 motorcycles and six horses (INEFAN, *in litt.*, 1995). Due to decentralisation of the Ecuadorean public sector, the Park management is headed by two managers whose offices are located at Riobamba and Macas (M.de A. *in litt.*, 2003). The Association of Indigenous Guides of the Volcanoes Altar and Sanguay, the indigenous co-operative, uses proceeds from tourism to finance projects to benefit their community. A new management plan is prepared, and WWF with the Ecuadorian conservation organisation *Fundacion Natura*, have implemented a five year conservation project funded by the Dutch government to deal with some of the issues faced by the Park such as assisting the State Party to avoid conflicts over land use and wildlife, and developing sustainable activities among the local people (UNESCO, 1999, 2004).

One of UNDP's 2004 Equator prizes for the country went to the indigenous and campesino communities comprising the *Asociación de Trabajadores Autónomos San Rafael-Tres Cruces-Yurac Rumi* (ASARATY) which has, since 1999, been managing 8,000 ha of montane grassland (*páramos*) to counter the degradation of habitat adjacent to the Park. It has developed a participatory planning process to raise Alpacas sustainably and market products from Alpaca wool; also to increase food security, and develop income-generating ecotourism (UNDP, 2004). The Amarzaga Project of the *Fundación Wanduk Yachai*, aided by the Tropical Rainforest Coalition (TRC) has bought 125 ha of primary premontane rainforest in the Llushin valley just east of the Park boundary to ensure its protection. The Wanduk family which manages the Foundation from the town of Puyo nearby have also been given permission to manage 50,000 ha of rainforest within the Park itself (TRC, 2004).

MANAGEMENT CONSTRAINTS

The Park is most open to invasion on the east and south-east, and up the Alao valley in the west to hunters from Riobamba. Most of the subtropical lowland forest on the eastern boundary has been converted into cattle pasture and agricultural land. Overgrazing of the fragile *páramo* by cattle and sheep has occurred in the western areas of Filo de Plazapamba and Culebrillas Chico, resulting in extensive soil erosion and compaction. In 1987, fires burned approximately 300 ha in Naranjal Chico and 1,000 ha in Atilio destroying native vegetation (J. Thorsell, pers. comm. 1989) but the area has since recovered (M.de A. *in litt.*, 2003).

Native animals do not yet seem to have been adversely effected by fire or introduced livestock, except in the Alao area northwest of Sangay volcano where urban poachers take mountain tapirs and deer, and the range of mountain tapir may be affected by increasing numbers of cattle. A 1996 report mentions the introduction of non-native species of trout into Rio Culebrillas which may subsequently colonise Rio Namaquim, one of the Sangay rivers, and the upper Rio Palora (P. Catelan, *in litt.*, 1996). Subsistence poaching occurs in the areas around Filo de Plazapamba and Altar. There has been sporadic confrontation between the residents of Atilio and Park guards, the last in 1995 (INEFAN, *in litt.*, 1995). Both spontaneous and organised colonisation of the lower slopes of the Andes around the edge of the Park is destroying the vegetation, contributing to erosion and could threaten important watersheds. Poaching by Shuar Indians who lost most of their land to colonists migrating from the Sierras, still occurs. There are incursions into the forests along the western and southern boundaries of the Park and into the Llushin River area in the north (J. Thorsell, pers. comm., 1989).

In 1992, the site was placed on the list of World Heritage in Danger mainly because of the construction of a road by the Ministry of Public Works across the south end of the Park from Guamote in the high Andes to Macas on the plain to the southeast which divides the World Heritage site from the southern half of the Park outside it. Although the site is only crossed by the road for 8km, it was severely affected by the construction impacts: pollution of the Upana River and nearby lakes, use of dynamite, destruction of biological corridors, microclimate changes and indirect effects: new settlements, cattle ranching, poaching and logging (Wunder, 1995). However, since completion, the roadsides have begun to re-forest. This area has since been excluded from the World Heritage site. The construction also worried local people about their rights to land. The IUCN team and Park staff met opposition at the time but relations with the local people are now good (M.de A. *in litt.*, 2003) and according to INEFAN, colonisation in the Guamboya valley and along Rio Palora and small scale mining activities have been stopped (UNESCO, 1998). There is also a potential threat of artisanal gold mining in the Llushin Grande and Huamboya areas. Effective management has been greatly hindered because of a lack of staff and too low a budget (INEFAN, *in litt.*, 1995). Encroachment by hunters, farmers and herdsman and unresolved conflicts over land tenure are still common. But by 2001, a UNF-

funded pilot project to test the effectiveness of monitoring and management tools developed by IUCN and WCPA led to the removal of the site from the danger list (UNESCO, 2002).

STAFF

Two park managers, at the Macas and Riobamba centres, three biologist/sub-superintendents, four technicians and 12 guard parks. In 1994 the Park staff was reduced by 30% because of government budgetary cuts (M.de A. *in litt.*, 2003). Staff are still too few and ineffective to monitor the site and enforce regulations.

BUDGET

A budget of 120,000,000 sucres (US\$55,000) was proposed for 1995, US\$1.6 million was pledged by the government of the Netherlands, to be implemented by Fundacion Natura, the WWF, and the Nature Conservancy to help protect the Park (UNESCO, 1999). In 2002 a UNF/IUCN/UNESCO pilot study *Enhancing Our Heritage* was started to improve conservation and monitoring of the area. But central government funding has been severely cut back in recent years (UNESCO, 2005).

ADDRESSES

The Director, INEFAN, Junto al Ministerio de Agricultura y Ganaderia, Av. Eloy Alfonso y Amazonas, Quito, Ecuador.

The Director, INEFAN, Junto al Ministerio de Agricultura y Ganaderia, Riobamba, Ecuador.

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DATE December 1982. Updated 5-1989, 9-1989, 7-1995, 7-1997, 4-2002, October 2005.