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Tropical Montane Cloud Forests: An Urgent Priority for Conservation

By World Conservation Monitoring Centre

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SUMMARY

Tropical montane cloud forests (TMCFs) are high on the list of the world's most threatened ecosystems. In order to achieve the conservation of remaining areas there is an urgent need for information on the location, extent, protection status, biological importance, socio-economic conditions and current threats on a site by site basis. This report describes a first phase of work on the development of a global database and draft directory of Tropical Montane Cloud Forests. Interim results and conclusions are provided from a global overview of the information gathered to date. It concludes by recommending a series of activities to be undertaken in a further phase of work.

INTRODUCTION

Tropical montane cloud forests (TMCFs) are high on the list of the world's most threatened ecosystems, and it is widely believed that the majority of those which remain are small areas or remnant fragments of their original extent. The situation is critical – James Luteyn, a botanist with the New York Botanic Garden states that "*some 90% of mountain forests have disappeared from the northern Andes*", whilst attention has been focused on the plight of tropical rain forests of the Amazonian basin (Wuetrich, 1993). Immediate action is required to achieve the conservation of remaining TMCFs before any more of these rare and valuable habitats are lost for good.

Much of their value is related to their unique characteristics of biodiversity and endemism and the functions that they provide. In addition to having a wealth of biological diversity which has been previously undervalued, TMCFs possess a very high proportion of endemic species, and probably many more as yet unknown to science. Many TMCF areas serve as refugia for endangered species which are being marginalised by the transformation and/or destruction of ecosystems at lower elevations. Furthermore, the hydrological role of TMCFs through their water stripping function gives them a value in terms of water resources that is quite distinct from other forests or types of land use (Stadtmuller, 1987, quoted in

Hamilton *et al*. 1993). Leaves and branches of tree crowns intercept wind-driven cloud moisture, which drips to the ground, resulting in the addition of water to the hydrological system. As a result TMCFs play an important role in watershed protection by maintaining ground cover, thus minimising soil erosion and providing a regular and controlled supply of water to communities living downstream.

If managed sustainably, TMCFs can provide a valuable range of other services to local populations living in or adjacent to the forest. As well as being a source of fuelwood and small dimension timber, they may provide a range of non-wood forest products including honey, medicinal plants and bushmeat.

However, despite their considerable value, these fragile habitats are under increasing threat from a wide range of sources. In particular, human population pressures have forced the conversion of more marginal and previously less accessible areas for both subsistence and cash crops. Many areas are under pressure from encroachment by live-stock or have already been cleared to provide new grazing land. In many areas the exploitation of fuelwood and non-wood forest products has reached unsustainable levels resulting in irreversible damage to the forest habitat. The same is true for hunting or capture of fauna (for sport, subsistence or commercial trade), tourism and recreation. Plans for new road building projects threaten many remaining TMCFs along with mining and geothermal development schemes, many of which are well established.

DEFINITION

Hamilton *et al*. (1993) acknowledge that "*clear definition of tropical montane cloud forest is fraught with difficulty*". Despite having a number of key recognisable features, these vary greatly from one area to another, and this, combined with an enormous range in the terminology used to identify TMCFs leads to considerable confusion. At a *Tropical Montane Cloud Forests International State-of-knowledge Symposium and Workshop* held in Puerto Rico in June 1993, a synthesis working definition was developed which

Box 1. Synthesis Working Definition

Hamilton, Juvik, and Scatena (from Hamilton *et al*, (1993));

"The tropical montane cloud forest is composed of forest ecosystems of distinctive floristic and structured form. It typically occurs as a relatively narrow altitudinal zone where the atmospheric environment is characterised by persistent, frequent or seasonal cloud cover at the vegetation level. Enveloping cloud or wind-driven clouds influence the atmospheric interaction through reduced solar radiation and vapour deficit, canopy wetting, and general suppression of evapotranspiration. The net precipitation (throughfall) is significantly enhanced (beyond rainfall contribution) through direct canopy interception of cloud water (horizontal precipitation or cloud stripping) and low water use by the vegetation.

In comparison with lower latitude tropical moist forest, the stand characteristics generally include reduced tree stature and increased stem density. Canopy trees usually exhibit gnarled trunks and branches; dense compact crowns; and small, thick and hard (sclerophyll) leaves. TMCF is also characterised by having a high proportion of biomass as epiphytes (bryophytes, lichens and filmy ferns) and a corresponding reduction in woody climbers. Soils are wet and frequently waterlogged and highly organic in the form of humus and peat (histosol). Biodiversity in terms of tree species of herbs, shrubs and epiphytes can be relatively high (considering the small areal extent) when compared with tree species-rich lowland rain forest. Endemism is often very high.

TMCF occurs on a global scale within a wide range of annual and seasonal rainfall regimes i.e. 500–10,000mm.year). There is also significant variation in the altitudinal position of this mountain vegetation belt. For large, inland mountain systems, TMCF may typically be found between 2000–3500m (Andes, Rwenzoris), whereas in coastal and insular mountains this zone may descend to 100m (Hawai'i). Under exceptionally humid marine, equatorial conditions, a TMCF zone may develop on steep, small island mountains at elevaitons as low as 500m or even lower (Kosrae in Micronesia and Gau in Fiji)."

has been used as a guide for the purposes of the current project (Box 1).

DEVELOPMENT OF A GLOBAL DATABASE

The need for information

To date, at the global level, relatively little is known about the whereabouts, extent and condition of the remaining areas of TMCF. In particular, detail is required on the protection status, biological importance, socio-economic conditions and current threats on a site by site basis. Although in some cases detailed information exists for specific sites, it is widely scattered and often not generally available.

In response to these issues, the TMCF Symposium in Puerto Rico was organised with the aim of drawing together information on the global extent of TMCFs. In addition to producing regional maps showing general concentrations of TMCF, and a list of sites by region and country, the participants made a series of recommendations concerning general and specific research needs.

As a priority, they recommended that relevant information should be collected and analysed in a co-ordinated way in order to improve understanding of these ecosystems, and to ensure that reliable information is made available to a range of users for effective decision making. They also proposed the development of a standardised methodology and format for collecting information, through a world-wide inventory of TMCFs, with textual, numerical and spatial data stored on a centralised database at the World Conservation Monitoring Centre (WCMC).

METHODS

Database Design

Following a review of the types of information available which contained descriptions of TMCF sites, a draft framework for recording data in a database was developed. A set of draft materials were then sent to a core group of contacts with experience and/or knowledge of cloud forest issues, for comment. These materials included a proposed structure for recording both summary and more detailed information, along with a detailed national map designed to facilitate the addition of cloud forest sites. Having reviewed the range of responses from the core group, the database layout was designed.

A new recording facility to store data on TMCFs was added to the existing Protected Areas database at WCMC. This includes the ability to link cloud forest sites to protected area records. Based on the database layout, blank summary site data sheets were designed for collecting information. The Geographic Information System (GIS) database was also prepared to receive site locations where available.

Information Gathering

A pilot information gathering exercise began with sets of materials being sent to more than 40 contacts in South and Central America. Each set included a country map, copies of the blank summary site sheets, and a photocopy of the synthesis working definition developed at the Puerto Rico Symposium, accompanied by a letter of explanation. In practice the results from this exercise were poor, although in a minority of cases, sets of completed site sheets were returned along with maps on which the location of cloud forest sites had been marked. At this point it was decided to complement the information received with material gathered from a comprehensive review of information available through research at WCMC.

Data were recorded on a site by site basis where available. However the amount of detail was very variable between sites, so it was decided to group sites into sub-national regions (often mountain ranges or islands, but in some cases single, isolated mountain peaks). Descriptive information from the sites in a particular region was compiled into a summary paragraph for the region, which was entered into the database in a memo field.

Compilation of a draft directory

Following an intensive period of research and compilation, a draft directory of TMCFs has been produced. It is intended to distribute it to all contributors and a number of other contacts in hard copy form. In addition the material will be made available on the WCMC Internet Web Site.

A global directory has been compiled, consisting of sections on each of the major tropical regions,

Africa, Latin America and south-east Asia, which contain a chapter on each country included. Each chapter begins with a national overview, map and summary table showing the main sub-national cloud forest regions and sites identified with latitude and longitude co-ordinates where available, along with an indication of which sites have an element of formal protection (this refers to sites classified as meeting IUCN Management Category I–VI criteria). This is followed by summary paragraphs describing each of the sub-national regions in terms of location, biodiversity, conservation status, and giving details of the values of the TMCF sites in the area and the pressures currently faced. An example chapter is shown in the Annex along with map 4.

RESULTS

Global Overview

A total of 605 TMCF sites in 41 countries have been identified to date (see Tables 1 to 4). These are marked on maps 1–3 which show the distribution of montane cloud forest sites in the three tropical regions. The highest concentration is found in Latin America, where 280 sites (46%) are found in only 12 countries, the majority in Venezuela, Mexico, Ecuador and Colombia. In south-east Asia, 228 sites have been identified in 14 countries principally in Indonesia and Malaysia and to a lesser extent in Sri Lanka, Philippines and Papua New Guinea. In Africa, 97 sites have been recorded in 21 countries, with many cloud forests found on relatively isolated mountains which are scattered across the continent.

Details of the size of particular cloud forest sites have been difficult to obtain, except where the information has been supplied by local experts. In any case, the actual extent of cloud forest itself as distinct from the surrounding or adjoining forest type is very difficult to determine, even on the ground.

An initial assessment of the values of cloud forests shows that the majority of areas are exceptionally important habitats for endemic and other threatened species of flora and fauna, including many important tree species and plant such as tree ferns *Cyatheaceae* and orchids *Orchidaceae*. Large numbers of bird species and mammals such as the spectacled bear *Tremarctos ornatus* and howler monkeys *Alouatta* spp. are dependent on cloud forest habitat for their survival. In addition these forests have a high socio-economic value to local populations principally as a source of fuelwood, building materials and food amongst others, but also on a larger scale for watershed protection and climate regulation. At the same time, overcutting for fuelwood, clearance for agriculture, encroachment by grazing animals and the spread of fire from grass-burning of adjoining areas were identified as amongst the major localised threats to these fragile ecosystems and their inhabitants. In addition many areas are under pressure from mining companies and large-scale road building projects, often against the wishes of local people.

Globally from the information gathered, just under half the sites identified have an element of protection by being within protected areas classified as meeting IUCN Management Category I–VI criteria. Others may be under less formal protection as private reserves or in collaborative forest management agreements, although this information is not available at this stage. In south-east Asia, 50% of sites identified are within IUCN protected areas, while Latin America has 44% (Central America has only 30%, while South America has 47%), and Africa has 39%. However, despite the fact that cloud forests in these areas are legally designated as “protected”, in practice many are under pressure from the threats described above and are continuing to become more fragmented, and in some areas completely lost, at an alarming rate.

TABLE 1: SOUTH-EAST ASIA

Total number of regions and sites per Country, with the number of sites protected.

Country	Total No. of CF regions*	Total No of CF sites	Total No of sites with protection
Australia	1	2	0
Brunei Darussalam	1	5	5
Cambodia	1	1	0
China	1	1	1
India	1	3	3
Indonesia	12	66	29
Lao PDR	0	0	0
Malaysia	24	54	46
Myanmar	1	1	1
Papua New Guinea	3	28	2
Philippines	14	32	19
Sri Lanka	2	33	7
Thailand	1	1	1
Viet Nam	1	1	0
Total	**63**	**228**	**114**

TABLE 2: AFRICA

Total number of regions and sites per Country, with the number of sites protected.

Country	Total No. of CF regions*	Total No of CF sites	Total No of sites with protection
Angola	2	10	0
Burundi	2	2	0
Cote d'Ivoire	1	1	0
Cameroon	5	9	2
Equatorial Guinea	1	3	3
Ethiopia	2	2	1
Gabon	4	4	0
Guinea	1	1	0
Kenya	4	15	12
Liberia	1	1	0
Madagascar	3	4	2
Malawi	3	3	3
Mozambique	5	5	0
Nigeria	3	3	2
Reunion	1	2	0
Rwanda	3	4	2
Sao Tome and Principe	1	1	0
Sierra Leone	2	2	1
Tanzania	3	11	2
Uganda	4	4	3
Zaire	6	10	5
Total	**57**	**97**	**38**

TABLE 3a: CENTRAL AMERICA

Total number of regions and sites per Country, with the number of sites protected.

Country	Total No of CF regions*	Total No of CF sites	Total No of sites with protection
Belize	1	1	1
Costa Rica	4	14	10
El Salvador	1	13	3
Guatemala	5	12	6
Mexico	6	64	7
Panama	8	16	9
Total	**25**	**120**	**36**

TABLE 3b: SOUTH AMERICA

Total number of regions and sites per Country, with the number of sites protected.

Country	Total No of CF regions*	Total No of CF sites	Total No of sites with protection
Bolivia	3	7	6
Brazil	2	6	7
Colombia	8	28	14
Ecuador	10	35	10
Peru	5	18	8
Venezuela	9	64	31
Total	**37**	**160**	**76**

TABLE 4: GLOBAL TOTALS

Total number of countries, and sites per country, with the number of sites protected.

Region	Total No of Countries	Total No of CF sites	Total No of sites with protection
Asia	14	228	114
Africa	21	97	38
Central America	6	120	36
South America	6	160	76
Global Total	**41**	**605**	**264**

**The term CF region refers to a sub-national grouping of cloud forest sites (see the section on Information Gathering for more details).*

CONCLUSIONS

The production of this draft directory as the first output from the TMCF database at WCMC represents an important initial stage in the development of a standardised methodology and format for collecting information on TMCFs on a site by site basis. It is hoped that WCMC can continue to provide a focal point for information exchange, through further data gathering and dissemination in a subsequent phase of work.

Whilst the database provides the best available information on the location and status of TMCFs, considerable work is required to develop the level of detail on a site by site basis. As indicated in the global overview the current level of detail varies considerably depending on the types of information available, but more importantly on the level of input from those with a detailed knowledge of a particular area. In order to produce a more comprehensive information base, the collaboration of regional and national cloud forest contacts should be encouraged. Such a relationship must be mutually beneficial, and should be developed by expanding the existing number of contacts by activating a contact network and the facilitation of regional workshops attended by local experts from all sectors. In addition collaboration with related conservation initiatives such as the Mountains Programme of the IUCN-WCPA (World Commission on Protected Areas) must be sought.

It is also important that the information available should be disseminated as widely as possible. In particular it should be made available to a range of users at the policy and decision making levels. This should be done by distribution of this directory in hard copy form and on the World Wide Web. In addition to making the information available and increasing awareness of the issues, it will also be possible to encourage readers to review the existing material, and provide feedback and more detailed information where possible.

As the detail of the information improves it will be possible to develop more detailed analyses to determine the gaps in protection and priority areas for conservation using criteria developed at regional and national levels. This would also be assisted by the development of a number of selected local case studies looking at particular issues in more detail, perhaps in collaboration with existing field projects. In addition priority sites where further research or development work is urgently needed should be identified.

RECOMMENDATIONS FOR FURTHER WORK

A detailed funding proposal is currently being developed at WCMC for a subsequent phase of work, based on the conclusions above and the recommendations of a number of cloud forest experts from whom advice has been sought. The main activities are listed below.

I. Workshops:

Following an initial management advisory workshop, to determine data, technology and information needs and set work priorities, a series of similar regional meetings will be held with regional and local experts.

ii. Expand the information base:

Expand on the information compiled under Phase I, to produce a more comprehensive coverage of site des- criptions, to fill information gaps and to consolidate information on bound- aries of cloud forests and protected cloud forests.

iii. Function as a global focal point for cloud forest work:

Function as a focal point to facilitate information and expertise exchange, by activating a cloud forest network initially from those contacts already identified, and an e-mail discussion group. Also act as a repository for information collected under detailed local cloud forest case studies, passing on knowledge to others. Enhance local scale projects by providing a global context for cloud forest conservation.

iv. Establish Conservation Priorities:

Undertake analyses, in collaboration with the Mountains Programme of IUCN-WCPA and others, to determine gaps in cloud forest protection and to identify priorities for conservation planning.

v. Distribute Data Effectively:

Improve the distribution of data via a number of different media such as CD-ROM, over the Internet and with the production of a Cloud Forest Handbook.

vi. Assist in an awareness campaign on the threatened status of cloud forests:

Promote the importance of cloud forests to a wider audience by assisting in a campaign proposed by Dr. Larry Hamilton and IUCN-WCPA with support from Netherlands Committee for IUCN and WWF, by producing information papers, a colour posters and other material suitable for media coverage.

ANNEX

ECUADOR

The majority of montane cloud forests in Ecuador are found along the Andean Cordillera which run the length of the country, with a small number on the west coast in the Cordillera de la Costa. These forests have very high endemism of both fauna and flora, and perform an important watershed protection function. However, they are under severe pressure from the rapidly increasing population in the Interandean valleys, which provides fertile soils and an hospitable environment. The main pressures are from agricultural encroachment, grazing, hunting and cutting for fuelwood. Almost all the natural forests of the central valley have been removed and only 4% on the west Andean slopes remain (Dodson and Gentry, 1991). With regard to cloud forest, in the main Interandean valley only a few highly disturbed patches remain on the inner slopes. On the Pacific slopes cloud forest exists between 1500 and 3500m, particulary in the north. Eastern slopes are relatively undisturbed although under increasing threat (Harcourt and Sayer, 1996). Some forests are within legally protected areas, but remain vulnerable to pressure for clearance. Much of the cloud forest remains in isolated patches which are not protected, while others have been secured under private or community ownership, as reserves, whilst more secure protected area status is sought.

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ECUADOR: CLOUD FOREST SUMMARY

Cloud Forest Region	Cloud Forest Site			Protected Yes/No?
Cajas Mountains	Río Mazan	2°49'S/	79°07'W	No
Chilla Mountains	Buenaventura	3°40'S/	79°44'W	No
	Manu Forest	/		No
Cordillera Occidental	Atacazo	0°22'S/	78°36'W	No
	Cotacachi-Cayapas	0°35'N/	78°25'W	Yes
	Intag	0°36'N/	78°20'W	No
	Volcán Pichincha	0°06'S/	78°35'W	No
Cordillera Oriental	Podocarpus National Park	4°08'S/	78°58'W	No
	Sangay	2°00'S/	78°20'W	Yes
	Zapote Najda Mountains	3°0l'S/	78°38'W	No
Cordillera de la Costa	Machalilla	1°39'S/	80°41'W	Yes
Cordillera del Condor	Chinapinza	3°59'S/	73°34'W	No
	Shaime	4°22'S/	78°39'W	No
Galapagos Islands	Fernandina	0°21'S/	91°32'W	Yes
	Isabela	0°48'S/	91°07'W	Yes
	Santa Cruz	0°37'S/	90°2l'W	Yes
Orientales Cordillera Real de los Andes	Cayambe-Coca	0°01'S/	77°49'W	Yes
	Cerro Mongus	0°21'N/	77°52'W	No
	Cordillera de Guacamayo	0°29'S/	78°00'W	No
	Playón de San Francisco	0°30'N/	77°40'W	Yes
	Volcán Sumaco	0°34'S/	77°38'W	Yes
Saraguro	Cuesta de Cañabrada	3°32'S/	79°22'W	No
	El Quingueado	/		No
	El Sauce	3°45'S/	79°20'W	No
	Huashapamba	3°38'S/	79°17'W	Yes
	Ingapirra	3°42'S/	79°13'W	No
	Oñacapa/Hiñuña	3°41'S/	79°12'W	No
	Santiago	3°48'S/	79°17'W	No
	Torré	3°38'S/	79°13'W	No
South and West Loja Province	Alamor	4°00'S/	80°00'W	No
	Angashcola	4°34'S/	79°22'W	No
	Celica	4°07'S/	19°58'W	No
	Lagunillas	4°47'S/	79°22'W	No
	Sozoranga	4°20'S/	79°48'W	No
	Vicentino	3°57'S/	79°57'W	No
Total No. of CF Regions = 10	Total No. of CF Sites = 35	Total No. of CF Sites with an element of protection = 10		

* *'Protected' refers to sites classified as meeting IUCN Management Category I–VI criteria*

CLOUD FOREST REGION SUMMARIES

Cajas Mountains

In the Andes of southern Ecuador, the Cajas Mountains are to the north-west of the town of Cuenca. The topography has largely resulted from extensive glaciation, with U-shaped valleys, moraines and numerous "boxed" glacial lakes, from dammed river valleys ("Cajas" meaning caja or box). Cloud forest is found in the Protected Landscape (IUCN Category V) of Cajas National Recreation Area and the privately owned Rio Mazan reserve. The montane cloud forest zone from 2800–3400m consists of woodland containing typical cloud forest species such as *Myrtus* and *Podocarpus*, grasslands and some areas of chaparral (dominated by scrub species, as climax woodland does not form as a result of overgrazing and fire management). In Mazan there is a huge diversity of orchids and fungi, with many species recently new to science (Barnett, 1988). Both areas contain threatened bird species, including the grey-breasted mountain toucan *Andigena hypoglauca*, and mammals including the northern pudu *Pudu mephistopheles*. Careful management is required to maintain the recrea- tional benefit of these areas to the people of the region whilst protecting the rich biodiversity. A land use zoning approach has been used in Cajas to achieve this. The forests are particularly important for watershed protection following widespread timber extraction in the area. The Rio Mazan reserve was purchased by the people of Cuenca in order to protect their water supply and wildlife (Barnett, 1988).

Chilla Mountains

Unconfirmed reports suggest that there are large tracts of cloud forest in these mountains which are in El Oro Province (pers.comm, Paul Toyne, 1996). Manu forest is one such area, along with Hacienda Buenaventura which is 9km west of Piñas at 900–1050m. Covering *c*.3000ha, two-thirds is cattle pasture, with humid cloud forest in patches across the rest, which at present is protected (Wege and Long, 1995).

Cordillera Occidental

Located in North-West Ecuador, the Cordillera Occidental is the western half of two parallel rows of peaks and ridges which form the northern end of the Ecuadorian Andes. Many of the higher peaks reach almost 6000m with connecting ridges at 4000m. The cordillera contains five main areas of cloud forest which, in general lie between 1500 and 3000m. These range from unprotected areas on the ridge crests of Volcán Pinchincha and Atacazo, to the legally protected privately owned land of the Intag Reserve, and on Cerro Golondrinas (both described further below), and areas within the Cotacachi-Cayapas Strict Nature Reserve. In addition there is protection forest on the western slope of Volcán Pinchincha. Despite the area being a distinct phytogeographic zone (Myers, 1988 in Harcourt and Sayer, 1996) with a particular abundance of endemic epiphytes, the Cotacachi-Cayapas Reserve is the only large conservation area protecting the moist forests in western Ecuador. In unprotected areas much of the natural vegetation has been completely cleared as a result of burning and grazing.

Cordillera Oriental

Part of the main Andean range in Central Ecuador, this Cordillera has cloud forests in the High Andes zone which is characterised by deep, steep-sided valleys, abundant cliffs an many rocky jagged peaks. Due to its elevation (1000-5140m) the area has a subtropical and temperate climate despite being in the tropics. Important areas of cloud forest are found in Sangay National Park, which is dominated by the Sangay Volcano at 5140m, and in the to-date unprotected Zapote Najda Mountains to the south, where a large tract of temperate cloud forest remains on the eastern side. In Sangay, montane rain forest occurs below 3750m on the wetter eastern slopes. The upper half is of low stature, c.5m and is dominated by *Nuerolepsis* spp. and associations of *Myrtus communis*. Below 3000m a 12m canopy dominated by *Weinmannia* spp and *Oreopanax* spp develops. Ferns, epiphytes and orchids are abundant. The fauna of the area is not well studied, but thought to be species rich. Sangay is an important habitat of the endangered mountain tapir *Tapirus pinchaque* which depends on cloud forest for shelter, but is rapidly declining throughout its range

(Downer, 1996). These forests are also important in protecting the upper watersheds of many rivers, as run-off and erosion is substantial due to the steep terrain and high rainfall. However in the south of Ecuador, cloud forest on this mountain range lacks high elevations and snowy peaks resulting in differences in the fluvian network and paramo ecosystem compared with mountains in the north. Without run-off from snow melt the rivers are fed from subterranean springs formed from rainwater filtered through the forest floor. The Podocarpus National Park (described below) was established for the protection of large areas of natural cloud forest which protect and regulate the water supply in at least four regionally important catchments. Unprotected cloud forest is found on adjoining ranges at Angashcola and Lagunillas.

Podocarpus National Park

The park covers 146,000ha and has very irregular topography covering altitudes from 950m to 3700m (90% above 1500m), and has a wide range of vegetation types. It still retains large tracts of undisturbed forest, continuous from upper tropical to temperate zones. This is the only large remaining tract of continuous Andean forest in Ecuador. Montane forest is dominated by Podocarpus trees (*Romerillos* spp.) which are the only genus of conifers native to Ecuador. Many threatened mammals have been recorded in the park, including mountain lion *Felix concolor*, and it is one of the richest areas in the world for birds with a total of 600-700 species including the bearded guan *Penelope barbata* and white-breasted parakeet *Pyrrura albipectus*. The two main pressures on the park are mining activities and colonization along the western and north-western boundaries, and there is some hunting and illegal extraction of orchids and medicinal plants (Mansour, J. 1995).

Cordillera de la Costa

The Cordillera de la Costa runs up the northern half of Ecuador's western coast. These coastal and foothill forests ranging from sea level to 800m are of great biological importance due to the large number of species and high levels of endemism they support (Parker and Carr, 1992).

Machililla National Park, the only national park in Western Ecuador, is found in the middle portion of this mountain range. It covers small but very important areas of fog and dry forest, the most biologically diverse area being Cerro San Sebastián, where small patches of fog forest remain on the mountain peaks. There are other remnants of fog and cloud forest on the low hills along the coast, which include Cerro Mutiles (fog forest, relatively dry), Cabecaras de Bilsa (very wet, cloud condensation), Cerro Pata de Pájaro (fog/cloud forest) and Manta Real (cloud forest). With an average lower limit of clouds between 500m and 600m, moving upward to peaks at 800-1000m, the cloud forests in this region are at significantly lower altitudes than in other parts of the Andes. However the forests are very wet all year round, receiving water from fog drip and cloud condensation. Trunk climbers, epiphytes and mosses are profuse and diverse. Locally endemic and threatened tree species are present, including *Caryodaphnopsis theobromifolia* and *Carapa guianensis* as well as truly montane Andean genera. Mammals found in the area include the endangered mantled howler monkey *Alouatta palliata*, jaguars *Panthera onca* and white-fronted capuchin *Cebus albifrons*, and there are many species of bat, some typical only of undisturbed forest (Parker and Carr, 1992).

In Machililla, as with most of the forests in this area, the main pressures are timber harvesting, small-scale agriculture, livestock grazing and hunting by the local human population. The large proportion of land area under private ownership within the park is also a problem. In addition to being the last remaining habitat for local endemic and threatened species, many of the forests fulfill an important watershed role. All of these remnants require improved protection with the involvement of local residents in sustainable management programmes.

Cordillera del Condor

The Cordillera del Condor run up the south-eastern boundary with Peru. Cloud forest is found on ridges close to Chinapinza and Shaime at elevations of 1700 and above. These areas are not protected, but are adjacent to the eastern boundary of Podocarpus National Park and it has been proposed that they should

become part of a buffer zone. This would reduce the current pressures of agricultural encroachment, gold mining and other development, and offer protection to the Shuar Indians who live in the area.

Galapagos Islands

The Galapagos Archipelago is found in the east Pacific Ocean, 1000km west of mainland Ecuador. World famous for their endemic fauna and flora, the islands form a National Park and Biosphere Reserve. An unusual form of cloud forest is found between 1500m and 1700m on the mountains and volcanoes of the larger islands, principally Isabela, Santa Cruz and Fernandina. In the dry season (as opposed to the hot season), caused by the Humboldt

current, a temperature inversion causes cloud to form. When these are blown towards land, and forced to rise, a persistent drizzly mist or 'garua' envelops the highlands. This provides sufficient water to support permanent vegetation - only found on these islands (Horwell, 1988). Characteristic species include *Scalesia* spp. *Psidium galapagenium* and *Pisona floribunda*.

Orientales Cordillera Real de los Andes

The eastern Cordillera Real de los Andes run the length of the country. In the north the area has steep rugged slopes with deep, narrow valleys in between. Cloud forest is found between 2000 and 3500m. In addition to the Cayambe-Coca Strict Nature Reserve, areas of cloud forest are found in the protection forests on the slopes of Volcán Sumaco and at Playon de San Francisco, on a side spur Cordillera de Guacamayo, at Hacienda Aragón, and on Cerro Mongus to the north, all of which are not protected. The main tree species include members of the genera *Guarea*, *Nectandra*, *Cedrela* and *Eugenia*. The highly adundant and diverse fauna includes mammals such as the spectacled bear *Tremarctos ornatus* and margay *Oncifelis wiedii*. Birds include the andean condor *Vultur gryphus* and andean cock-of-the-rock *Rupicola peruviana*. On Sumaco vegetable cultivation by the increasing human population is posing a serious threat.

Saraguro

To the south of the Cajas Mountains, there are a number of cloud forest fragments surrounding the city of Saraguro in Loja Province, which include the eastern slopes of the Cordillera Cordoncillo. These areas, including El Sauce, Oñacapa/Hiñuña, Ingapirra, Huashapamba, Torré, Cuesta de Cañabrada, Santiago, El Quingueado are essen- tially fragments although ongoing analysis of aerial photographs suggests they are linked by corridors of hilltop forest (Toyne, pers comm, 1996). Generally found between 2400 and 3200m, all have similar vegetational composition with slight differences due to aspect and altitudinal variations. The area is important for threatened avifauna including the red-faced parrot *Hapalopsittaca pyrrhops*, golden-plumed parakeet *Leptosittaca branickii* and the bearded guan *Penelope barbata*. Only Huashapamba has some protection, as a Community Forest jointly owned by three Saraguro Indian communities. However the pressures on these forests for fuel and construction wood, and grazing by these communities are great.

South and West Loja Province

West of the Eastern Andes, a number of important, unprotected cloud forest fragments are found in the south-west of Loja Province. Most are confined to inaccessible steep ravines at altitudes between 1200 and 2000m, slightly lower than found on the Eastern Andean slopes. The areas, including Alamor, Angashcola, Cordillera de Celica, Lagunillas, Sozoranga and Vicentino (2500-3100m) vary in size from tiny patches of less than 10ha, to larger blocks of several hundred hectares. At Angashcola and Lagunillas threatened bird species include the recently described chestnut-bellied cotinga *Doliornis remseni* along with populations of the threatened mountain tapir *Tapirus pinchaque* and spectacled bear *Tremarctos ornatus* (Wege and Long, 1995). The main pressures on the unprotected sites come from hunting and periodic burning of the lower slopes. Little is known about the other sites except that they are an important habitat for some of Ecuador's threatened bird species (Wege and Long, 1995)

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World Conservation Monitoring Centre

The World Conservation Monitoring Centre (WCMC), based in Cambridge, UK is a joint venture between the three partners in the *World Conservation Strategy* and its successor *Caring for the Earth*: IUCN – The World Conservation Union, UNEP – United Nations Environment Programme, and WWF – World Wide Fund For Nature. The Centre provides information services on the conservation and sustainable use of the world's living resources and helps others to develop information systems of their own.

WCMC is expanding its information services by using international communications networks – especially the Internet, allowing WCMC to access and be accessed electronically by other users of the network.

WCMC Forest Programme

Solutions to the global problems of deforestation and loss of forest biodiversity depend on accurate, up-to-date and accessible information. WCMC's Forest Programme exists to meet the demand for this information, bringing together a range of information management and dissemination activities undertaken by the Centre in collaboration with WWF, IUCN, UNEP and other conservation and development agencies worldwide.

Global Forest Information Service WCMC is developing an integrated global forest information service on the internet through cooperation with major forest data holders worldwide.

Mapping Forest Extent: The Conservation Atlas of Tropical Forests WCMC, in collaboration with IUCN-The World Conservation Union, has gathered national mapped forest data and worked these data into regional coverages and a global coverage of the remaining tropical moist forests. The data are published in *The Conservation Atlas of Tropical Forests* and maintained on WCMC's Geographic Information System (GIS).

Global Overview of Forest Cover Data holdings in the Biodiversity Map Library (BML), a GIS application developed by the WCMC, are being updated and expanded.

World Forest Map In collaboration with WWF *Forests For Life* Campaign, WCMC has compiled the first global map of temperate and tropical forests. The map, which shows how much of the remaining forests of the world are protected, has been distributed worldwide.

Tropical Montane Cloud Forests WCMC is compiling a global database on the location, extent, management, conservation status, and threats to Tropical Montane Cloud Forests.

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