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A GLOBAL DIRECTORY OF TROPICAL MONTANE CLOUD FORESTS

DRAFT

AUGUST 1997



WORLD CONSERVATION
MONITORING CENTRE



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The World Conservation Monitoring Centre,
provides information services on the conservation and
sustainable use of species and ecosystems and supports
others in the development of their own
information systems.

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DRAFT

by Mark Aldrich, Clare Billington, Mary Edwards and Ruth Laidlaw

World Conservation Monitoring Centre, Cambridge, UK.

August 1997

IUCN
The World Conservation Union

Netherlands Committee



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In addition thanks to all the cloud forest enthusiasts around the world who have contributed information and expressed an interest in working with WCMC in raising awareness of the value of remaining cloud forests. Many are listed along with their contact details as an annexe to this directory. Apologies to any that have been missed.

We trust that this draft directory and the database from which it has been compiled provide a valuable resource. We also hope to build on this and the rapidly developing network of contacts in a subsequent phase of work, which will contribute towards the conservation of the remaining areas of this unique and fragile ecosystem.

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. WCMC provides information services on conservation and sustainable use the world's living resources, and helps others to develop information systems of their own.

Prepared by Mark Aldrich, Clare Billington, Mary Edwards and Ruth Laidlaw with funding from IUCN Netherlands Committee.



Netherlands Committee



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A GLOBAL DIRECTORY OF TROPICAL MONTANE CLOUD FORESTS

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INTRODUCTION AND BACKGROUND TO THE DEVELOPMENT OF THIS DIRECTORY

1. AN INTRODUCTION TO TROPICAL MONTANE CLOUD FORESTS

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. Much of their value is related to their unique characteristics of biodiversity and endemism and the functions that they provide. If managed sustainably, TMCFs can provide a valuable range of 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.

1.1 Values

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). Tree crowns act to intercept wind-driven cloud moisture on leaves and branches 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.

TMCFs also make excellent ecosystems and sites for monitoring climate change and air quality due to their relatively undisturbed tropical location.

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. Throughout the tropics, the TMCF zone provides habitat for notable plant species such as tree ferns (*Cyatheaceae*) and many rare and endemic orchids (*Orchidaceae*) along with other economically valuable plants and tree species. TMCFs are also the last remaining habitat for many threatened species of mammals and birds. According to Long (1993), 260 of the world's nationally endemic bird species have cloud forest habitats.

With this wealth of diversity, cloud forest areas are becoming an increasingly important draw for ecotourism, such as bird watching holidays, and for local education and recreation. However while such activities may provide a valuable source of income, they must be carefully managed in order to help conserve the unique environment and benefit local communities.

1.2 Threats/Pressures

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, including legal or illegal drug plant production. Many areas are under pressure from encroachment by livestock or have already been cleared to provide new grazing land. TMCFs may also provide a valuable source of fuelwood and small dimension timber, along with a range of non-wood forest products, but in many areas such exploitation 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), and 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.

1.3 The need for information

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 their conservation before any more of these rare and valuable habitats are lost for good.

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. At a local level, experience from a number of IUCN conservation projects in montane forest areas suggests that the major constraint to cloud forest conservation is lack of awareness and commitment of all the participants and interest groups to the long-term conservation of these forests.

1.4 Related activities

In response to these issues, a *Tropical Montane Cloud Forests International State-of-knowledge Symposium and Workshop* was held in Puerto Rico in June 1993, with the aim of drawing together information on the global extent of TMCFs. In response to a lack of detailed global or national maps, the participants produced regional maps showing general concentrations of TMCF, along with a list of sites by region and country, and a series of recommendations concerning general and specific research needs (see Sections 3.4 and 4, below).

Later the same month, another symposium, *Neotropical Montane Forests: Biodiversity and Conservation*, also concerned with the threat to montane cloud forests was held at the New York Botanical Garden. Participants, which included 120 scientists, 60 of them Latin American, discussed potential conservation efforts. These included the need for biological inventories to determine the most threatened areas, ecological restoration and in-situ and ex-situ conservation. In particular, the importance of international co-operation was stressed

In 1995, IUCN - The World Conservation Union published a booklet in their Focus Series entitled *A Campaign for Cloud Forests: unique and valuable ecosystems at risk*. Written by Dr. Lawrence Hamilton (co-organiser of the Puerto Rico Symposium and Vice-Chair for Mountains in the World Commission for Protected Areas (WCPA)) it was an attempt to promote a better understanding of TMCFs among a clientele of IUCN members, partners, donors and a wider audience. In addition to highlighting the need for **awareness raising** both at national and international level of the value of cloud forests, an number of further actions required for their conservation were identified.

Dr. Hamilton is also Editor of *Mountain Protected Areas Update*, the newsletter of the WCPA Mountains Programme. Produced bi-monthly it often includes reports on initiatives in cloud forest areas, and has information on forthcoming meetings, activities of members and reviews of publications.

2. DEFINITIONS AND TERMINOLOGY

2.1 Difficulties with 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, as confirmed by a number of other authors of cloud forest studies such as Stadtmuller and Ohsawa.

At the Puerto Rico Symposium the participants recognised the need for a clear definition of TMCF (qualified as it might be), and discussed a number of alternatives. As a result, a synthesis working definition was developed - this is reproduced along with the thoughts of some other authors in Section 2.1.1 (below). It was decided to use this working definition as a guide for the purposes of the current project (see Section 4. for Background), rather than attempt to develop it any further. In deciding which TMCF sites or areas to include several characteristics served as valuable indicators. In summary these were as follows:

- A distinctive floristic and structural form, trees often described as having low stature and crooked and gnarled trunks and branches. Certain tree species appeared to be good indicators, as was a high proportion of epiphytes. High floral and faunal biodiversity and endemism.
- Climatic features: persistent, frequent or seasonal cloud cover at the vegetation level. Relatively high net precipitation enhanced through direct canopy interception of cloud water (cloud stripping).
- Typically occurring in a relatively narrow altitudinal zone. However, considerable variation in its position between large island mountain systems, and coastal areas or on small islands in marine, equatorial conditions.

As mentioned earlier a wide range of terminology is used to describe cloud forests (see Section 2.2). Regional differences are apparent particularly with the term "cloud forest" itself. For example when searching the literature as part of this project, the term "cloud forest" or its Spanish equivalents were commonly used in association with montane forests in South and Central America, but not with those in Asia, Africa, Caribbean Islands or in the Oceania/Pacific region. This made the data gathering exercise considerably more difficult and time consuming for these regions.

In Asia it appeared that cloud forest best equated to the more commonly described upper montane rainforests. This is confirmed by Ohsawa (1993) who reports that "*botanists have observed that cloud forests on the tropical mountains of South-East Asia roughly correspond to the upper montane rainforests dominated by microphyllous trees*". Whitmore (1975) and Whitten (1984) also link the commonly used pseudonyms of cloud forest, elfin forest and moss forest with upper montane forest in South East Asia.

When attempting to identify cloud forests in Africa, the relationship is less obvious. "Upper montane" is less commonly used, with the more general Afromontane being more common.

In the Caribbean and Oceania/Pacific regions, cloud forests are commonly found in small patches on island mountains at a wide range of elevations. In many cases they are unique, highly endemic ecosystems and where documented are referred to as TMCFs. The mossy or elfin features of other areas are often identified, and due to a high elevational range they may be associated with either lower montane forests or as *facies* of upper montane forest (Merlin and Juvik, 1993).

2.1.1 Working definitions

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

"The tropical montane cloud forest is composed of forest ecosystems of distinctive floristic and structural 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 clouds 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) in such forests 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 (ie 500-10,000 mm/year). There is also significant variation in the altitudinal position of this

mountain vegetation belt. For large, inland mountain systems, TCMF may typically be found between 2000-3500m (Andes, Rwenzoris), whereas in coastal and insular mountains this zone may descend to 1000m (Hawai,'i). Under exceptionally humid, marine, equatorial conditions, a TCMF zone may develop on steep, small island mountains at elevations as low as 500m or even lower (Kosrae in Micronesia and Gau in Fiji)."

Stadtmüller, T. (1987):

"Cloud forest" is neither a scientific term, nor does it serve as a definition within the disciplines of meteorology, hydrology, geography and biogeography, floristic composition, fauna, ecology, silviculture and conservation, and for this reason there may be confusion. Nevertheless "cloud forest" is frequently used in scientific literature which recognises the strong influence clouds and mist have on forest vegetation, its ecological properties and characteristics.

For the purposes of this study the following definition of "cloud forest in the humid tropics" is used:

Cloud forests include all forests in the humid tropics that are frequently covered in clouds or mist; thus receiving additional humidity, other than rainfall, through the capture and/or condensation of water droplets (horizontal precipitation), which influences the hydrological regime, radiation balance, and several climatic, edaphic and ecological parameters.

Ohsawa, M. (from Hamilton *et al.* 1993):

Definition and Distribution of Tropical Montane Cloud Forest in Southeast Asia

"The characteristic features of TCMF include a thick coat of bryophytes (Frahm and Gradstein 1991) and vascular epiphytes such as filmy ferns, bromeliads, crassuraceans, ginger, orchids, and ericaceous shrubs. The trees are more or less stunted and gnarled, and canopy surfaces are relatively smooth (Leigh 1975; Stadtmüller 1987). However, in humid climates such as in Southeast Asia, the TCMF cannot easily be identified solely by such physiognomic or structural features, because the surrounding upland forests are also relatively humid from heavy precipitation throughout the year (Whitmore 1984). The "true" cloud forest, which is mainly sustained by cloud humidity, is easily recognisable when surrounded by totally different arid areas such as savanna or desert. This type of cloud forest can be clearly distinguished from the surrounding dry area because its altitudinal position results in significant moisture augmentation from fog and cloud. This situation is sometimes referred to as an isolated cloud forest (Sugden 1982) or an additional oasis (Cloudsley-Thompson, 1977). Such montane cloud forest often forms a narrow belt with an upper and lower treeline, and in most cases is confined to a windward exposure."

2.2 Commonly used Terminology

The participants in the Puerto Rico Symposium offered a diverse list of local or professionally accepted names for TMCF in seven languages.

These included mossy forest, elfin forest, montane thicket, dwarf cloud forest, nuboselva, bosque montano nebuloso, selva neblina, bosque nuboso, bosque de ceja, selva sublada, nebelwald, wolkenwald, forêt néphéiphile, forêt de nuage, unmu-rin, bosque anao, foresta nebulosa, mata nebulosa, matinha nebulosa, floresta fe neblina, floresta nuvigena, mata de neblina, matinha de altitude, floresta ombrófila densa montana e/ou alto-montana, floresta de altitude, floresta nublada, and floresta pluvial montana e/ou alto montana.

In addition a number of other commonly used names are listed by Stadtmüller, T. (1987).

Spanish Terminology

"The term "bosque nublado" is the most frequent and general denomination in Spanish to describe forest under the strong influence of clouds (Lamprecht, 1954). Veillon (1974) uses the term "selva nublada" which he considers equivalent to the "bosque muy humedo montano bajo" according to Holdridge's classification. Other authors, e.g. Cáceres (1981) mention cloud forests in the "bosque muy humedo premontano" life zone."

English Terminology

"Cloud forest" is the most common term used worldwide to describe forest types under the influence of clouds. However, considerable numbers of authors have created other terms to describe such forests. The majority of these terms are those included in tropical vegetation classification systems e.g. Montane rain forest."

German Terminology

"The most frequently used term in German literature to describe cloud forest is the term "Nebelwald". The term "Nebelwald" signifies fog forest. In recent years the majority of authors use the term "Wolkenwald" in order to represent the translation of the most widely used term at the international level, "cloud forest", more accurately. Another German term synonymous with cloud forest is "Gebirgs-Nebelwald" which means mountain cloud forest."

3. DISTRIBUTION OF TMCFs

3.1 Global Distribution

Prior to the Puerto Rico Symposium, the limited knowledge of the global distribution of TMCFs was based on the available information on the geographical distribution of montane and submontane forests. This suggested that they are potentially found on all the major mountain chains in tropical regions, where topo-climate conditions are favourable to the occurrence of ground-level clouds during a considerable period of the year. As a result, TMCFs tend to occur more frequently in Tropical America and Southeast Asia than in tropical Africa due to a wider distribution of mountain ranges subject to oceanic differences in

these areas (Doumenge *et al.* 1993). Persson (1974, in Hamilton *et al.* 1993)) estimated that TMCF constituted one-quarter of montane and submontane rain forest (c.50 million ha) although this was probably an over-estimate.

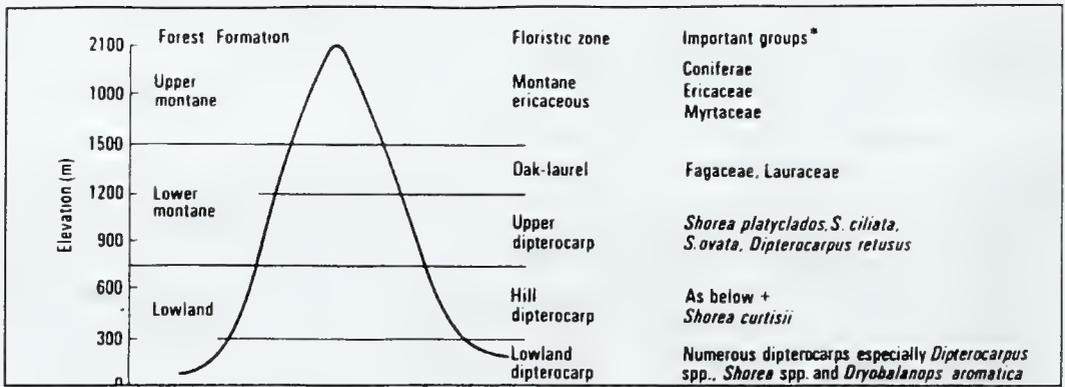
3.2 Altitude, latitude and the *Massenerhebung* effect

Localised variations in the extent and elevational limits of TMCF are found as a result of changes in the relationship between altitude and temperature. In tropical areas the cloudiness and high water vapour content of the atmosphere significantly reduces the amount of solar radiation received by the forest canopy compared with drier tropical environments. Furthermore whereas in general temperature declines with increasing altitude, there are marked differences above and below the condensation level which is marked by the cloud base. Below this level the rate of decline of temperature is relatively high, whereas above the cloud base rates of change in the saturated air tend to be much slower (Richards, 1966). These effects combined with the direction of prevailing winds may lead to striking differences between vegetation types on either side of the same mountain range (Kappelle and Zamora, 1995), (Lawton and Dryer, 1980). A good example is in Costa Rica where the mean temperature on the Continental Divide of mountains running down the centre of the country is commonly 2°C higher on the Pacific side than on the wetter Atlantic (or Caribbean side). Here the North-East trade winds (from the Atlantic) are also a prominent feature of the climate at higher elevations throughout the year. Forest on the windward side has a lower and more open canopy, and trees have significantly thicker trunk diameters than on the leeward side. Species composition is also affected by a more open canopy where shade intolerant species are prominent, and there is a thicker shrub layer. Density of bryophytic and vascular epiphytes also increases with exposure to prevailing winds due to the rising frequency of cloud in the forest (Lawton and Dryer, 1980).

In addition larger mountain masses tend to be warmer at comparable altitudes than isolated mountains, as large upland surfaces provide extensive areas for heating by solar radiation, a process which increases significantly with higher altitudes. This phenomenon has been termed the *Massenerhebung* effect. In the humid tropics this means that lowland rain forest is replaced by montane forest at a higher elevation in large mountain ranges such as the Andes. This is compared with isolated mountains, particularly near the coast, where the zones are more compressed (Richards, 1966).

3.3 Altitudinal Distribution

In general there is a transition in forest type with increasing altitude, moving from lowland moist forest through lower montane, upper montane and alpine forest before reaching alpine shrub or grassland vegetation (commonly referred to as "paramo") above the treeline. As mentioned earlier TMCF is generally found within the upper montane belt, although there is huge altitudinal variation (see diagram below). Depending on latitude, the lower limit of TMCF on large inland mountain systems is typically between 1,500 and 2,500 metres above sea level (m), with the upper limit between 2,400 and 3,300m (Bruijnzeel and Proctor, 1993).



Vegetation zones on the main mountains of Malaya (from Whitmore, T C 1984)

In addition to this general distribution, TMCF may occur as micro-occurrences where there is a cooler climate and stronger influence of mists and clouds than might normally be expected. Examples in Africa include the isolated low elevation Belinga mountains of Gabon (800-900m), and the Angola Highlands where there is an extension of dense forests from Southern Zaire (Doumenge *et al.* 1993).

In the Caribbean and Oceania/Pacific regions, the cloud forests are commonly found at relatively low elevations (500m or lower) on small island mountains. In the Pacific TMCF typically occur as small and isolated patches on high volcanic mountains. In Oceania and the Caribbean, the TMCF belt occurs at higher elevations on larger islands, and at much lower elevations close to the equator.

3.4 Mapping

In preparation for the Puerto Rico Symposium, Doumenge *et al.* (1993), with the help of WCMC attempted a global map of TMCF distribution based on the larger categories of montane and submontane tropical rain forests. More detailed, larger scale regional maps were also provided for the participants to review.

4. BACKGROUND TO THE DEVELOPMENT OF A GLOBAL DATABASE

In addition to producing regional maps showing general concentrations of TMCF, and a list of sites by region and country, participants in Puerto Rico made a series of recommendations concerning general and specific research needs. These maps and site list, which name and locate individual cloud forests, protected areas, and known remaining undisturbed areas, were thought useful in that they were collected as a starting point. However the Proceedings stated- "*we hope that this will be the start of a more complete location map for these ecosystems*" - and the data collected was sent to WCMC "*who will maintain and improve the data set*" (Hamilton *et al.* 1993). Readers were asked to send information about other cloud forest sites to WCMC.

Amongst the research needs identified, participants felt it necessary to raise the profile of TMCFs at the international scale. Again the lack of detailed and available information on TMCF areas was highlighted. In response they recommended that relevant information is collected and analysed in a co-ordinated way in order to improve understanding of these ecosystems, and ensure that reliable information is made available to a range of users for effective decision making. It is generally felt that a systematic initiative was required to gather, process, store and disseminate this information.

It was recommended that this should include the development of a standardised methodology and format for collecting information, through a worldwide inventory of TMCFs, with textual, numerical and spatial data stored on a centralised database at the World Conservation Monitoring Centre.

In addition it was also recommended that at the local level, efforts at raising the awareness of local owners and users of land, along with politicians and agencies about the value of the resource they are impacting must underlie all direct actions taken to reduce the threats to TMCFs from human impacts. In addition, support must be given to local initiatives which involve interest groups in participatory planning and management.

As a result a project proposal to develop a TMCF database was prepared at WCMC, which included an information gathering exercise through a range of contacts with a knowledge of cloud forests and/or experience in the management of cloud forest areas. The further development of a cloud forest contacts network was also proposed in order to provide a focal point for information exchange and allow those with an interest in the management and conservation of TMCFs to share their experience of existing conservation initiatives, to the benefit of future projects.

Funding for a first phase of work was provided by the Government of the Netherlands through the Tropical Rainforest Programme of the IUCN Netherlands Committee. In order to publicise the project and identify willing contributors, information on the project was circulated widely through International forestry and conservation newsletters, meetings and other fora, as well as e-mail and on the WCMC Web page. These activities proved very successful in stimulating interest and identifying new contacts.

5. DEVELOPMENT OF A STANDARDISED METHODOLOGY AND FORMAT FOR RECORDING DATA

Following a review of the types of information available containing descriptions of TCMF sites, including material held at WCMC, scientific papers, articles and books, a draft framework for recording data in a database was developed through consultation with a number of interested parties. 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 TCMFs was added to the existing Protected Areas database at WCMC. This includes the ability to link cloud forest sites to existing protected area records. Selected database fields were added and a new cloud forest category created. Based on the database layout, blank summary site data sheets were designed for collecting information which could later be added to the database. A sheet giving the proposed layout of more detailed information as an accompanying text description for each site was also prepared.

6. DATA GATHERING EXERCISE: PROBLEMS

The initial intention was to gather data on cloud forest sites, by enlisting the help of contacts with knowledge of cloud forests in a particular country or region. These contacts were either previously known to staff at WCMC or had responded to a plea for help when the project was being publicised. It was hoped that the data gathered would supplement the relatively limited information already held at WCMC. This 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. Similar exercises were planned for Africa, South-East Asia and the Pacific/Oceania.

In practice the results from this exercise were poor. It is likely that this was due to lack of time available for contacts to complete site sheets, despite efforts made to minimise the effort required. However, 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. This information was very useful and was entered in the database.

As a result of the poor response to this initial widespread data gathering exercise and the relatively small number of contacts identified in other regions, it was decided to concentrate further efforts through correspondence only with those contacts who had expressed a willingness to help. In order to provide a useful product at the end of the first phase of the project it was also decided to combine the information received with material gathered from a comprehensive review of information available through research at WCMC.

Data on a site by site basis was recorded 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, islands or 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. These paragraphs were then incorporated into country chapters for the draft directory.

7. COMPILATION OF A DRAFT DIRECTORY

Following an intensive period of research and compilation, a draft directory of TMCFs has been produced, for widespread distribution to all contributors and other identified 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 a global overview followed by a section on each of the major tropical regions, 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.

As a result of the variable level of detail gathered to date at the site level, no further site information has been included in this first draft version of the directory. However detailed information is held in the database for some sites, and can be added for other sites as it becomes available. An example of the site sheet which has been used to gather information and shows the database fields which exist for recording the more detailed data, is included in Annex 1.

8. DEVELOPMENT OF A CLOUD FOREST NETWORK

In addition to the cloud forest contacts identified through the Puerto Rico Symposium and the other related activities described in Section 1.4, a significant number of new contacts, particularly researchers active in the field and local NGOs have been made during the first phase of this project. A full list of names by country with contact details is enclosed with this directory. It is hoped that this can be developed further into a contacts network, linked by an e-mail List-Server and Newsletter, in a subsequent phase of this project subject to funding being found.

9. GLOBAL OVERVIEW

The work to date has identified a total of 605 TMCF sites in 41 countries (see Tables 1, 2, 3 and 4 below). These are marked on the following map which shows the distribution of montane cloud forest sites in the tropics. 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. This is perhaps not surprising due to the large and high mountainous areas of the Andes region which are subject to oceanic influences, but also it is indicative of the fact that the term "cloud forest" is more widely used and recognised than in the other continents. This is discussed in Section 2 of the Introduction, *Definitions and Terminology*. 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 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. As a result the sites identified should generally be considered as areas of forest containing a proportion of cloud forest.

An initial assessment of the values of cloud forests shows that the majority of areas are incredibly important habitats for endemic and other threatened species of flora and fauna, including many important tree species and plants 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. 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. 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 such 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.

GLOBAL DISTRIBUTION OF CLOUD FOREST SITES





TABLE 1: SOUTH-EAST ASIA

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

Country	Total N° of CF regions	Total N° of CF sites	Total N° 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 N° of CF regions	Total N° of CF sites	Total N° 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 N° of CF regions	Total N° of CF sites	Total N° 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 N° of CF regions	Total N° of CF sites	Total N° of sites with protection
Bolivia	3	7	6
Brazil	2	8	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 N° of Countries	Total N° of CF sites	Total N° 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

10. CONCLUSIONS

The production of this draft directory as the first output from the TCMF database at WCMC represents an important initial stage in the development of a standardised methodology and format for collecting information on TCMFs 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 TCMFs, 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.

The current directory provides a useful overview of the location of cloud forest sites, with some general information on their importance for biodiversity, protection status, socio-economic and wider environmental values, and the some of the major threats to their survival. 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.

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.

11. PROPOSED FUTURE ACTIVITIES

Phase II will aim to build on the existing information through the following activities.

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 descriptions, to fill information gaps and to consolidate information on boundaries 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 the existing contacts network, and an e-mail discussion group. Also act as a repository for information collected under detailed local cloud forest case studies (to be funded independently), 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 poster and other material suitable for media coverage.

For more information on Cloud Forests Phase II please contact Mark Aldrich at WCMC. Any suggestions for improvements to the database would be gratefully received.

12. REFERENCES

- Bruijnzeel, L.A. and J. Proctor (1993) Hydrology and Biogeochemistry of Tropical Montane Cloud Forests: What do we really know? In Hamilton *et al.* (1993) (Eds) Tropical Montane Cloud Forests - Proceedings of an International Symposium at San Juan, Puerto Rico, 31 May - 5 June 1994, East-West Center, Honolulu, Hawai'i, USA. Pages 25-46.
- Doumenge, C., D. Gilmour, M. Ruiz Perez, and J. Blockhus (1993). Tropical Montane Cloud Forests: Conservation Status and Management Issues. In Hamilton *et al.* (1993) (Eds) Tropical Montane Cloud Forests - Proceedings of an International Symposium at San Juan, Puerto Rico, 31 May - 5 June 1994, East-West Center, Honolulu, Hawai'i, USA. Pages 17-24.
- Hamilton, L., J.O. Juvik, and F. Scatena (1993). The Puerto Rico Tropical Cloud Forest Symposium: Introduction and Workshop Synthesis. In Hamilton *et al.* (1993) (Eds) Tropical Montane Cloud Forests - Proceedings of an International Symposium at San Juan, Puerto Rico, 31 May - 5 June 1994, East-West Center, Honolulu, Hawai'i, USA. Pages 1-16.
- Kappelle, M. and N. Zamora (1995). Changes in Woody Species Richness along an Altitudinal Gradient in Talamancan Montane Quercus Forests, Costa Rica. In Steven Churchill *et al.* (1995) (Eds) Biodiversity and Conservation of Neotropical Montane Forests, 135-148. New York Botanic Garden, USA.
- Lawton, R. and V. Dryer (1980). The Vegetation of the Monteverde Cloud Forest Reserve. *Brenesia* 18: 101-116.
- Long, A.J (1993). Restricted-Range and Threatened Bird Species in Tropical Montane Cloud Forests. In Hamilton *et al.* (1993) (Eds) Tropical Montane Cloud Forests - Proceedings of an International Symposium at San Juan, Puerto Rico, 31 May - 5 June 1994, East-West Center, Honolulu, Hawai'i, USA. Pages 47-65.
- Ohsawa, M. (1993). The Montane Cloud Forest and its Gradational Changes in Southeast Asia. In Hamilton *et al.* (1993) (Eds) Tropical Montane Cloud Forests - Proceedings of an International Symposium at San Juan, Puerto Rico, 31 May - 5 June 1994, East-West Center, Honolulu, Hawai'i, USA. Pages 163-170.
- Richards, P.W. (1966). The tropical rain forest. Cambridge University Press, Cambridge, UK.
- Stadtmuller, T. (1987). *Cloud Forests in the Humid Tropics. A bibliographic review.* United Nations University, Tokyo, and CATIE, Turrialba, Costa Rica.
- Whitmore, T.C. (1984). Tropical rainforests of the Far East. 2nd Edition. Clarendon Press, Oxford.

- Whitten, A.J., Damanik, S.J., Anwar, J. and N. Hisyam (1984). *The Ecology of Sumatra*. Gadjah Mada University Press.
- Wuetrich, B. (1993). Forests in the clouds face stormy future. *Science News* **144**(2):23.

THE DIRECTORY

Legend to the Maps





PART ONE

AFRICA

Angola
Burundi
Cameroon
Côte d'Ivoire
Equatorial Guinea
Ethiopia
Gabon
Guinea
Kenya
Liberia
Madagascar
Malawi
Mozambique
Nigeria
Reunion
Rwanda
Sao Tome and Principe
Sierra Leone
Tanzania
Uganda
Zaire

ANGOLA

The biomes of Angola range from hyper-arid Karroo-Namib in the south-west, to Guinea-Congolian rainforest in the far north-west. Cloud forests are limited in extent, and confined to isolated Afromontane forest patches totalling less than 200ha in the districts of Huambo, Benguela and Huila, and to more extensive but discontinuous forests along the upper Angola escarpment. At least two protected areas have been recommended to protect certain of these cloud forests, and pressures range from timber and fuelwood collection, to coffee plantations. The forests are considered vulnerable due to their small size and often restricted range (Collar and Stuart, 1988; Huntley, 1974; World Bank, 1993).

References

- Collar N.J. and Stuart S.N. 1988. *Key forests for threatened birds in Africa*. ICBP Monograph No. 3, International Council for Bird Preservation, Cambridge.
- Huntley B.J. 1974. *Ecosystem conservation priorities in Angola*. Unpublished MS, prepared for Servico de Protecçao a Fauna.
- World Bank 1993. *Ecologically Sensitive Sites in Africa: Volume III: South-Central Africa and Indian Ocean*. Compiled by the World Conservation Monitoring Centre for The World Bank, Washington, DC, USA.

ANGOLA



0

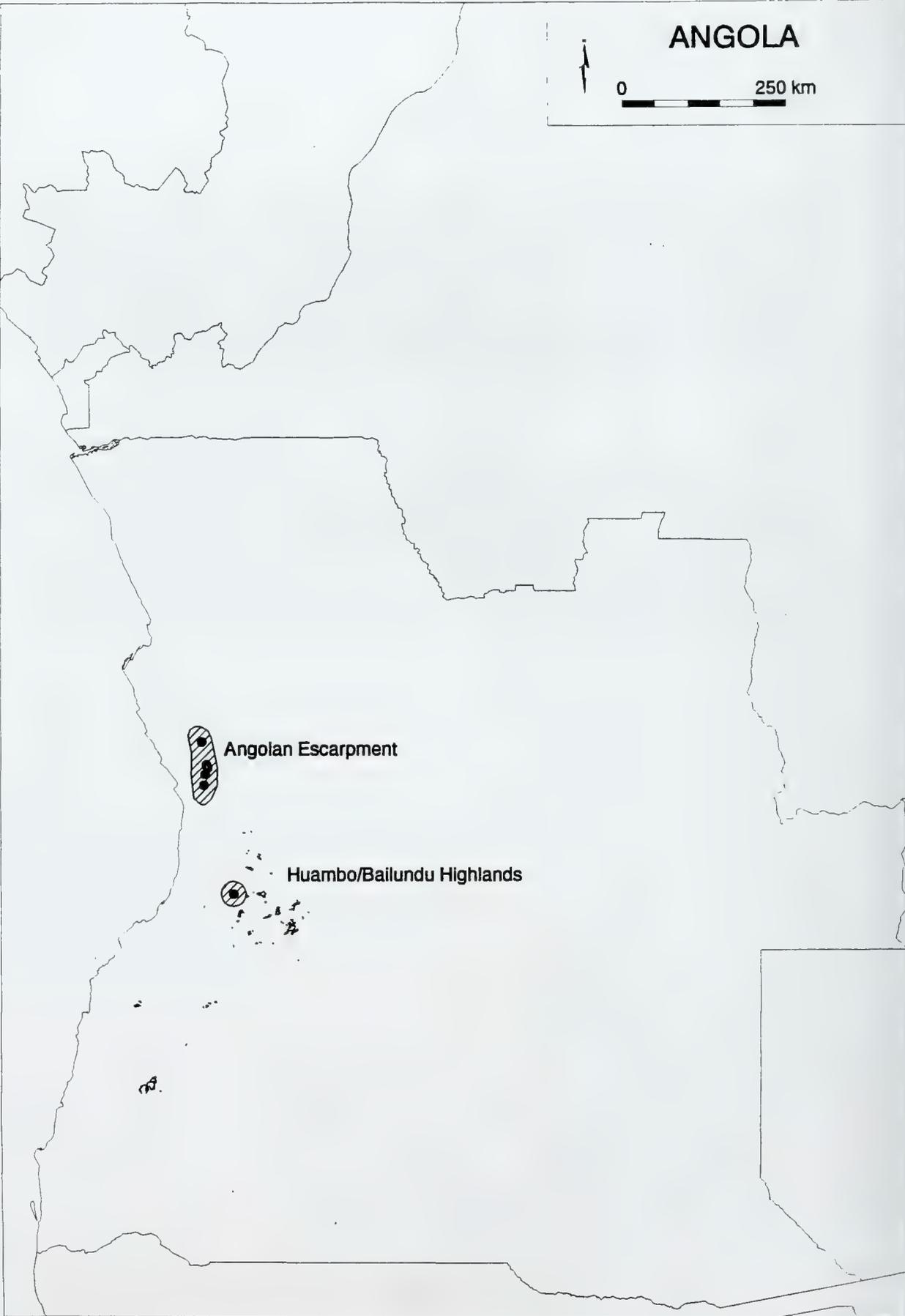
250 km



Angolan Escarpment



Huambo/Bailundu Highlands



Cloud Forest Region Summaries: Angola

Angolan Escarpment

A number of fragmented forests extending along the Angolan Escarpment between Dondo and Quilenges, varying in size between a few to several thousand hectares. The largest is the Amboim Forest, with other forests occurring at Gabela, Vila Nova do Seles, Dondo, Mumbondo, Asango and Conda. Grading into a dryer forest at lower elevations, the moist upper forests attain a canopy height of up to 40m and are typified by trees such as *Bombax reflexum*, *Khaya acanthotheca*, *Blighia unijugata*, *Zanha golungensis*, *Piptadeniastrum africanum*, *Celtis mildbraedii* and *Spathodea campanulata*. Epiphytes are abundant. The forests are considered important as refugia for several threatened and near-threatened bird species. The gabela helmet-shrike *Prionops gabela*, gabela akalat *Sheppardia gabela* and amboim bush-shrike *Laniarius (luhderi) amboimensis* are near-endemics to the Gabela region, whilst monteiro's bush-shrike *Malaconotus monteiri* and pulitzer's longbill *Macrosphenus pulitzeri* are endemic to the Angolan escarpment. Threats to the forests are exacerbated due to their generally small and fragmented nature. They include planting of coffee as an understorey cash crop. No areas are currently protected, but a 50sq.km. Gabela Strict Nature Reserve has been proposed. Part of the lower, drier forest type has been incorporated within Parque Nacional da Kisama (Collar and Stuart, 1988; World Bank, 1993).

Huambo/Bailundu Highlands

Numerous small to very small Afromontane forests covering a total area of under 200ha are scattered through the mountains of Huambo, Benguela, Cuanza Sul and Huila districts. They primarily occur in sheltered ravines at elevations between 2000-2500m and are of great biological importance as they represent isolated relics of a formerly more widespread biome. The most important aggregations of forest occur on Mount Môco, where a total forested area of about 100ha exists, and on Mount Soque and the Mambolo Plateau. Threats to the forests include the collection of fuelwood and hunting by local communities. Dominant trees are 10-15m in height, and include the genera *Podocarpus*, *Pittosporum*, *Olea* and *Ilex*. Larger mammals have been heavily hunted, but yellow baboon *Papio cynocephalus*, red-footed squirrel *Funisciurus pyrrhopus*, bushpig *Potamochoerus porcus* and blue duiker *Cephalophus monticola* survive. The forests support an interesting avifauna. Of thirty species collected from Mount Môco, seven are restricted to the isolated montane forests of Africa in Cameroon, Ethiopia, Bioko, Uganda and Tanzania. Swierstra's francolin *Francolinus swierstrae* is an Angolan highland endemic, and black-chinned weaver *Ploceus nigrimentum* and Margaret's batis *Batis margaritae* have also been recorded.

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Angolan Escarpment	Amboim Forest	/	No
	Assango Forest	10°28'S/ 14°12'E	No
	Conda Forest	10°33'S/ 14°10'E	No
	Dondo Forest	/	No
	Gabela Forest	10°25'S/ 14°11'E	No
	Mumbondo Forest	10°06'S/ 14°07'E	No
	Vila Nova do Seles Forest	10°42'S/ 14°09'E	No
Huambo/Bailundu Highlands	Mambolo Plateau	/	No
	Mount Môco	12°13'S/ 14°34'E	No
	Mount Soque	/	No
Total No. of CF Regions= 2	Total No. of CF Sites= 10	Total No. of CF Sites with an element of protection = 0	

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

BURUNDI

Covering an area of 27.731sq.km (of which 2000sq.km forms part of Lake Tanganyika), Burundi is situated in the highlands along the eastern arm of the Western Rift Valley. The land surface only falls below the 1000m contour along the shores of Lake Tanganyika (773m). Cloud forests occur on the ridge of the Zaïre-Nile Divide which extends from Uganda, through Rwanda and Burundi down into Zambia. This ridge forms part of the larger Albertine Rift region. In Burundi the ridge is located on the western boundary at approximately 2679m, runs roughly north-south and provides the highest land in the country.

The protected areas system comprises ten protected areas, four of which are demarcated on the ground. This system currently covers just over 3% of the country, most of which is montane cloud forests. Although the reserves are of national significance, they are not important on a regional scale and do not merit international aid (MacKinnon and MacKinnon, 1987).

Burundi is very densely populated, leading to a high population pressure on natural resources.

References

- FAO/PNUD. 1974. La conservation et la gestion de la faune et de la flore au Burundi. Rapport au gouvernement du Burundi, établi sur base des travaux de J.B. Bider. 37pp.
- MacKinnon, J., MacKinnon, K. 1986. *Review of the protected areas system in the Afrotropical Realm*. IUCN, Gland, Switzerland and Cambridge, UK/UNEP, Nairobi, Kenya. 259 pp.
- Ndabaneze, P. 1990. The mountain flora of Burundi. In: (Eds.) Messerli, B. and Hurni, H., *African mountains and highlands*. African Mountains Association. Pp. 229-236
- Verschuren, J. 1976. *Conservation de la nature et parcs nationaux au Burundi*. Rapport de mission, 25 juin au 26 août 1976. Résumé et Conclusions. Institut Royal des Sciences Naturelles de Belgique, Bruxelles. 2 pp.
- Verschuren, J. 1977. Burundi and wildlife: Problems of an overcrowded country. *Oryx* 14(3): 237-240.
- Weber & Vedder. 1984. Forest conservation in Rwanda and Burundi. *Swara* 7(6) 32-35.
- Wilson V.J. 1990. Preliminary survey of the duikers and other mammals of Burundi, east Africa. Pan African Decade of Duiker Research (1985-1994).

BURUNDI



0

50 km



Kibira

Bururi



Cloud Forest Region Summaries : Burundi

Bururi

A relic forest covering 1600ha located on the southern edge of the Zaire-Nile Divide. Bururi Forest is interesting given that it is recognised as a biogeographical crossroads. The cloud forest lies between 1900m and 2150m. Approximately 19 species of tree are found, dominated by *Strombosia* and *Myrianthus*, *Tabernaemontana*, *Newtonia* and *Entadrophragma*. The forest supports important fauna, including 87 bird species, 5 carnivores, and 5 primates, including the chimpanzee *Pan troglodytes*.

Kibira

Located in the north of the country on the central portion of the Zaire-Nile Divide, Kibira forest covers an area of 40,000ha and constitutes an extension of Nyungwe forest (90,000ha) in Rwanda. Together they form the largest afro-montane forest block in Africa. The forest ranges in altitude from 1600m to 2900m. Kibira has been protected since 1933, but in reality from only 1980 (Wilson 1990). Only 16% remains as primary forest (Wilson 1990), composed of *Symphonia globulifera*, *Newtonia buchananii*, *Albizia gummifera* and *Entadrophragma excelsum*. The forest holds animal species of conservation concern, including the mountain monkey *Cercopithecus lhoesti*, chimpanzee *Pan troglodytes*, and several restricted range bird species (*Bradypterus graueri*, *Alethe poliophrys*, *Hemitesia neumanni*, *Cryptospiza shelleyi*). There is much pressure on the forest due to illegal activities including poaching, bamboo cutting, wood cutting and burning.

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Bururi	Bururi	3°56'S/ 29°35'E	No
Kibira	Kibira	2°43'S/ 29°20'E	No
Total No. of CF Regions= 2	Total No. of CF Sites= 2	Total No. of CF Sites with an element of protection = 0	

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

CAMEROON

Although much of southern and south-western Cameroon is forested, montane forest is primarily confined to the western high plateaux along the border with Nigeria. These include the Tchabal Mbabo and Bamboutos Mountains, and to related but isolated massifs such as Mts. Manengouba, Cameroon and Kupe. Western Cameroon has the largest area of montane habitats in West and West-central Africa, yet the combined area of montane forest and montane grassland constitutes less than one percent of the country's land area. Trees that are characteristic of montane forests in Cameroon include *Podocarpus latifolius*, *Prunus africanus*, *Rapanea melanophloeos* and *Syzygium staudtii*. Levels of endemism are fairly high, but species diversity is low. This is assumed to result from gross reductions in forest cover during glacial epochs. Wildlife typical of the montane forests includes Preuss's guenon *Cercopithecus preussi*, bushbuck *Tragelaphus scriptus*, blue duiker *Cephalophus monticola*, black-fronted duiker *C. nigrifrons* and yellow-backed duiker *C. sylvicultor*. Much of the montane areas are threatened by activities associated with human encroachment (ICBP 1987, 1988; Lamarque *et al.*, 1990; Sayer *et al.*, 1992; Richards, 1996; World Bank 1993).

References

- ICBP. 1986. *Conservation of Cameroon Montane Forests*. Ed. S.N. Stuart. Report of the ICBP Cameroon Montane Forest Survey.
- ICBP. 1987. *The conservation of Oku Mountain Forest, Cameroon* (project proposal). Cambridge, UK.
- ICBP 1988. *Key forests for threatened birds in Africa*. ICBP Monograph No. 3. Lamarque F., Stark M.A., Fay J.M. and Alers M. 1990. *Cameroon*. In: *Antelopes - Global Survey and Regional Action Plans. Part 3: West and Central Africa*. Ed. R. east, IUCN/SSC Antelope Specialist Group.
- Larison B., Smith T.B., Fotso R., McNiven D., Holbrook K. and Lamperti I. 1995. *Preliminary report - Surveys of selected montane and lowland areas of Cameroon*. Unpublished WWF MS.
- Richards P.W. 1996. *The tropical rain forest - an ecological study (second edition)*. Cambridge University Press.
- Sayer J.A., Harcourt C.S. and Collins N.M. 1992. *The conservation atlas of tropical forests: Africa*. Macmillan.
- World Bank 1993. *Ecologically sensitive sites in Africa. Volume I: Occidental and Central Africa*. Compiled by the World Conservation Monitoring Centre for The World Bank, Washington, DC, USA.

CAMEROON



0

250 km

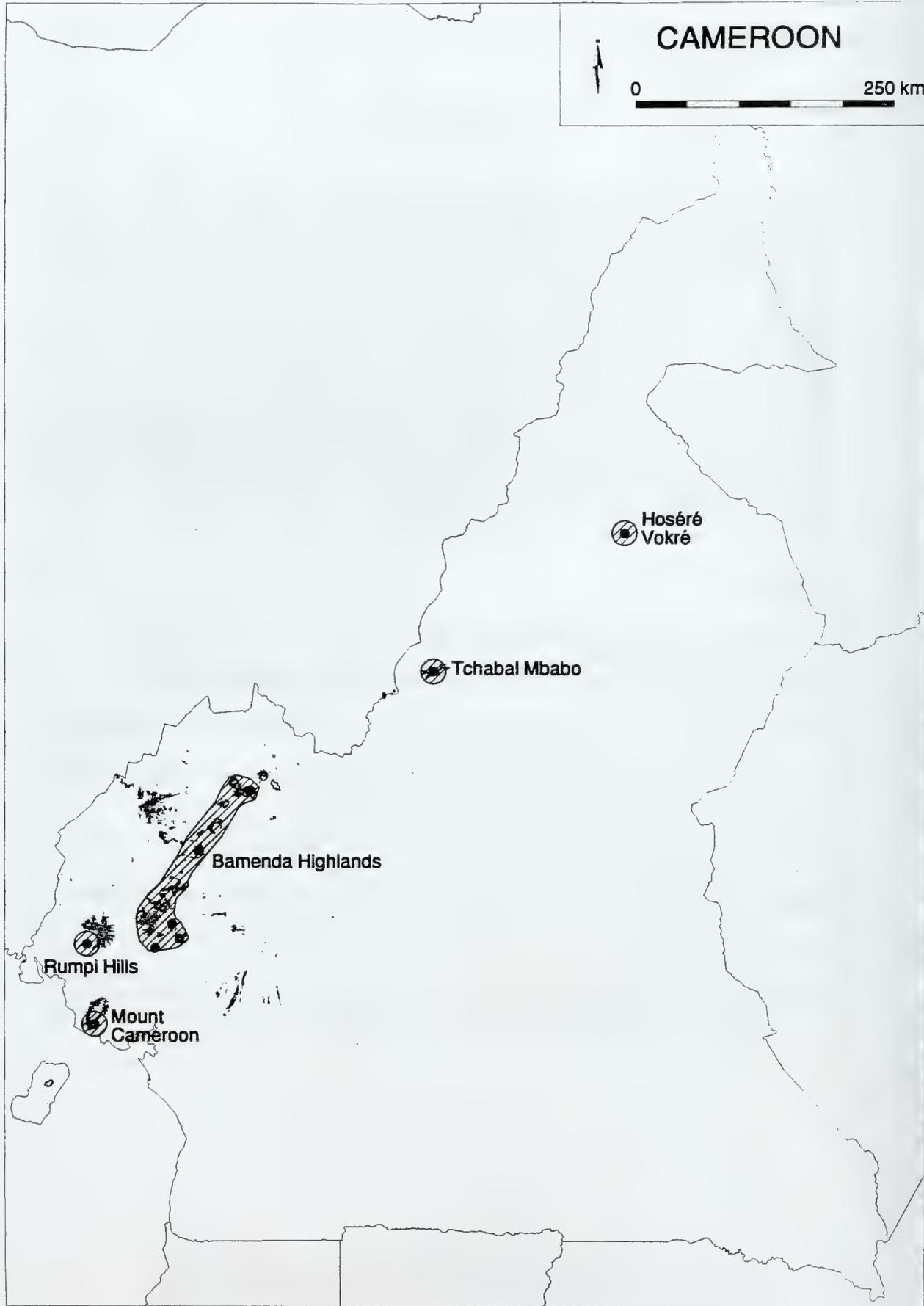
Hoséré
Vokré

Tchabal Mbabo

Bamenda Highlands

Rumpi Hills

Mount
Cameroon



Cloud Forest Region Summaries: Cameroon

Bamenda Highlands

Lying along the Nigerian border and extending into Nigeria in parts, these highlands contain the Bamboutos Mountains and Mt. Oku, and are connected with the Tchabal Mbabo plateau in the north.

Hoséré Vokré

Relict *Podocarpus* forests exist on this isolated massif. The pink-footed puffback *Dryoscopus angolensis*, cinnamon bracken warbler *Bradypterus cinnamomeus* and Preuss's sunbird *Nectarinia preussi* occur at the northernmost limit of their distribution. Human impacts are extreme and include encroaching agriculture, fire, grazing pressure and hunting (WWF, 1995).

Mount Cameroon

This is an isolated, active volcano on the coast of Cameroon's South-West Province, and is the highest mountain in West Africa. Reaching a height of 4100m it supports a narrow belt of montane forest between 1800-2130m dominated by trees such as *Schefflera abyssinica*, *Syzygium staudtii* and *S.mannii*. The lower woody stratum is dominated by *Allophylus bullatus*, and by semi-woody plants such as *Mimulopsis solmsii* and *Oreacanthus mannii*. Wildlife includes species such as Preuss's guenon *Cercopithecus preussi*, drill *Mandrillus leucophaeus*, chimpanzee *Pan troglodytes* and low numbers of elephant *Loxodonta africana*. The Mount Cameroon francolin *Francolinus camerunensis* is endemic to the mountain, and two threatened and four near-threatened bird species occur. A protected area has been proposed that would incorporate the upper forests around the southern end of the mountain, and the Mount Cameroon Project has been initiated to help achieve this. Threats to the forests include the felling of trees for their medicinal bark, intensive hunting by locals, and annual fires in the grasslands above the forests. Periodic lava flows have destroyed areas of forest in the past (Collar and Stuart, 1988; Richards, 1996).

Rumpi Hills

Covering an area of about 45km by 30km, the Rumpi Hills support limited amounts of montane forest on the higher peaks. The highest is Mt. Rata, at 1768m. A few montane species such as *Xylopia africana* occur, and Preuss's guenon *Cercopithecus preussii* is reportedly common. Three threatened and four near-threatened bird species have been recorded as has the endemic

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Bamenda Highlands	Bamboutos Forests	5°40'N/ 10°05'E	No
	Mount Kilum/Idjim	6°12'N/ 10°32'E	Yes
	Mount Kupé	4°47'N/ 9°42'E	No
	Mount Manenguba	5°01'N/ 9°51'E	No
	Mount Nlonako	4°53'N/ 9°55'E	No
Hoséré Vokré	Hoséré Vokré	8°30'N/ 13°50'E	No
Mount Cameroon	Mount Cameroon	4°07'N/ 9°10'E	Yes
Rumpi Hills	Rumpi Hills	4°50'N/ 9°06'E	No
Tchabal Mbabo	Tchabal Mbabo	7°16'N/ 12°09'E	No
Total No. of CF Regions= 5	Total No. of CF Sites= 9	Total No. of CF Sites with an element of protection = 2	

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

chameleon *Chamaeleo eisentrauti*, but it is not known to what extent they utilise the montane elements of the hills (ICBP, 1986; World Bank, 1993).

Tchabal Mbabo

Tchabal Mbabo is a 25km long, bowl-shaped east-west ridge, the north and west-facing slopes of which are extensively forested with dense montane forest between 1600-2010m. The upper storey is dominated by the trees *Syzygium staudtii*, *Schefflera abyssinica* and *Carapa grandiflora*, with a high diversity of epiphytes. Species associated with grassland and forest openings are *Adenocarpus mannii*, *Philippia mannii* and *Aguaria salicifolia*. Significant wildlife populations survive, including buffalo *Syncerus caffer*, yellow-backed duiker *Cephalophus sylvicultor*, bay duiker *C. dorsalis*, bushbuck *Tragelaphus scriptus*, black and white colobus *Colobus guereza* and giant forest hog *Hylochoerus meinertzhageni*. Several bird species endemic to the western Cameroon/eastern Nigeria uplands region have been recorded, three of which are regarded as threatened or potentially threatened. The area offers one of the most significant possibilities to protect montane forest in Cameroon. The forests are extensive and human pressures are low (Collar and Stuart, 1988; World Bank, 1993; Larison *et al.*, 1995).

COTE D'IVOIRE

The only higher altitude forest that occurs in Côte d'Ivoire occurs on Mount Nimba on the joint borders with Liberia and Guinea. The mountain supports a transitional "mist forest" between 1000-1600m dominated by *Parinari excelsa* and *Uapaca chevalieri*. It is mentioned here because of its exceptionally high degree of endemism (Collar and Stuart, 1988; WCMC 1991).

References

- Collar and Stuart 1988. *Key forests for threatened birds in Africa*. ICBP Monograph No.3
World Bank 1993. *Ecologically sensitive sites in Africa. Vol.IV: West Africa*. Compiled by the
World Conservation Monitoring Centre for The World Bank, Washington, DC, USA.
World Conservation Monitoring Centre 1991. *Guide de la diversité biologique de Cote d'Ivoire*.
WCMC, Cambridge. UK.

CÔTE D'IVOIRE



0

150 km



Mount Nimba

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Nimba Range	Mount Nimba	7°33'N/ 8°27'W	No
Total No. of CF Regions= 1	Total No. of CF Sites= 1		Total No. of CF Sites with an element of protection = 0

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

Cloud Forest Region Summaries: Cote d'Ivoire

Nimba Range

Part of the "Guinea Backbone", which is found across the borders of Liberia, Côte d'Ivoire and Guinea, Mount Nimba reaches an altitude of 1752m. It features a very high degree of endemism, with over 500 new species described from the area. Endemics include the Nimba flycatcher *Melaenornis annamarulae*, lesser otter shrew *Nectophrynoides liberiensis* and over 20 species of invertebrate. The massif has high water catchment values. The Mount Nimba Strict Nature Reserve covers 5000ha and is also a World Heritage Site (World Bank, 1993).

EQUATORIAL GUINEA

Equatorial Guinea comprises the small mainland territory of Rio Muni on the Atlantic coast between Gabon and Cameroon, and the island islands of Bioko (Fernando Po) and Annobon in the Gulf of Guinea. The only montane areas occur on the island of Bioko, which is part of the Cameroon Line of Tertiary to recent volcanoes and lies 32km off the coast of Cameroon (WCMC, 1996).

References

- Collar and Stuart. 1988. *Key forests for threatened birds in Africa*. ICBP Monograph No.3.
- Sayer J.A., Harcourt C.S., Collins N.M. 1992. *The conservation atlas of tropical forests: Africa*. Macmillan.
- WCMC 1996. PADU datasheet.
- World Bank 1993. *Ecologically sensitive sites in Africa. Volume I: Occidental and Central Africa*. Compiled by the World Conservation Monitoring Centre for The World Bank, Washington, DC, USA.

EQUATORIAL GUINEA



0

15 km

Bloko



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Bioko	Gran Calera de Luba	3°20'N/ 8°33'E	Yes
	Pico Basile	3°35'N/ 8°46'E	Yes
	Pico Biao	3°20'N/ 8°38'E	Yes
Total No. of CF Regions= 1	Total No. of CF Sites= 3	Total No. of CF Sites with an element of protection = 3	

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

Cloud Forest Region Summaries: Equatorial Guinea

Bioko

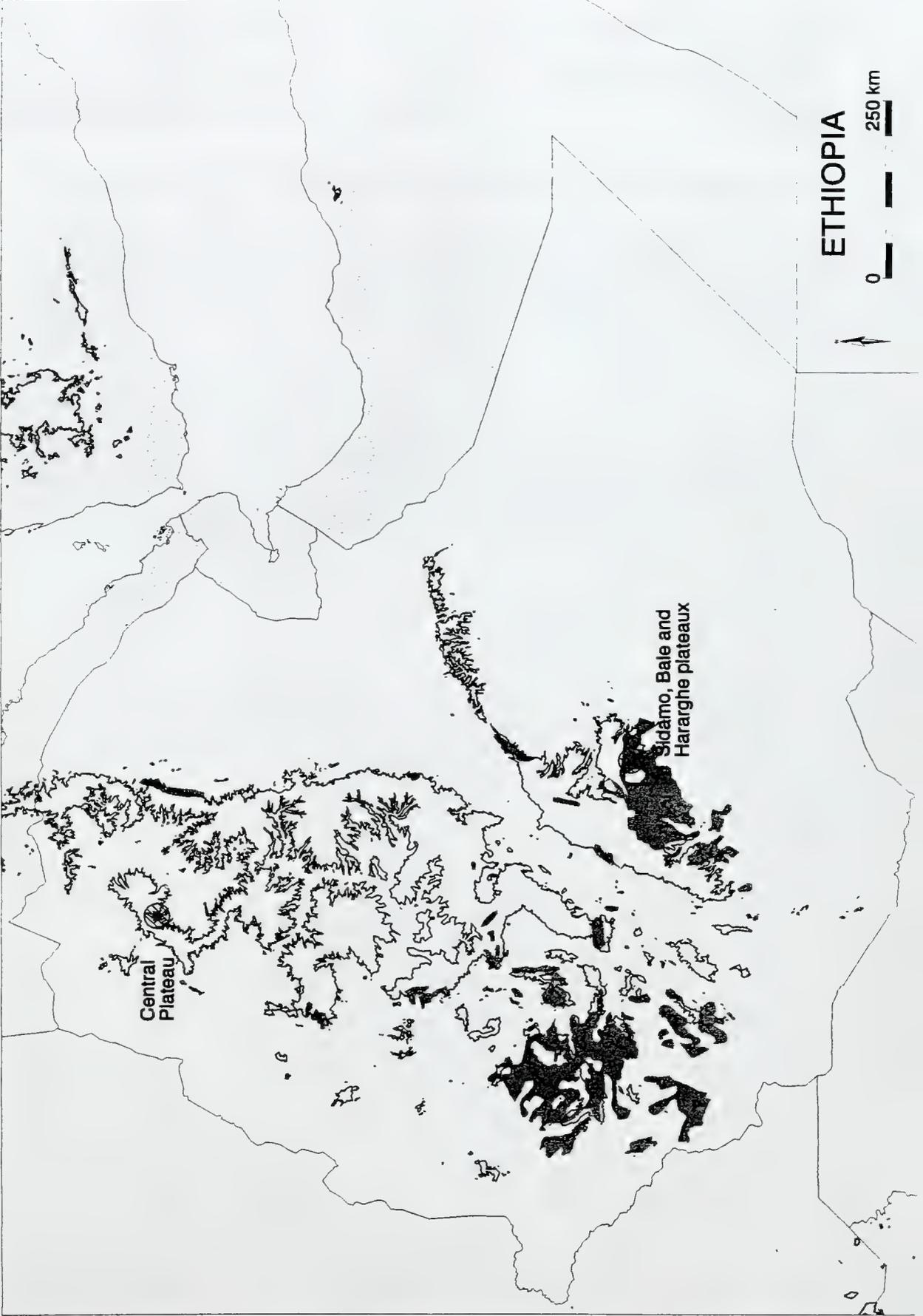
Covering an area of 2017sq.km. Bioko Island was connected to the African mainland between 10,000-11,000 B.P. when sea levels were lower. The island is dominated by two connected mountain masses. Pico Basile (3011m) in the north is the island's highest point, while the southern third of the island consists of a rugged plateau reaching a height of 2009m on Pico Biao, and 2261m on Gran Caldera de Luba. Rainfall in the wetter south of the island can exceed 10,000mm/annum. Although montane rain forest occurs between 900-2400m, true *Schefflera*-dominated "lichen forest" only occurs above 1900m. The upper forests are home to the island's only endemic bird, the Fernando Po speirops *Speirops brunneus*, and several rare primate species such as an endemic subspecies of drill *Mandrillus leucophaea* occur. Two protected areas exist: Pico Basile o Sta. Isabel and Sur de la Isla de Bioko, both of which include montane forests. Pressures on the montane forests are low, apart from hunting (Collar and Stuart, 1988; Sayer *et al.*, 1992; World Bank, 1993).

ETHIOPIA

Highlands above 2500m in elevation cover 43% of Ethiopia, and account for 90% of agriculturally suitable land. The Rift Valley runs from the south-west of the country north and north-eastwards towards the Red Sea and Gulf of Aden, on either side of which lie highland plateaux averaging between 2100-2500m in elevation. Dry and moist forms of montane and upper montane forests occur along the eastern escarpment north of the Rift Valley, around the Bale, Sidamo and Hararghe plateaux, on massifs on the huge Central Plateau such as Simen (incorporating the highest point in Ethiopia at 4624m), Guna and Birhan massifs, and in the south-west of the country in southern Wollega, Illubabor and Kaffa provinces. The montane forests of Ethiopia can be divided into moist and dry forms. Drier forests are typified by trees such as *Juniperus procera*, *Apodytes dimidiata*, *Halleria lucida*, and *Olea* species. Wetter forms of montane forest are characterised by mixed *Podocarpus gracilior*-broadleaf communities. Upland and montane forests have been under intense human pressure in Ethiopia for a considerable period, and it is estimated that of an original cover of 176,000 sq.km of *Podocarpus/Juniperus* forest, only 0.9% now remains. Similarly, only 11% of the area formerly covered by broadleaved upland forests now survives (WCMC, 1991).

References

- Hillman J.C. 1993. *Ethiopia: Compendium of Wildlife Conservation Information. Vols 1 & 2.* Ethiopian Wildlife Conservation Organisation, Addis Ababa.
- Ministry of Agriculture, Natural Resources Conservation and Development 1986. *Management Plan: Simen Mountains National Park and Surrounding Rural Area.* UNESCO and WCS.
- The World Bank. 1993. *Ecologically sensitive sites in Africa. Volume II: Eastern Africa.* Compiled by the World Conservation Monitoring Centre for The World Bank, Washington, DC, USA.
- Uhlig S.K. and Uhlig K. 1991. Studies on the altitudinal zonation of forests and alpine plants in the central Bale Mountains, Ethiopia. *Mountain Research and Development*, Vol.11(2) pp. 153-156.
- WCMC. 1991. *Biodiversity guide to Ethiopia.* World Conservation Monitoring Centre, Cambridge.



Central Plateau

Sidamo, Bale and Hararghe plateaux

ETHIOPIA

0 250 km



Cloud Forest Region	Cloud Forest Site	13°00'N/ 38°00'E 7°00'N/ 40°00'E	Protected* Yes/No?
Central Plateau Sidamo, Bale and Hararghe plateaux	Simen Mountains Bale Mountains		Yes No
Total No. of CF Regions= 2	Total No. of CF Sites= 2	Total No. of CF Sites with an element of protection = 1	

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

Cloud Forest Region Summaries: Ethiopia

Central Plateau

Occurring at elevations between 1600-3300m, only scattered remnants of this forest type now survive. Dominant trees are *Juniperus procera* and *Olea europaea* ssp. *africana*, associated in places with species such as *Podocarpus gracilior*, *Cordia abyssinica*, *Dombeya schimperiana* and *Ehretia cymosa*. It includes sites such as the Simen Mountains in north-central Ethiopia, and Mt. Guge (4200m) to the west of Lake Abaya (WCMC, 1991; World Bank, 1993).

Sidamo, Bale and Hararghe plateaux

Occurring in the south-east of Ethiopia, these plateaux support both moist and dry forests between 1500-2700m. Little is known of their overall composition. The Bale Mountains (7°N, 40°E) form the highest section of the southern plateaux south of the Rift Valley, reaching a height of 4377m (World Bank, 1993; Uhlig and Uhlig, 1991; WCMC, 1991).

GABON

Gabon, located on the west coast of Equatorial Africa, lies entirely within the Guineo-Congolian regional centre of endemism which is the most biologically diverse region in the continent. The interior uplands consist mainly of plateau surfaces of 450m to 600m dissected by the Ogooué River system into distinct blocks. The plateau surface is broken by the Monts de Cristal in the north and the Massif du Chaillu in the south, with the highest mountains just over 1000m.

The rain forests, which comprise an estimated 8000 species of plants, cover about 85% of the country. In the north-east of the country the mountains are covered between 950m and 1000m with a type of vegetation known as "elfin thicket" found nowhere else in Africa. The remaining area, mostly in the south-east and south-west, is largely savanna, which is thought to be a climatic remnant from a drier past.

Gabon is one of the few countries in the world that still offers exceptional potential for conservation, as in general, the major ecosystems remain intact. Along with adjacent areas of Cameroon and Congo, it forms what is probably the largest intact forest block remaining in Africa (WWF, 1991). However, forest exploitation is highly selective, 90% of trees cut being of one species, okoumé *Aucomea klaineana*, an important species for use as plywood and veneer (Tutin and Fernandez, 1987).

The protected areas system (excluding forest reserves) currently comprises 10 reserves which cover just over 6% of the country. No national parks exist and selective logging has affected the forests in four of the areas (Sayer, Harcourt and Collins, 1992). Additional areas are in need of protection, particularly the primary forest north and south of the Ogooué. The ecological impact of shifting cultivation is not serious as population density is very low.

References

- Davis, S.D., Droop, S.J.M., Gregerson, P., Henson, L., Leon, C.J., Villa-Lobos, J.L., Synge, H. and Zantovska, J. 1986. *Plants in danger: what do we know?* IUCN, Gland, Switzerland and Cambridge, UK. Pp. 127-128.
- Hughes, R.H. and Hughes, J.S. 1991. *Directory of African wetlands*. IUCN, Gland, Switzerland and Cambridge, UK/UNEP, Nairobi, Kenya/WCMC, Cambridge, UK. Pp 481-492.
- IUCN. 1987. *Action strategy for protected areas in the Afrotropical Realm*. IUCN, Gland, Switzerland and Cambridge, UK. 60 pp.
- IUCN. 1989. *La conservation des écosystèmes forestiers d'Afrique centrale*. IUCN, Gland, Switzerland and Cambridge, UK. 124 pp.

- IUCN. 1990. *La conservation des écosystèmes forestiers du Gabon*. Based on the work of Chris Wilks. IUCN, Gland, Switzerland and Cambridge, UK. 228 pp.
- IUCN. 1983. *La répartition des aires protégées en fonction des besoins de la conservation des communautés biotiques de l'Afrique Centrale et de l'Ouest*. Working Document. IUCN, Gland, Switzerland.
- MacKinnon, J. and MacKinnon, K. 1986. *Review of the protected areas system in the Afrotropical Realm*. IUCN, Gland, Switzerland and Cambridge, UK/UNEP, Nairobi, Kenya. 259 pp.
- McShane, T.O. 1990. Conservation before the crisis-an opportunity in Gabon. *Oryx* 24: 9-14.
- McShane, T.O. and McShane-Caluzi, E. 1990. Conservation before the crisis: A strategy for conservation in Gabon. WWF.
- Nicoll, M. and Langrand, O. 1986. *Conservation et utilisation rationnelle des écosystèmes forestiers du Gabon*. Project 3247. WWF/IUCN, Gland. 143 pp.
- Sayer, J.A., Harcourt, C.S. and Collins N.M. 1992. *The Conservation Atlas of Tropical Forests: Africa*. IUCN, Gland, Switzerland and Cambridge, UK.
- Tutin, C.E.G. and Fernandez, M. 1987. Gabon: A Fragile Sanctuary. *Primate Conservation* 8: 160-161.
- WWF. 1991. *List of Approved Projects*. Vol. 6: Africa/Madagascar. P. 6072.

GABON



0

150 km



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Monts Doudou	Monts Doudou	2°23'S/ 10°20'E	No
Monts de Bélinga	Monts de Bélinga	1°07'N/ 13°12'E	No
Monts de Christal	Monts de Christal	0°35'N/ 10°36'E	No
Monts du Chaillou	Monts du Chaillou	1°37'S/ 11°53'E	No
Total No. of CF Regions= 4	Total No. of CF Sites= 4	Total No. of CF Sites with an element of protection = 0	

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

Cloud Forest Region Summaries: Gabon

Monts Doudou

The Monts Doudou are located between Sette-Cama and Moukalaba Reserves in the south-west of Gabon. They constitute a mountain range oriented north-south, covering an area of 260,000ha. The vegetation belongs to the Guineo-Congolean type. The flora of the Monts Doudou is rich and includes a new sub-species of *Begonia bongoensis* and an undescribed *Impatiens* species (IUCN, 1990). The forest is dominated by okoumé *Aucoumea klaineana*, *Monopetalanthus* spp., *Toubaouate brevipaniculata*, *Dialium pachyphyllum*, *Desbordesia glaucescens*, *Librevillea klainei*, *Allanblackia floribunda* and *Coula edulis*. The site is particularly important for the rocky areas whose diverse fauna includes *Cephalus ogilbyi crusalbum*, endemic to Gabon. However, the Monts Doudou are not officially protected (IUCN, 1990).

Monts de Bélinga

Located near Belinga, in the north-east of Gabon, the Monts Belinga contain many high peaks lying north-south, the highest reaching 1024m. The mountains hold a unique vegetation of "elfin thicket", located at altitudes above 900m. The vegetation is dense and reaches 4-8m height. Epiphytes, orchidae, bryophytes and lianes are abundant. The fauna is not well known. Limited human activities are recorded, although an area of 200-300ha has been proposed for protection as an integral forest (IUCN, 1990), due to its unique vegetation. Mining project to exploit iron.

Monts de Christal

Located on the north-western Gabon-Equatorial Guinea border, the Monts de Cristal (also called Tchimbele) cover an area of 410,000ha. The vegetation is Guineo-Congolean and the site is recognised as one of the most important centres of endemism in Gabon. A number of endemics in the Begoniaceae family are found. The rocky area in the north-east of the mountains holds species characteristic of the Soudanian, including *Dissotis barterii*, *Afrotrilepis* sp. and *Sanseveria* sp. The fauna includes *Picathartes oreas*, which is only found in forests of Cameroon and Gabon. Levels of forest exploitation are low although poaching occurs in some areas. A power station project being developed at Kinguélé and Tchimbélé offers a potential threat to the forest (IUCN, 1990).

Monts du Chaillou

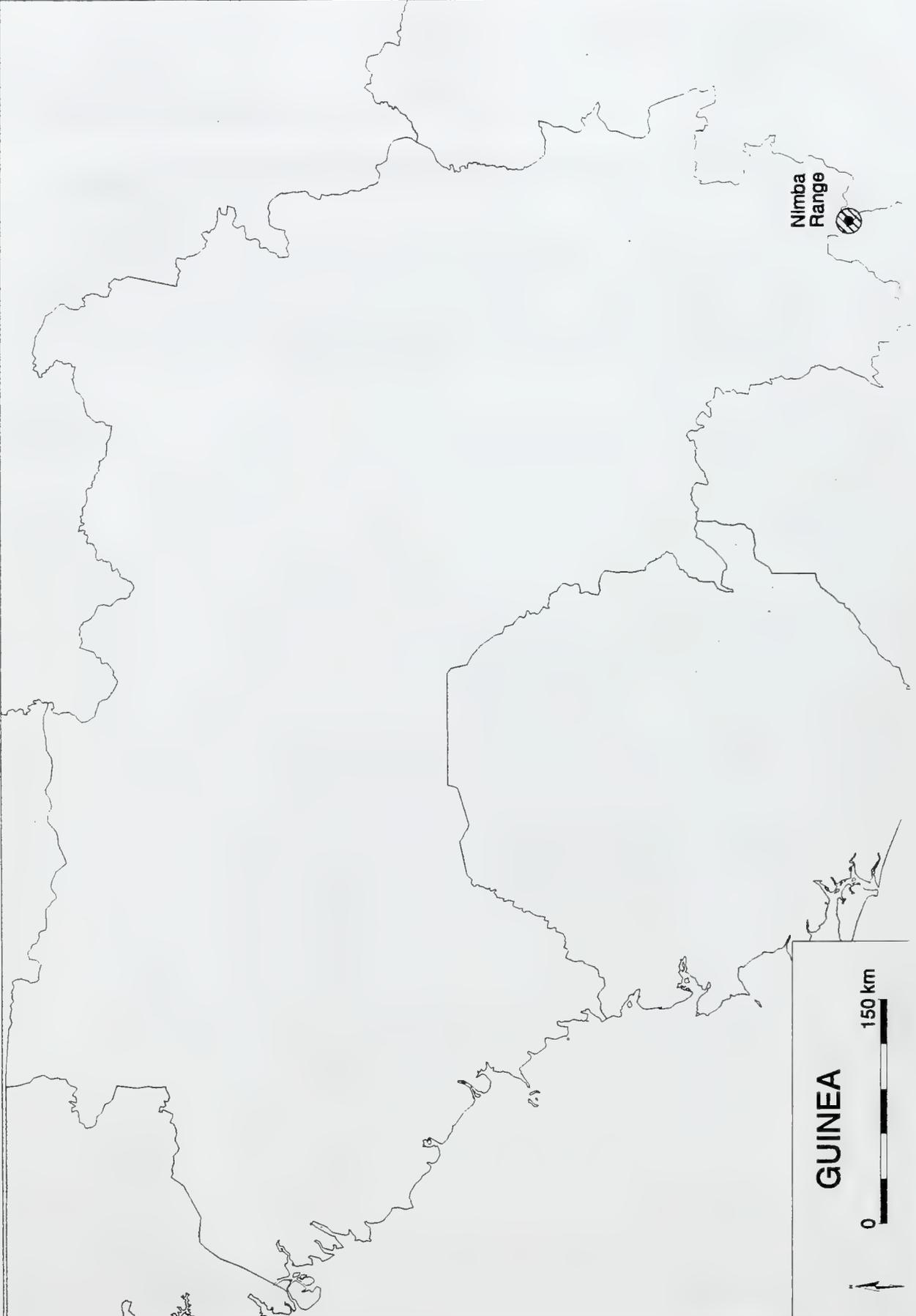
Located in the central Chaillou massif, the Monts Chaillou are also called Monts Soungou-Milondo, the names of the two main peaks: Mont Soungou (1022m) and Mont Milondo (1020m). The area covers 100,000ha and is not officially protected. Vegetation is again dominated by okoumé *Aucoumea klaineana*. Sub-montane forest occurs above 750m and includes *Begonia thomeana*, which is only found outside Gabon in Sao Tome. Human pressure is mainly from poaching and limited to within 2-3 km of the roads bordering the site to the north, west and south (IUCN, 1991).

GUINEA

Approximately 20-25% of land in Guinea exceeds 1000m in elevation, most of this in the Fouta Djallon and Nimba mountains. The greater part of the country is covered by degraded rain forest. The only higher altitude forest that occurs is on Mount Nimba on the joint borders with Liberia and Cote d'Ivoire, which reaches a height of 1752m. The mountain supports a transitional "mist forest" between 1000-1600m dominated by *Parinari excelsa*. It is mentioned here because of its exceptionally high degree of endemism (Collar and Stuart, 1988).

References

- Collar and Stuart. 1988. *Key forests for threatened birds in Africa*. ICBP Monograph No.3
World Bank 1993. *Ecologically sensitive sites in Africa. Vol.IV: West Africa*. Compiled by the
World Conservation Monitoring Centre for The World Bank, Washington, DC, USA.



Nimba
Range

GUINEA

150 km

0



Cloud Forest Region	Cloud Forest Site	7°34'N/ 8°28'W	Protected* Yes/No?
Nimba Range	Mount Nimba		No
Total No. of CF Regions= 1	Total No. of CF Sites= 1	Total No. of CF Sites with an element of protection = 0	

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

Cloud Forest Region Summaries: Guinea

Nimba Range

Part of the "Guinea Backbone", which is found across the borders of Liberia, Côte d'Ivoire and Guinea. Mount Nimba reaches an altitude of 1752m. It features a very high degree of endemism, with over 500 new species described from the area. Endemics include the Nimba flycatcher *Melaenornis annamarulae*, lesser otter shrew *Nectophrynoides liberiensis* and over 20 species of invertebrate. The massif has high water catchment values. The Mount Nimba Strict Nature Reserve covers 5000ha and is also a World Heritage Site (World Bank, 1993).

KENYA

Kenya covers an area of 580,370 sq.km, bordered by Tanzania to the south, Uganda to the west, Sudan and Ethiopia to the north, and the Indian Ocean to the east. The altitude ranges from sea level to 5200m at Mt. Kenya. The highlands form most of the south-west and central parts of the country and have an elevation of between 1400 and 2800m (FAO, 1981).

Kenya has the most diverse forests in East Africa, with lowland rain forest in western Kenya, montane forest in the central and western highlands and on higher hills and mountains along the southern border. In addition, there are some coastal mosaic forests and fairly extensive mangroves, particularly at Lamu and the mouth of the Tana River. However, only 3.8% (2.2 million ha) of the country is composed of forested land, 2.1% is inland water bodies, and about 75% composed of woodlands, bushlands and grasslands, mostly in arid and semi-arid areas (ETMA/NES, 1985; Polhill, 1989; WCMC, 1991).

Cloud forest is found at several sites in the northern mountain range, the southern hills, Mount Kenya range and on Mount Elgon.

The largest proportion of existing national parks and wildlife reserves (74%) are found in arid and semi-arid regions (Pertet, n.d.). Forest areas with limited protection in either national parks or reserves include the Guineo-Congolese rain forest, coastal forest and woodland and coastal palm woodland. Recommendations to expand the protected areas network to include these areas are found in MacKinnon and MacKinnon (1986), IUCN (1987) and Stuart and Adams (1990).

There are reports of heavy encroachment and over-exploitation of many forest areas and other biotic communities. Population growth has led to increases in agricultural encroachment, shifting cultivation, cattle grazing, illegal settlement, and subsistence hunting, which have put the forests under severe pressure. In addition, intensive logging and unlicensed timber extraction for building poles and charcoal, the conversion of indigenous forest to plantations and the legal degazetting of forest land for conversion to other types of land use and rapid industrialisation are major threats to the forest resource, both within and around various forest reserves (ERL, 1990; Young, 1984). Other threats include poaching, uncontrolled bushfires, invasion of alien plant species, and tourism impacts (Marsh, 1985; KWS, 1990).

References

- Bronner, G. 1990. Vegetation and Land use in the Matthews Range Area, Samburu District, Kenya. *Dissertationes Botanicae* 160: 1-182. Berlin:J.Cramer.

- Bussman, R.W. The forests of Ol Doinyo Lenkiyo (Mathews Range, Samburu District, Kenya).
- Bussmann, R.W. 1994. The forests of Mount Kenya (Kenya) - Vegetation, Ecology, Destruction and Management of a tropical mountain forest ecosystem. Dissertation Universitat Bayreuth.
- ERL 1990. *Environmental study of the Mau and Trans Mara Forests, Kenya*. Environmental Resources Ltd. Ministry of Environment and Natural Resources, Nairobi, Kenya. 143 pp.
- ETMA/NES 1985. *Endangered resources for development*. The report on the strategy conference for the management and protection of Kenya's plant communities: forests, woodlands, bushlands, savannahs, and aquatic communities. Nairobi, 22-23 August 1984. ETMA (Environmental Training and management in Africa) Regional Office, Nairobi. 55 pp.
- FAO 1981. *Tropical Forest Resource Assessment Project: Forest Resources of Tropical Africa (Part II: Country Briefs – Kenya)*. FAO, Rome. Pp. 257-268.
- Hughes, R.H. and Hughes, J.S. 1991. *Directory of African wetlands*. IUCN, Gland, Switzerland and Cambridge, UK/UNEP, Nairobi, Kenya/WCMC, Cambridge, UK. Pp. 162-188.
- IUCN 1987. *Action strategy for protected areas in the Afrotropical Realm*. IUCN, Gland, Switzerland and Cambridge, UK. Pp. 36-37.
- IUCN 1990. *Regional Office – Eastern Africa: Triennial Report 1988-1990*. Prudential Printers Ltd., Nairobi. 72 pp.
- KWS 1990. *Kenya Wildlife Service – A policy framework and development programme 1991-96: Annex 6 – Community conservation and wildlife management outside parks and reserves*. Kenya Wildlife Service, Nairobi. 181 pp.
- MacKinnon, J. and MacKinnon, K. 1986. *Review of the protected areas system in the Afrotropical Realm*. IUCN, Gland, Switzerland and Cambridge, UK/UNEP, Nairobi, Kenya. Pp. 214-216.
- Marsh, C.W. 1985. *A resurvey of Tana River primates and their forest habitat*. New York Zoological Society, New York. 23 pp.
- Polhill, R.M. 1989. East Africa (Kenya, Tanzania, Uganda). In: Campbell, D.G. and Hammond, D. (Eds), *Floristic Inventory of Tropical Countries*. New York Botanical Garden, New York. Pp. 218-231.
- Stuart, S.N., and Adams, R.J. 1990. *Biodiversity in Sub-saharan Africa and its islands: conservation, management and sustainable use*. IUCN, Gland, Switzerland. Pp. 112-119.
- WCMC 1991. Protected areas system: Kenya. World Conservation Monitoring Centre, Cambridge, UK. Draft. 18 pp.
- Young, T.P. 1984. *Kenya's indigenous forests: status, threats and prospects for conservation action*. A report to the WWF/IUCN Eastern Africa Regional Office, Nairobi, Kenya. 41 pp.



Protected*
Yes/No?

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Mount Elgon	Mount Elgon	1°02'N/ 34°30'E	Yes
Mount Kenya Volcanic Range	Aberdare Hills	0°25'S/ 36°41'E	Yes
	Mount Kenya	0°10'S/ 37°30'E	Yes
	Mount Mukogodo	0°04'N/ 37°26'E	Yes
	Ndare Ngare	0°13'N/ 37°21'E	Yes
	Ngaia Forest	0°22'N/ 38°01'E	Yes
	Nyambeni Hills	0°14'N/ 37°56'E	Yes
	Northern Mountains	Karisia Hills	1°11'N/ 36°47'E
	Mathews Range	1°17'N/ 37°18'E	Yes
	Mount Kulal	2°43'N/ 36°56'E	Yes
	Mount Marsabit	2°20'N/ 38°00'E	Yes
	Mount Nyiro	2°10'N/ 36°50'E	No
	Ndoto Mountains	1°50'N/ 37°10'E	Yes
Southern Hills	Loita Hills	1°42'S/ 35°53'E	No
	Nguruman Escarpment	1°49'S/ 35°55'E	No
Total No. of CF Regions= 4	Total No. of CF Sites= 15	Total No. of CF Sites with an element of protection = 12	

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

Cloud Forest Region Summaries: Kenya

The Northern Mountains

The northern mountain range of Kenya where cloud forest is found includes the Mathews Range, Ndoto Mountains, Mount Kulal, Mount Nyiro, Mount Marsabit, and Kariissia Hills which includes Maralal and Porrer. The annual average rainfall can be as low as 100-150mm in the plains, with 500mm in the valley of the Nyiro-Ndoto mountains. Maximum rainfall is recorded in the mountain forest zone, reaching about 1200mm.

Montane forest which includes cloud forest at higher elevations and in volcanic craters, is found between 1500 and 2700m. The vegetation is dominated by *Olea hochstetteri*, *O. africana*, *Cassipourea malosana* and *Juniperus procera*. It often forms distinct zones, such as on the Mathews range where the forest is composed of mainly *Croton megalocarpus* from 1500m to 2000m, with *Olea africana-Juniperus procera* around 1960m, and *Podocarpus latifolius* from 2000m to 2700m (Bronner, 1990). Montane grassland is often found above.

Although not endemic to cloud forests, bird species including the lammergeier *Gypaetus barbatus*, mountain buzzard *Buteo oreophilus*, yellow-billed hornbill *Tockus flavirostris*, star-spotted nightjar *Caprimulgus stellatus*, and Narina's trogon *Apaloderma narina* are all found in the mountain area. At Mount Kulal the fauna is particularly characterised by the presence of an endemic sub-species of bird, the montane white-eye *Zosterops poliogaster kulalensis*.

Most of these forests are gazetted forest reserves, although in many cases the actual forest area is only a small proportion of the total area of the reserve.

There is an increasing pressure on the forests from the local population, mainly by tree felling for fuel, and construction of houses and enclosures for livestock. The montane and sub-montane forests have been reduced and forest regeneration is hindered in several areas by removal of the understorey. Grass fires started by pastoralists erode the forest edge, and periodic droughts have also caused problems. A further threats is from extensives fires caused by honey hunters.

The Southern Hills

Cloud forests in southern Kenya, found between Nairobi and the Tanzanian border, include the Nguruman escarpment and the Loita Hills, where the altitude varies from 1500m to 2100m. The climate is characterised by two wet seasons from February-March to May and from October to December. Annual rainfall varies from 1500 to 2100mm.

Comprehensive species inventories have been conducted in the area. The montane range is dominated by *Juniperion procerae* and *Cassipourion malosanae*. Other species include *Ilex mitis*, *Ilea capensis*, *O. europaea*, *Juniperus procera*, and *Podocarpus falcatus* (Bussmann 1994, Beck and Bussmann 1995).

In addition to their richness in biodiversity and endemic species, these forests are important for watershed protection, socio-economic and medicinal uses, and there is a proposed tourism development in the Loita hills (Bussmann, pers. comm.). However, they are also under threat, due mainly to agricultural encroachment, grazing and fire.

Mount Kenya Volcanic Range

The Mount Kenya volcanic range form the central highlands and are composed of Mount Kenya itself, and the Aberdare Hills, Mount Mukogodo, Nyambeni Hills, Ngaia Forest and Ndare. Mount Kenya is the second highest mountain in Africa after Kilimanjaro in Tanzania. The highest peaks are Batian (5199m) and Nelion (5188m). The climate is characterised by a long wet period from March to June and a short dry season from December to February.

Altitude ranges between 1880 and above 5000m. The vegetation varies with this altitude, a rich alpine and sub-alpine flora giving way at lower altitudes to bamboo forests and then montane rainforest. On Mount Kenya, at higher altitudes (2500m-3000m with rainfall over 2000mm/year) the vegetation is dominated by bamboo *Arundinaria alpina* and a mosaic of bamboo and *Podocarpus milanjanus* with bamboo at intermediate elevations (2600m-2800m), and *Podocarpus* above (2800-3000m) and below (2500-2600m). Above 3000m, cold becomes an important factor, tree stature declines, and *Podocarpus* is replaced by *Hypericum* spp., and beyond 3400m there is an alpine zone. In the Aberdares, the lower montane forests (1829-2590m) are dominated by *Podocarpus*, *Olea* and cedar *Juniperus procera*, with some tree fern *Cyathea deckeni* succeeded at higher altitudes (2600-3000m) by *Podocarpus* and bamboo spp *Arundinaria alpina*, and *Hagenia abyssinica* with moorland above.

The fauna includes a number of threatened mammals such as the elephant *Loxodonta africana*, black rhinoceros *Diceros bicornis*, and leopard *Panthera pardus*. Bird life is abundant and varied, with over 200 recorded species including the green ibis *Mesembrinibis cayennensis*, mountain buzzard *Buteo oreophilus*, scaly francolin *Francolinus squamatus*, Hartlaub's turaco *Tauraco hartlaubi*, silvery-cheeked hornbill *Bycanistes brevis*, Mackinder's eagle owl *Bubo capensis* and the locally threatened scarce swift *Schoutedenapus myioptilus* in the forest areas.

Forest in the Aberdares is in theory well protected by the Aberdare National Park which was established in 1950 and acts as a core zone surrounded by a Forest Reserve of 26,480ha. The

park is bisected by a major road, and exploration of the high moorland on foot and trout-fishing are permitted. There is increasing pressure from surrounding farmland expansion and uncontrolled tree felling. Accidental forest fires may pose a potential threat if not controlled.

Mount Elgon

Mount Elgon is located on the western border with Uganda, and ranges in altitude from 2336-4627m. The mountain is a massive volcanic cone which rises to 4627m, overlooking a huge caldera which, together with half the mountain, lies in Uganda. The vegetation changes with increasing altitude from olive *Olea hochstetteri* and *Aningueria adolfi-friedericii* wet montane forest, through olive and *Podocarpus gracilior* forest, *Podocarpus* and bamboo *Arundinaria alpina* zone, with moorland and heath above. Of the 400 species recorded for the area the following are of particular note as they only occur in high altitude broad-leaf montane forest: *Ardisiandra wettsteinii*, *Carduus afro-montanus*, *Echinops hoehnelii*, *Ranunculus keniensis*, and *Romulea keniensis*. The fauna include threatened species such as leopard *Panthera pardus*, and elephant *Loxodonta africana*. Birds of the forest zone include species characteristic of such altitudes in Ceastern Africa and include the endemic subspecies of chat *Cercomela sordida rudolfi* and Hunter's cisticola *Cisticola Chunteri masaba*. Raptors include crowned eagle *Stephanoaetus coronatus*, African hobby *Falco cuvierii*, mountain buzzard *Buteo oreophilus*. The area was designated a National Park (16,923ha) in 1968 and is officially protected. However, there is severe encroachment into the western section of the reserve as well as into the forests and moorlands surrounding the Park which act as a buffer for the maintenance of these habitats within the reserve.

Mount Kenya Volcanic Range

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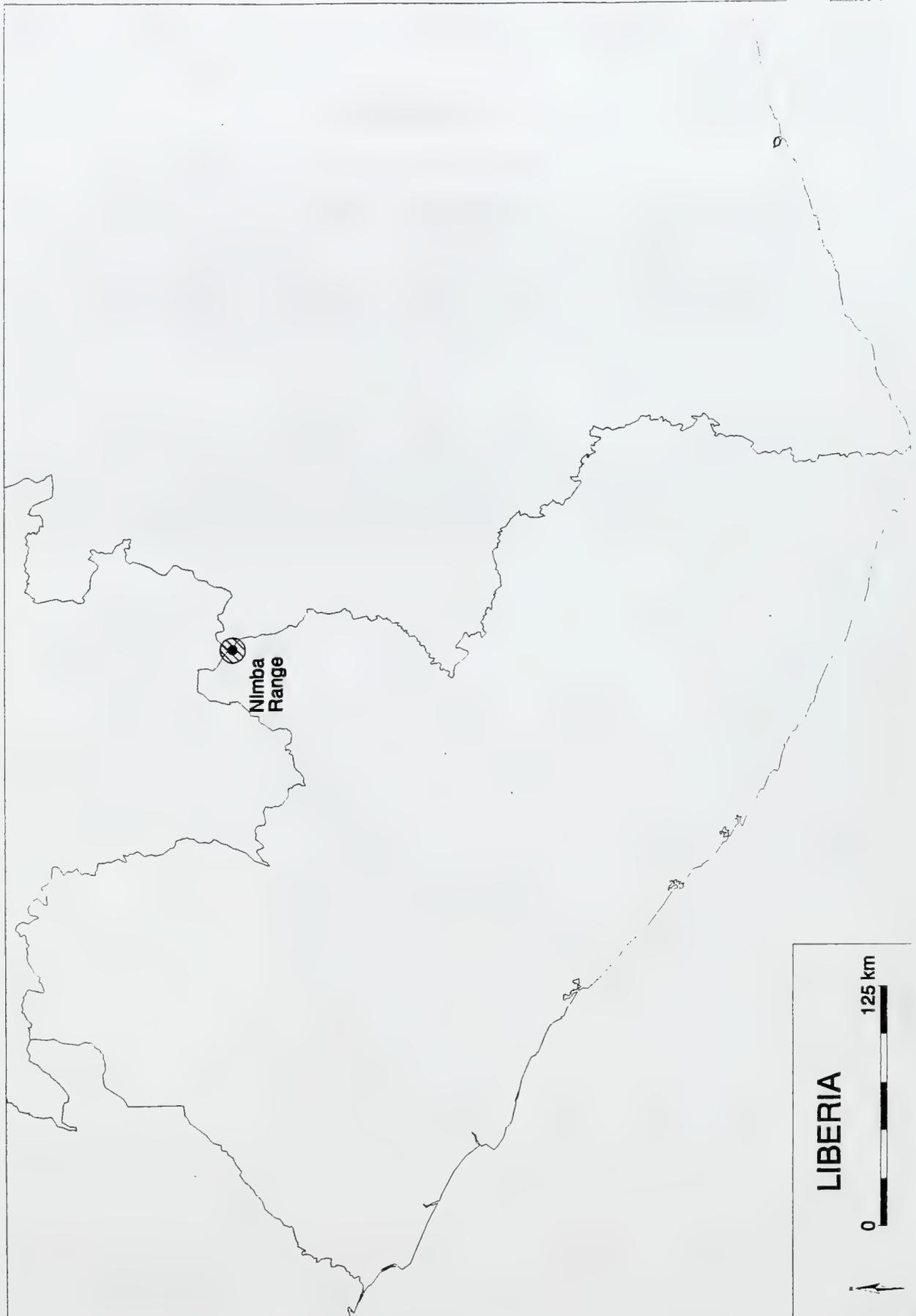
Podocarpus, *Olea* and cedar *Juniperus procera*, with some tree fern *Cyathea deckeni* succeeded at higher altitudes (2600-3000m) by *Podocarpus* and bamboo spp *Arundinaria Calpina*, and *Hagenia abyssinica* with moorland above. The fauna includes a number of threatened mammals such as the elephant *Loxodonta africana*, black rhinoceros *Diceros bicornis*, and leopard *Panthera pardus*. Bird life is abundant and varied, with over 200 recorded species including the green ibis *Mesembrinibis cayennensis*, mountain buzzard *Buteo oreophilus*, scaly francolin *Francolinus squamatus*, Hartlaub's turaco *Tauraco hartlaubi*, silvery-cheeked hornbill *Bycanistes brevis*, Mackinder's eagle owl *Bubo capensis* and the locally threatened scarce swift *Schoutedenapus myioptilus* in the forest areas. Threats to Mount Kenya.. Forest in the Aberdares is in theory well protected by the Aberdare National Park which was established in 1950 and acts as a core zone surrounded by a Forest Reserve of 26,480ha. The park is bisected by a major road, and exploration of the high moorland on foot and trout-fishing are permitted. There is increasing pressure from surrounding farmland expansion and uncontrolled tree felling. Accidental forest fires may pose a potential threat if not controlled.

Northern Mountains

The northern mountain range of Kenya where cloud forest is found includes the Mathews Range, Ndoto Mountains, Mount Kulal, Mount Nyiro, Mount Marsabit, and Karrissia Hills which includes Maralal and Porror. The annual average rainfall can be as low as 100- 150mm in the plains, with 500mm in the valley of the Nyiro-Ndoto mountains. Maximum rainfall is recorded in the mountain forest zone, reaching about 1200mm. Montane forest which includes cloud forest at higher elevations and in volcanic craters, is found between 1500 and 2700m. The vegetation is dominated by *Olea hochstetteri*, *O. africana*, *Cassipourea malosana* and *Juniperus procera*. It often forms distinct zones, such as on the Mathews range where the forest is composed of mainly *Croton megalocarpus* from 1500m to 2000m, with *Olea africana*-*Juniperus procera* around 1960m, and *Podocarpus latifolius* from 2000m to 2700m (Bronner, 1990). Montane grassland is often found above. Although not endemic to cloud forests, bird species including the Clammergeier *Gypaetus barbatus*, mountain buzzard *Buteo Coreophilus*, yellow-billed hornbill *Tockus flavirostris*, star-spotted nightjar *Caprimulgus stellatus*, and Narina's trogon *Apaloderma narina* are all found in the mountain area. At Mount Kulal the fauna is particularly characterised by the presence of an endemic sub-species of bird, the montane white-eye *Zosterops poliogaster kulalensis*. Most of these forests are gazetted forest reserves, although in many cases the actual forest area is only a small proportion of the total area of the reserve. There is an increasing pressure on the forests from the local population, mainly by tree felling for fuel, and construction of houses and enclosures for livestock. The montane and sub-montane forests have been reduced and forest regeneration is hindered in several areas by removal of the understorey. Grass fires started by pastoralists erode the forest edge, and periodic droughts have also caused problems. A further threats is from extensives fires caused by honey hunters.

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LIBERIA



LIBERIA

Although a country of fairly rugged topography, Liberia has no true montane cloud forest. The highest point in the country is Mount Nimba (1385m), which supports a "mist forest" between 1000-1600m dominated by *Parinari excelsa*. It is mentioned here both because of its exceptionally high degree of endemism, and the threats facing it. A large iron-ore mine has been operating on the mountains since 1963, which has attracted large numbers of people to the site. This has put enormous pressures on the natural resources of the mountain (Collar and Stuart, 1988).

References

- Collar and Stuart. 1988. *Key forests for threatened birds in Africa*. ICBP Monograph No.3
World Bank. 1993. *Ecologically sensitive sites in Africa. Vol.IV: West Africa*. Compiled by the
World Conservation Monitoring Centre for The World Bank, Washington, DC, USA.

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Nimba Range	Mount Nimba	7°32'N/ 8°28'W	No
Total No. of CF Regions= 1	Total No. of CF Sites= 1		Total No. of CF Sites with an element of protection = 0

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

Cloud Forest Region Summaries: Liberia

Nimba Range

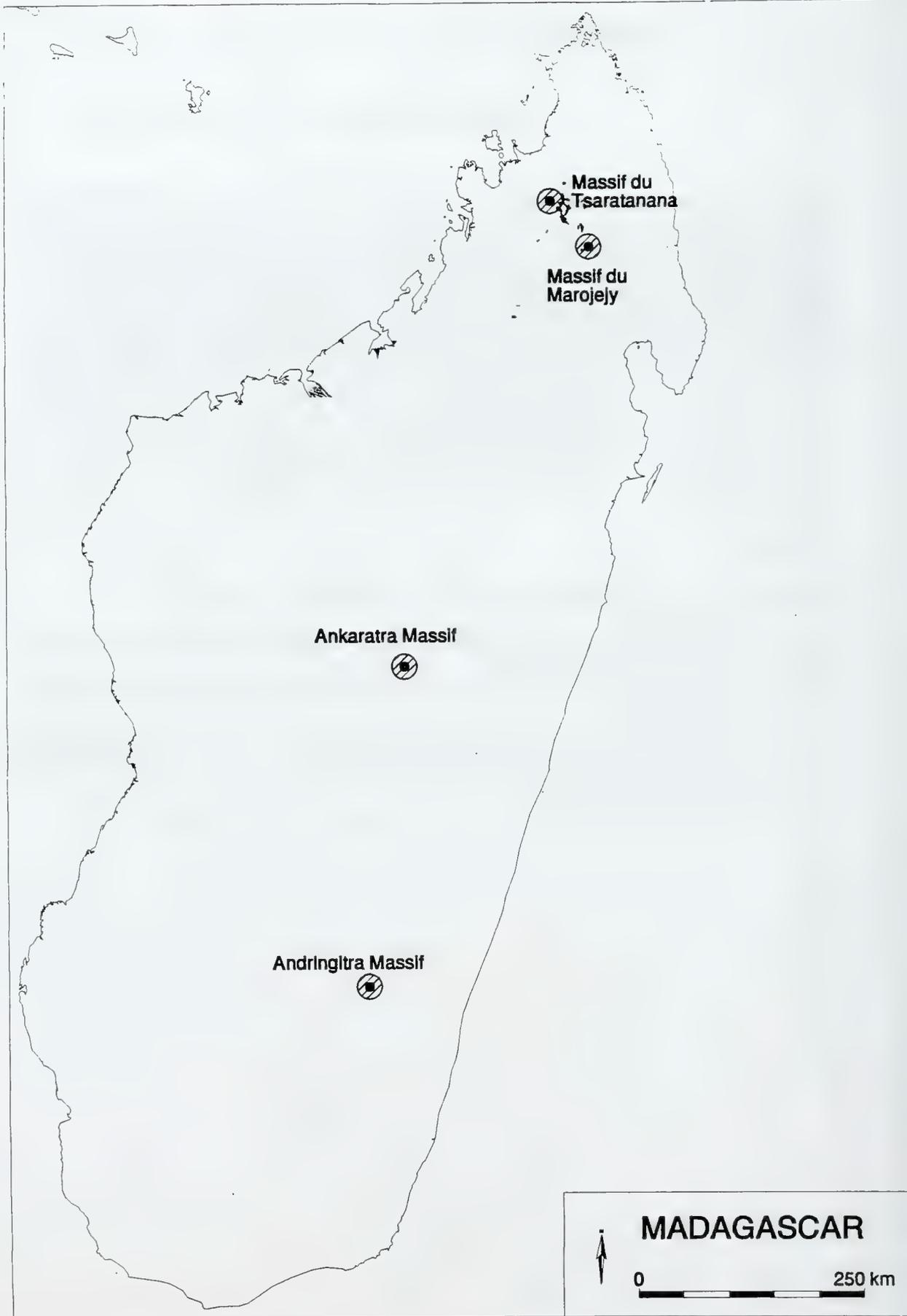
Part of the "Guinea Backbone", found across the borders of Liberia, Côte d'Ivoire and Guinea. Mount Nimba reaches an altitude of 1752m. It features a very high degree of endemism, with over 500 new species described from the area. Endemics include the Nimba flycatcher *Melaenornis annamarulae*, lesser otter shrew *Nectophrynoides liberiensis* and over 20 species of invertebrate. The massif has high water catchment values. The Mount Nimba Strict Nature Reserve covers 5000ha and is also a World Heritage Site (World Bank, 1993).

MADAGASCAR

Considered as one of the seven major world centres of biodiversity, Madagascar is divided into two major floristic zones. Covering about half of the country, the Eastern Zone extends westwards from the east coast to the central highlands. The dryer Western region reaches from the west coast, eastwards up to about the 800m contour. Most of the Eastern Zone was originally forested, but human pressures have had severe impacts on these. The total area of surviving montane forests has been estimated at 60,000ha. Sclerophyllous montane forests of gnarled *Philippia* trees with a canopy 10-13m in height occur along the east-facing central escarpment between 1300 and 2000m. Below this zone, moist montane rain forest occurs between 800-1300m, whilst a thicket of ericoid and herbaceous plants occur above 2000m on isolated massifs such as Tsaratanana, Marojejy, Ankaratra and Andringitra. The upper montane forests are considered to be highly susceptible to being negatively impacted by fire, and their limited size and extent are cause for concern (Sayer *et.al.* 1992; UICN/PNUE/WWF, 1990).

References

- Collar N.J. and Stuart S.N. 1988. *Key forests for threatened birds in Africa*. ICBP Monograph No. 3.
- IUCN/UNEP/WWF 1990. *Madagascar: Profil de l'environnement*. Ed. M.D. Jenkins. IUCN, Gland, Switzerland, and Cambridge, UK.
- Sayer J.A., Harcourt C.S. and Collins N.M. 1992. *The conservation atlas of tropical forests: Africa*. Macmillan.
- World Bank 1993. *Ecologically sensitive sites in Africa. Volume III: South-Central Africa and Indian Ocean*. Compiled by World Conservation Monitoring Centre for The World Bank, Washington, DC, USA.
- WWF 1986. *An action plan for conservation of biological diversity in Madagascar*. WWF.



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Andringitra Massif	Andringitra Massif	22°12'S/ 46°55'E	No
Ankaratra Massif	Ankaratra Massif	18°50'S/ 47°18'E	No
Tsaratanana/Marojejy Massif	Massif du Marojejy	14°26'S/ 49°15'E	Yes
	Massif du Tsaratanana	13°57'S/ 48°51'E	Yes
Total No. of CF Regions= 3	Total No. of CF Sites= 4	Total No. of CF Sites with an element of protection = 2	

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

Cloud Forest Region Summaries: Madagascar

Andringitra Massif

Amongst the coldest of the Madagascan upland areas, Andringitra is a rugged granitic massif enclosing a plateau area of 2500m on the south-eastern escarpment, west of Mankara. Sclerophyllous montane forest 4-5m in height occurs between 1500-2000m. It consists of species of *Schefflera*, *Weinmannia*, *Brachylaena* and *Philippia*. Seven endemic amphibians and two endemic molluscs occur, as well as several species of lemur. Fires are a problem. The Andringitra Strict Nature Reserve covers 31,160ha of the area (IUCN/UNEP/WWF, 1993; World Bank, 1993).

Ankaratra Massif

A volcanic massif lying about 70km south of Antananarivo, supporting badly degraded montane forests that are considered biologically important. Little recent information exists (IUCN/UNEP/WWF, 1990; World Bank, 1993).

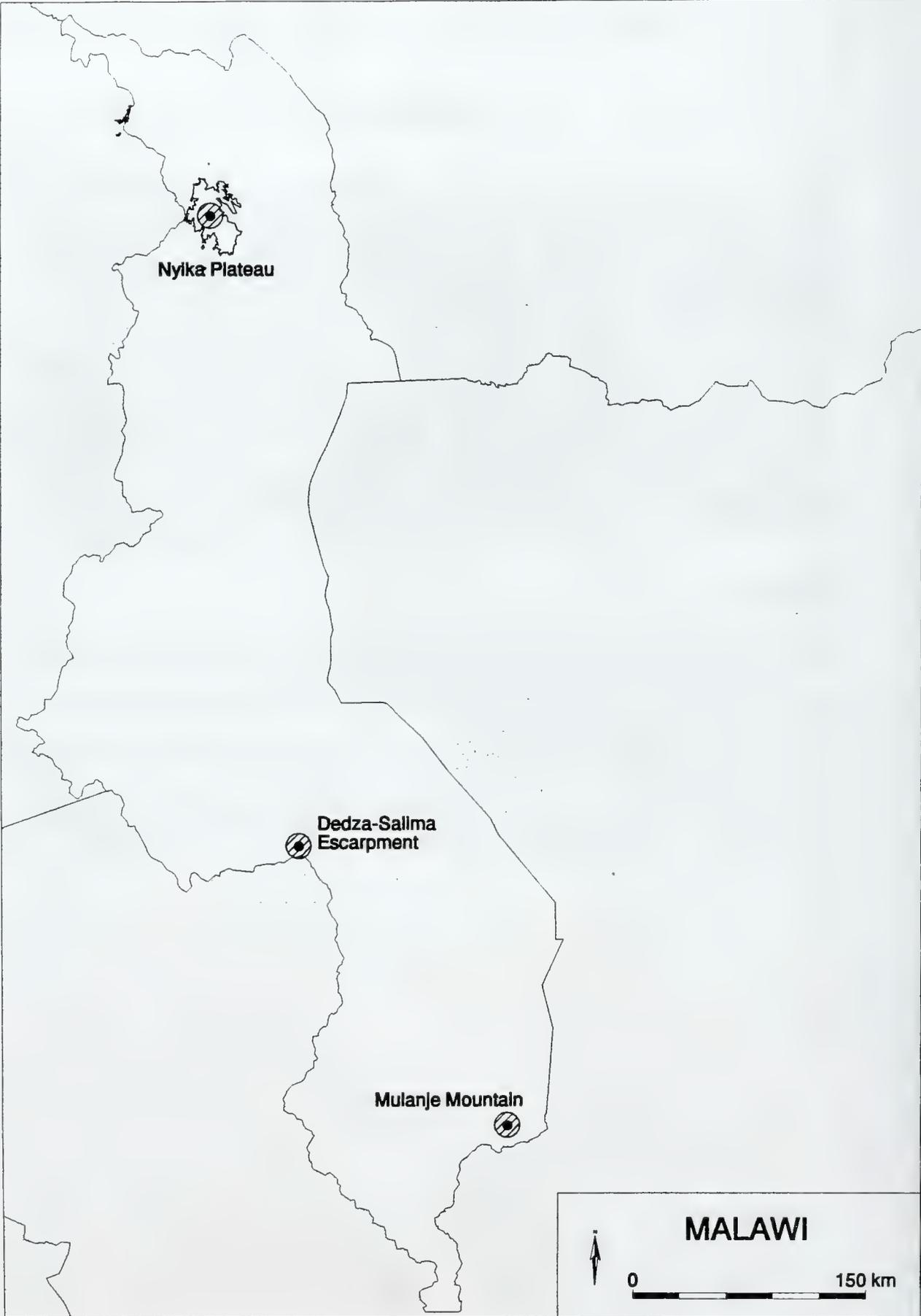
MALAWI

Malawi is situated at the southern end of the Western Rift Valley, and approximately 75% of the country's land surface consists of elevated plateaux between 750-1350m above sea level. These are distributed through the Northern, Central and Southern Regions, and are often contiguous with higher mountains such as Mt. Mulanje (at 3000m the highest peak in Malawi), Zomba and Mafinga mountains, and the highlands of Nyika, Misuku, Vipya and Dowa. Mean annual rainfall varies between 1000-3100mm.

These highlands support an estimated 324sq.km. of isolated but extensive montane forest patches between 1675-2600m which is generally differentiated into three forms dominated by Mulanje cypress *Widdringtonia whytei*, African juniper *Juniperus procera* and undifferentiated broadleaved Afromontane forest dominated by species such as *Ilex mitis*, *Kiggelaria africana*, *Allophylus abyssinicus*, *Ekebergia capensis*, *Pittosporum viridiflorum* and *Rapanea melanophloeos*. The bamboo *Arundinaria alpina* occurs (Chapman, 1983; Dowsett-Lemaire, 1989; MAB, 1982).

References

- Chapman J.D. 1983. The evergreen forests of Malawi. *Nyala* **9**(1/2):5-17.
- Dowsett-Lemaire 1989. Vegetation and birds of evergreen forests of southern Malawi, with special reference to mid-altitude forests. *Nyala* **14**(1):29-37.
- Lemon P.C. 1964. *Natural communities of the Malawi National Park (Nyika Plateau)*. Government Printer, Zomba, Malawi.
- MAB 1982. *Draft environmental profile of Malawi*. U.S. Man and the Biosphere Secretariat, Washington, D.C.
- World Bank 1993. *Ecologically sensitive sites in Africa. Volume VI: Southern Africa*. Compiled by the World Conservation Monitoring Centre for The World Bank, Washington, DC, USA.



Nyika Plateau

**Dedza-Salima
Escarpment**

Mulanje Mountain

MALAWI

0 150 km

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Dedza Mountain	Dedza Mountain	14°20'S/ 34°21'E	Yes
Mulanje Mountain	Mulanje Mountain	16°00'S/ 33°35'E	Yes
Nyika Plateau	Nyika Plateau	10°35'S/ 33°50'E	Yes
Total No. of CF Regions= 3	Total No. of CF Sites= 3	Total No. of CF Sites with an element of protection = 3	

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

Cloud Forest Region Summaries: Malawi

Dedza Mountain

Montane forest is known to occur between 2050-2150m on this mountain, which is within the Dedza-Salima Escarpment Forest Reserve, and adjacent to Mount Domue, a cloud forest site in Mozambique.

Mulanje Mountain

This is an isolated massif in southern Malawi, close to the border with Mozambique. The highest point in southern tropical Africa, it consists of a high plateau between 1800-1900m, surmounted by rocky peaks reaching a maximum height of 3001m. Montane forest occurs primarily in sheltered valleys and ravines between 1850-2300m. It is often dominated by Mulanje cypress *Widdringtonia whytei* and *Olea capensis*. Other species of note are *Podocarpus latifolius*, *Ekebergia capensis*, *Cassipourea malosana*, *Rapanea melanophloeos* and the endemic *Rawsonia burttdavyi*. Six forest birds are considered important; the Thyolo alethe *Alethe choloensis*, an endemic subspecies of olive-flanked robin *Alethe anomala*, Natal thrush *Turdus fischeri*, long-tailed forest scrub-warbler *Bradypterus cinnamomeus*, moustached green tinker-barbet *Pogoniulus leucomystax* and the near-threatened white-winged apalis *Apalis chariessa*. The cypresses of Mt. Mulanje have been exploited for timber since the turn of the century, and fires, refugees and invasive alien plants pose further threats. Part of the mountain has Forest Reserve status, but levels of protection are low. The mountain has high watershed values (WCMC, 1996; World Bank, 1993).

Nyika Plateau

This upland is located in north Malawi, on the edge of the East African Rift Valley. Isolated montane forest patches cover an estimated 2-4% of the plateau, primarily in sheltered valley heads and hollows. Trees such as *Hagenia abyssinica*, *Juniperus procera* and *Rapanea melanophloeos* occur. The plateau has high watershed values, and numerous endemics. Fires are a threat to the integrity of the forest patches. The Nyika National Park covers 313,400ha of the Malawian part of the plateau (Lemon, 1964; WCMC, 1996).

MOZAMBIQUE

The only Afromontane areas in Mozambique lie along the border with eastern Zimbabwe in the Chimanimani Mountains, and on nearby Mount Gorongosa. Tending to occur in sheltered areas, they attain a canopy height of 20m and are dominated by trees such as *Aphloia theiformis*, *Maesa lanceolata*, *Curtisia dentata*, *Widdringtonia cupressoides*, *Podocarpus latifolius* and *Tabernaemontana stapfiana* (Sayer *et al.*, 1992).

References

- Hughes R.H. and Hughes J.S. 1992. *A directory of African wetlands*. IUCN, Gland, Switzerland, and Cambridge, UK/UNEP, Nairobi, Kenya/WCMC, Cambridge, UK.
- Sayer J.A., Harcourt C.S. and Collins N.M. 1992. *The conservation atlas of tropical forests: Africa*. Macmillan.
- Tinley K.L., Rosinha A.J., Lobao Tello J. and Dutton P. 1974. *Wildlife and wild places in Mozambique*. Oryx XIII(4).

MOZAMBIQUE

0

250 km

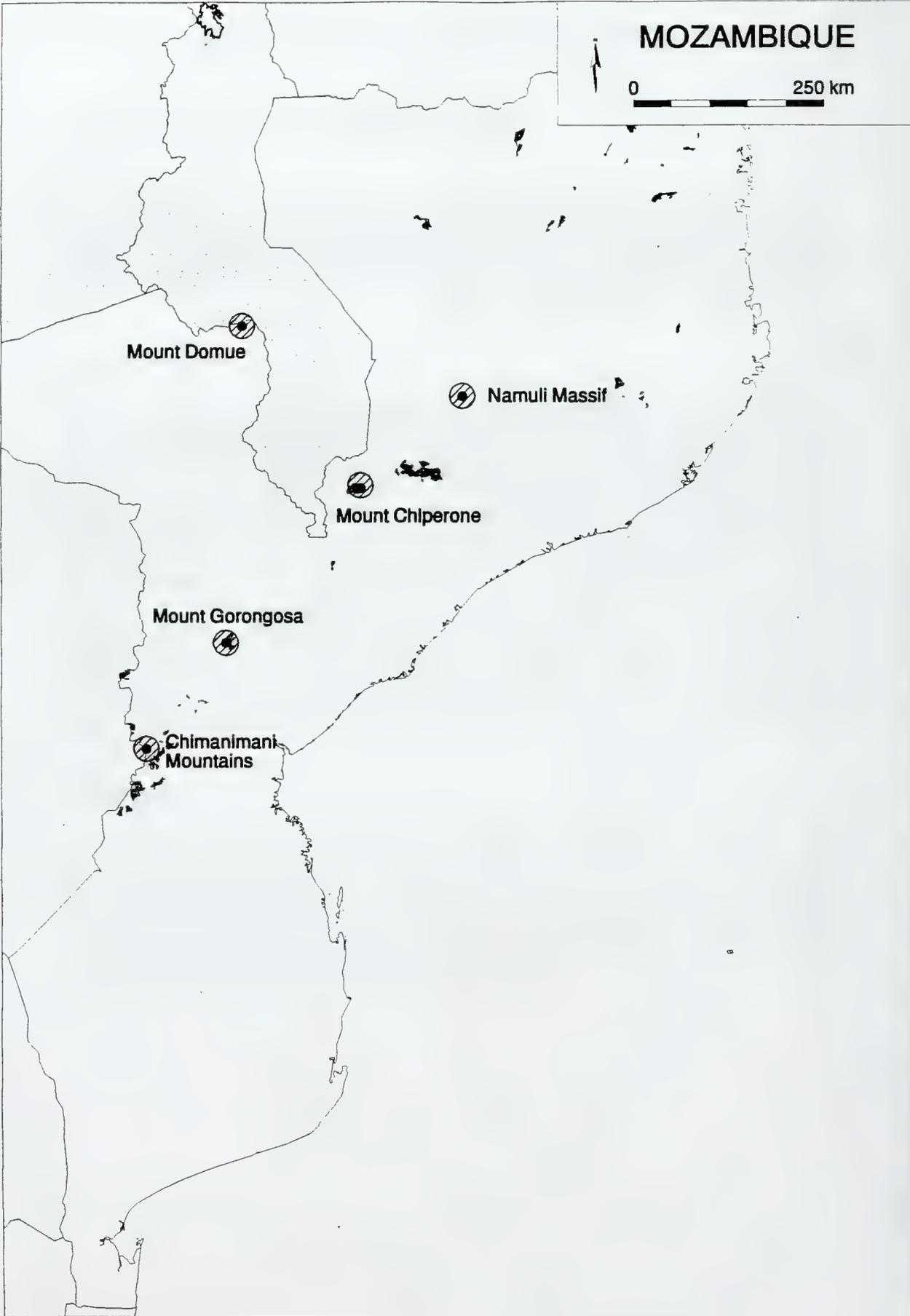
Mount Domue

Namuli Massif

Mount Chiperone

Mount Gorongosa

Chimanimani
Mountains



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Chimanimani Mountains	Chimanimani Mountains	19°47'S/ 33°03'E	No
Mount Chiperone	Mount Chiperone	16°30'S/ 35°44'E	No
Mount Domue	Mount Domue	14°28'S/ 34°15'E	No
Mount Gorongosa	Mount Gorongosa	18°27'S/ 34°03'E	No
Namuli Massif	Namuli Massif	15°21'S/ 37°02'E	No
Total No. of CF Regions= 5	Total No. of CF Sites= 5	Total No. of CF Sites with an element of protection = 0	

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

Cloud Forest Region Summaries: Mozambique

Chimanimani Mountains

Running north-south along the border with and extending into Zimbabwe in the southern region of Mozambique, these mountains support important montane communities, with numerous endemics. Montane forests extend into Zimbabwe, and include the adjacent Serra Maquta. They include Mt. Binga (2436m), the highest point in Mozambique.

Mount Chiperone

This isolated peak is situated in western Mozambique. Reaching a height of 2180m it supports areas of moist montane forest that are possibly similar to those in neighbouring Malawi (World Bank, 1993).

Mount Domue

Located in the central region of Mozambique, west of Lake Malawi, Mount Domue lies adjacent to Dedza Mountain in Malawi.

Mount Gorongosa

Lying 155km east of Zimbabwe's Inyanga Highlands, this is a montane area rising to 1863m. It supports extensive areas of wet montane forest, although the extent of true montane elements is unclear. Rare birds and an endemic subspecies of chameleon occur. Forest clearance is chronic, and the area has been recommended for inclusion within Gorongosa National Park (World Bank, 1993).

Namuli Massif

The Namuli Massif is the principal watershed of northern Mozambique, reaching a height of 2419m. Ravines and other sheltered areas support forest, but there is a lack of information on the extent and significance of montane elements (Frame and Frame, 1987; World Bank, 1993).

NIGERIA

Uplands over 1000m in height in Nigeria are restricted to the Cameroon Highlands along the south-eastern border with Cameroon, and the Jos Plateau in central Nigeria. The former include Chabbal Wadi, the country's highest peak (2419m). Limited areas of upland forest occur above 1500m, usually in ravines and steep-sided valleys. They support species such as *Syzygium staudtii*, *Carapa procera*, *Bridelia speciosa*, *Cephaelis mannii*, *Eriocoelum macrocarpum* and *Symphonia globulifera*. Specific information on the extent of true upper montane associations is limited, and it is possible that most, if not all, upland forests in Nigeria are submontane. Few parts of Nigeria have escaped modification by man, and it can be expected that montane and/or submontane associations outside protected areas such as Gashaka Gumpti and Obudu will be under threat (World Bank, 1993).

References

- Aderopo Akinsoji 1994. *Vegetation of Gashaka Gumpti National Park -1*. Report commissioned by NCF/WWF-UK.
- Hall J.B. 1981. Ecological islands in south-eastern Nigeria. *Afr.J.Ecol.* **19**:55-72
- Sayer J.A., Harcourt C.S. and Collins N.M. 1992. *The conservation atlas of tropical forests: Africa*. Macmillan.
- WCMC 1988. *Nigeria: Conservation of biological diversity*. WCMC, Cambridge.

NIGERIA



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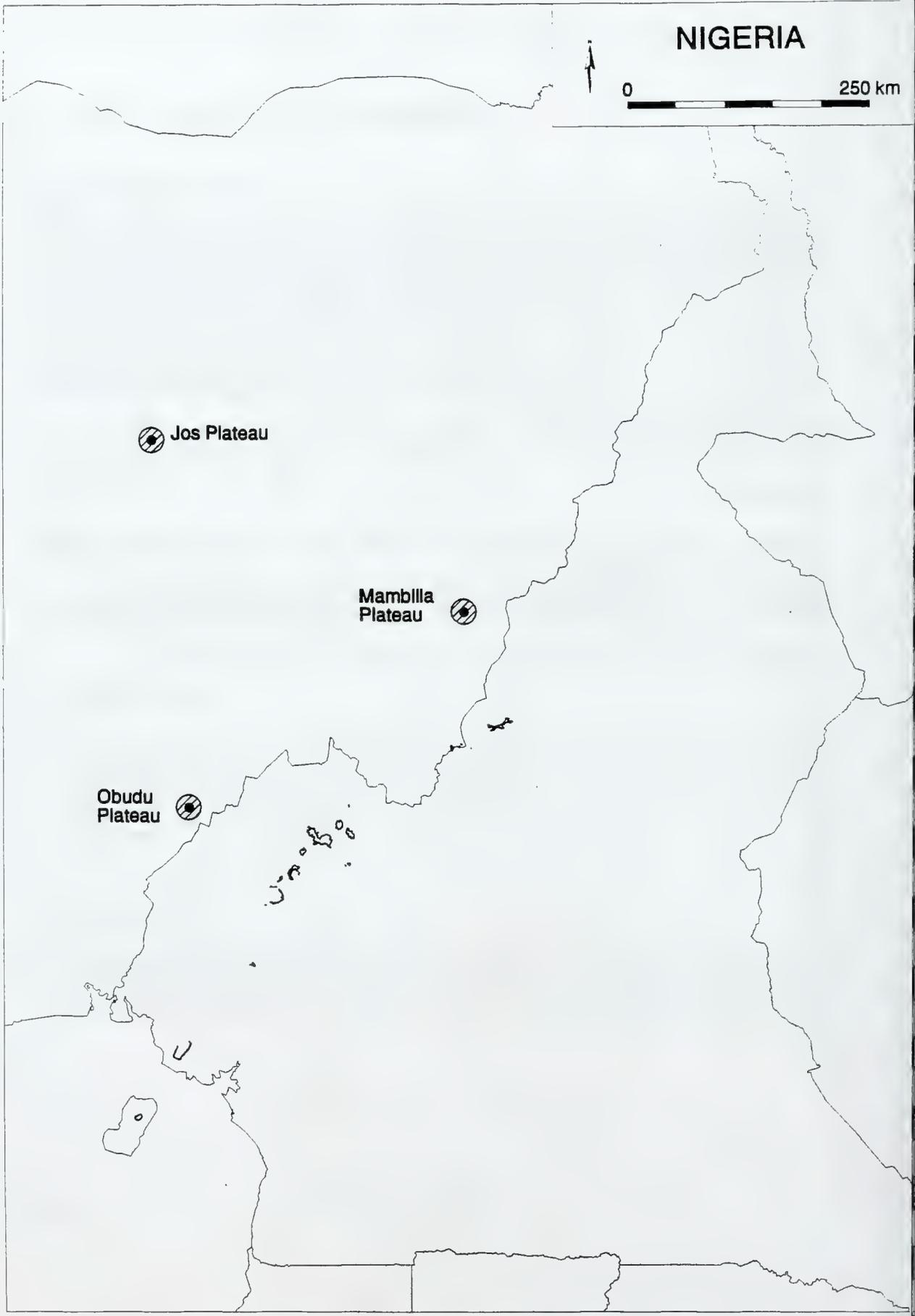
250 km



 Jos Plateau

Mambilla Plateau 

Obudu Plateau 



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Jos Plateau	Jos Plateau	9°57'N/ 8°54'E	No
Mambilla Plateau	Mambilla Plateau	8°20'N/ 11°50'E	Yes
Obudu Plateau	Obudu Plateau	6°30'N/ 9°15'E	Yes
Total No. of CF Regions= 3	Total No. of CF Sites= 3	Total No. of CF Sites with an element of protection = 2	

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

Cloud Forest Region Summaries: Nigeria

Jos Plateau

Small relict patches of upland forest occur in gullies and ravines, and along the edges of the Jos escarpment. Little information is available (Commonwealth Institute, 1983).

Mambilla Plateau

Relict upland forests occur in ravines and along drainages. Species include *Syzygium staudtii*, and species of *Syzygium*, *Agauria*, *Clausena* and *Peddiea*. Upper montane elements are indicated by *Podocarpus latifolius* and *Hypericum revolutum*. Part of the plateau is protected within Gashaka Gumti National Park (Aderopo, 1994; WCMC, 1988).

Obudu Plateau

Forests are confined to steep slopes and valleys, and consist of lowland forest with Afromontane elements such as *Podocarpus latifolius*, *Dasyalepis racemosa* and *Ritchiea albersii*. The forests are considered to be of great phytogeographical interest. Mammals include leopard *Panthera pardus*, chimpanzee *Pan troglodytes*, gorilla *Gorilla gorilla*, and several monkey species. Grazing, fires and hunting are threats (Hall, 1981; World Bank, 1993).

REUNION

Located to the east of Madagascar in the Indian Ocean, La Reunion is formed from two volcanic cones, one of which, Piton de la Fournaise (2500m), is still active. The island is mountainous, and has the highest peak in the Indian Ocean, Piton de Neiges at 3069m.

The montane forest is composed of four types of vegetation: 1). species-rich formations of *Bertiera rufa*, *Dombeya ficulnea*, *D. punctata*, *D. reclinata*, *Forgesia borbonica*, *Badula borbonica* var. *macrophylla*, and *Monimia rotundifolia*, 2). forest of *Acacia heterophylla* (endemic to the Reunion), often associated with *Nastus borbonicus*, 3). forest of *Pandanus montanus*, and 4). forest of *Philippia montana* located on slopes and crests (Cadet, 1977).

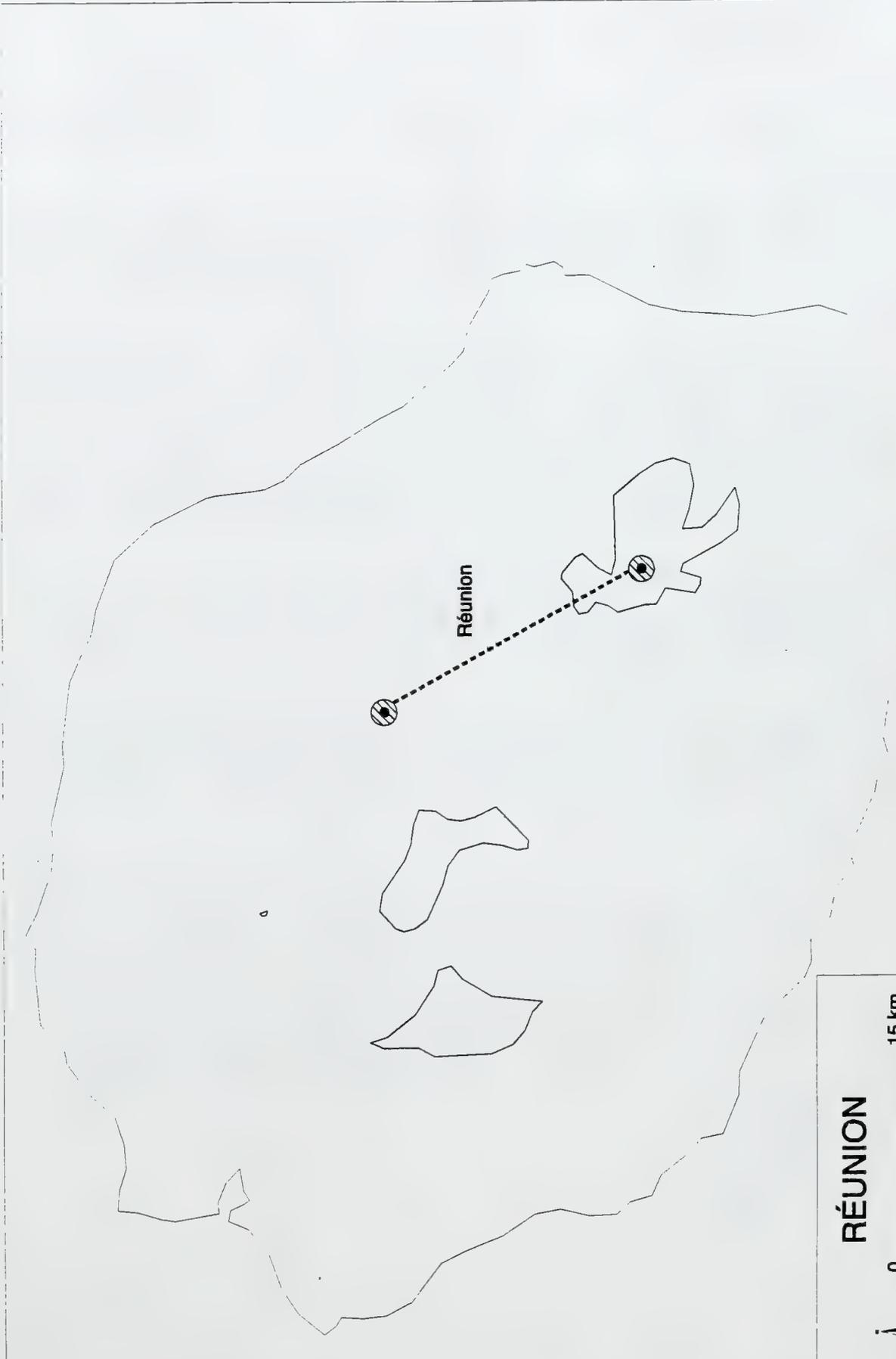
High degrees of endemism are found in both flora, 30% of flowering plants out of around 500 species and about 12% from more than 200 ferns and allies (Baumer 1981; Cadet, 1977; Davis et al., 1986), and fauna (Cheke, 1977, 1987b). However, introduced plant species may number up to 1000 (Macdonald *et al.*, 1991).

The altitude and the ruggedness of the terrain has meant that large areas of upland vegetation have remained more or less untouched by man's influence, although these have come under progressively greater pressure from fires and as use for pasture. In comparison, the relatively small area of lowland forest, has been all but totally destroyed by clearance for agriculture and grazing, fire, and competition from exotic species. Despite these pressures, Reunion has retained significantly more native woody vegetation than any of the other small Indian Ocean Islands. Invasion by alien plant species is widespread throughout the remnant native ecosystems. Outside these remnants, alien plants completely dominate the modern Reunion landscapes (Bossier, 1983; Cheke, 1987b; Macdonald *et al.*, 1991; White, 1983)). The threatened plants of Reunion are listed by Dupont and Girard (1989).

Protected areas were first established in 1963 with the creation of two strict biological reserves, and there are currently five reserves totalling 59 sq.km. of the island's 2500 sq.km (Sayer, Harcourt and Collins, 1992). However, despite the high rate of endemism and the rarity of certain plant and animal species, these are insufficient. Both MacKinnon and MacKinnon (1986) and IUCN (1987) include sections on Reunion which propose the establishment of nature reserves to protect mountain forest, and development of the marine protected areas system. In addition, Doumenge and Renard (1989) give detailed proposals for the reorganisation of conservation programmes and expansion of the protected area network, with information on 13 additional reserves.

References

- Baumer, M. 1981. Le couvert végétal à la Réunion. *Info-Nature* 18: 15-25.
- Bosser, J. 1983. Projet de constitution de réserves biologiques dans le domaine forestier de La Réunion. Report to the Office National de la Forêt prepared by the ORSTOM Director of Research. 35 pp.
- Cadet, J. 1977. La végétation de l'île de la Réunion. Thesis, University of Marseille. Published 1980. Imprimerie Cazal, St Denis.
- Cheke, A.S. 1977. Rapport sur la distribution et la conservation du Tuit-tuit, oiseau rarissime de la Réunion. *Info-Nature* 15: 21-38.
- Cheke, A.S. 1987a. An ecological history of the Mascarene Islands, with particular reference to extinctions and introductions of land vertebrates. In: Diamond, A.W. (Ed.), *Studies of Mascarene Island birds*. Cambridge University Press, Cambridge, England, UK. Pp. 5-89.
- Cheke, A.S. 1987b. The ecology of the surviving native landbirds of Reunion. In: Diamond, A.W. (Ed.), *Studies of Mascarene Island birds*. Cambridge University Press, Cambridge, England, UK. Pp. 301-358.
- Davis, S.D., Droop, S.J.M., Gregerson, P., Henson, L., Leon, C.J., Villa-Lobos, J.L., Synge, H. and Zantovska, J. 1986. *Plants in danger: what do we know?* IUCN, Gland, Switzerland and Cambridge, UK. Pp. 296-297
- Doumenge, C. and Renard, Y. 1989. *La conservation des écosystèmes forestiers de l'île de la Réunion*. IUCN, Gland, Switzerland and Cambridge, UK. 95 pp.
- IUCN 1987. *Action strategy for protected areas in the Afrotropical realm*. IUCN, Gland, Switzerland and Cambridge, UK. 60 pp.
- Macdonald, I.A.W., Thébaud, C. Strahm, W.A. and Strasberg, D. 1991. Effects of alien plant invasions on native vegetation remnants on La Réunion (Mascarene Islands, Indian Ocean). *Environmental Conservation* 18: 51-61
- MacKinnon, J. and MacKinnon, K. 1986. *Review of the protected areas system in the Afrotropical Realm*. IUCN, Gland, Switzerland and Cambridge, UK/UNEP, Nairobi, Kenya. P. 232.
- Sayer, J.A., Harcourt, C.S. and Collins N.M. 1992. *The Conservation Atlas of Tropical Forests: Africa*. IUCN, Gland, Switzerland and Cambridge, UK.
- White, F. 1983. *The Vegetation of Africa*. Unesco, Paris, France. 356 pp.



Réunion

RÉUNION



Cloud Forest Region	Cloud Forest Site	Coordinates	Protected* Yes/No?
Réunion	Picon de Neiges	21°04'S/ 55°35'E	No
	Picon de la Fournaise	21°13'S/ 55°40'E	No
Total No. of CF Regions= 1	Total No. of CF Sites= 2	Total No. of CF Sites with an element of protection = 0	

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

RWANDA

Located in the heart of central Africa, astride the east African Rift, all of Rwanda lies between 800 and 4500m. In general, the land mass is high and rugged, with an exceptional degree of relief in which hydrological features play an important role. The north is volcanic, the west is mountainous, the east is rolling terrain.

The varied topography is responsible for diverse regional climatic conditions and habitat, leading to a remarkable variety of different habitats and species. There are two major phytogeographic zones: a Sudano-Zambezi zone below 1800m elevation, and an Afro-Alpine zone between 1800m and 4500m. Cloud forests occur in the north and the west of the country, along the Zaïre-Nile Divide which extends from Uganda, through Rwanda and Burundi down into Zambia and is part of the larger Albertine Rift Region. The cloud forests are specifically found in the Afro-Alpine phytogeographic zone which may be subdivided into an African montane zone above 2000m, and an African submontane zone below 2000m.

All remnant forest lands were set aside as official reserves in 1933, in response to the rapid conversion of montane forest to pasture land which had recently occurred (Bissio, 1988; Weber and Vedder, 1984). Rwanda is now one of the most densely populated countries in Africa, yet is one of the few nations in the world to have more than 10% of its land included within protected areas, most of which lies within the two national parks, Volcans and Akagera.

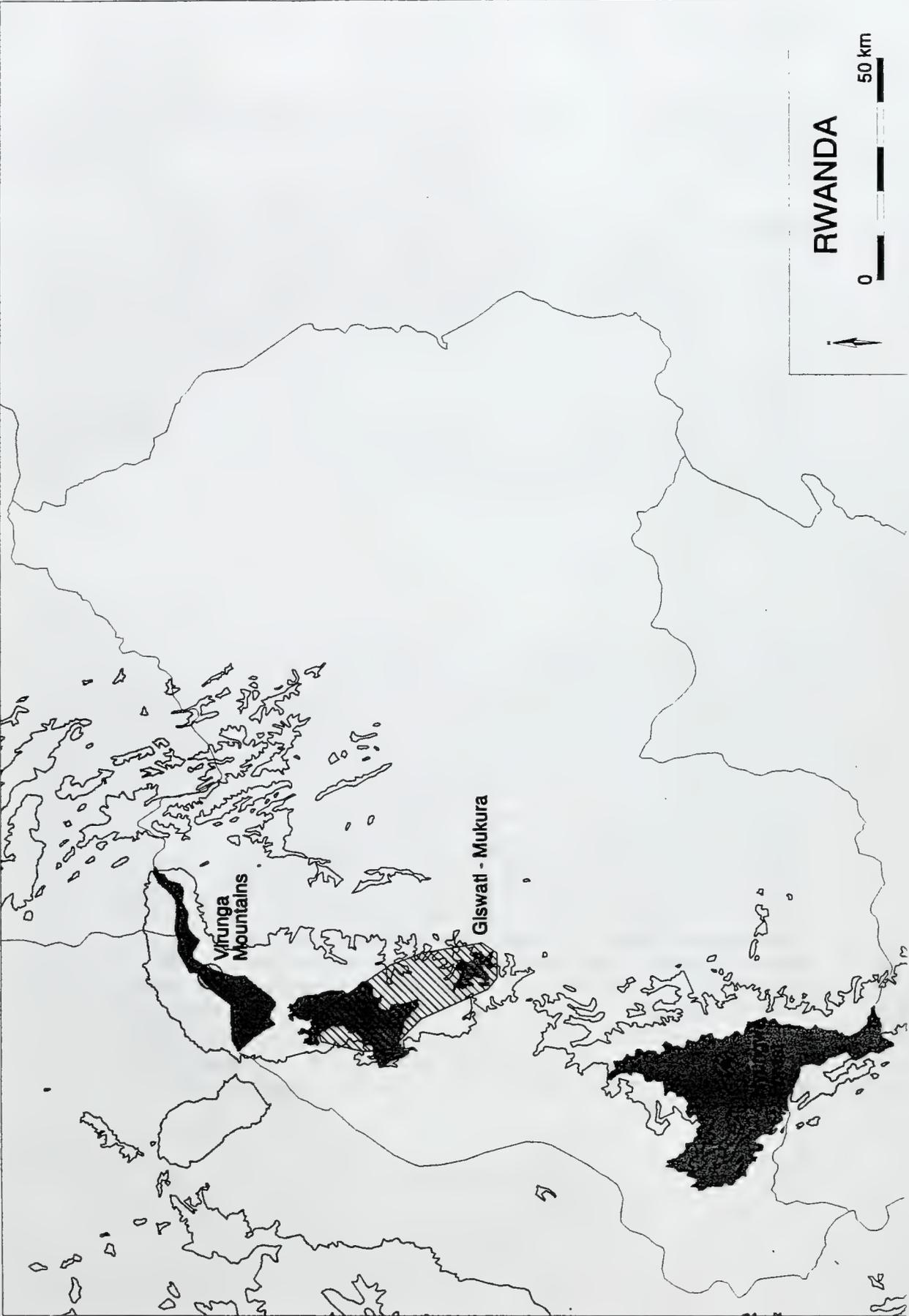
However, human pressure on natural habitats is very high and this has increased following the last civil war. Secondary forest mosaics produced by human activity have generally replaced natural vegetation in the African submontane zone (IUCN, 1979; Rattray, 1960).

References

- Bissio, R.R. (Ed.) 1988. In: *Third World Guide 89/90*. Third World Editors. Pp. 208-209.
- Dowsett R.J. 1990. Survey of the Fauna and Flora of Nyungwe forest, Rwanda. Tauraco Research Report, No. 3.
- IUCN 1979. The distribution of protected areas in relation to the needs of biotic community conservation in west and central Africa. IUCN, Morges, Switzerland.
- IUCN 1987. *Action strategy for protected areas in the Afrotropical Realm*. IUCN, Gland, Switzerland and Cambridge, UK. 60 pp.
- IUCN/WWF 1985. *Rapport d'une mission au Zaïre et Rwanda*. 20 pp.

A GLOBAL DIRECTORY OF TROPICAL MONTANE CLOUD FORESTS

- Kanyamibwa, S. 1993. Grey crowned cranes *Balearica regulorum* as indicators for wetlands conservation in Rwanda. Paper presented at the African Crane and Wetland Training Workshop. Maun, Botswana 8-15 August 1993. 6p
- Kanyamibwa S. 1996. Important Bird Areas in Rwanda - Report to BirdLife International. Important Bird Areas for Africa programme.
- MDP 1991. La stratégie nationale de l'environnement au Rwanda. Ministère du Plan. Projet Environnement et Développement. 1 p.
- Montfort, N. 1985. Les Mammifères du Rwanda. Rotary Club, Kigali.
- ORTPN (1991). Plan de conservation de l'éléphant au Rwanda. Unpublished report. Office Rwandais du Tourisme. 43 pp.
- Spinage, C., 1972. The ecology and problems of the Volcano National Park. Rwanda. *Biological Conservation* 4: 194-204.
- Verschuren, J. (1990). Que sont devenus les fameux parcs nationaux du Zaïre et du Rwanda? *Parcs Nationaux XLV*: 16-29.
- Weber, B. and Vedder, A. 1984. Forest conservation in Rwanda and Burundi. *Swara* 7: 32-35.
- Weber, B. and Vedder, A. (1991). Rwanda: fragile cease fire in gorilla Enclave. *Wildlife Conservation* 94(4): 8-9.
- Wilson V.J. 1990. Preliminary survey of the duikers and other mammals of Burundi, east Africa. Pan African Decade of Duiker Research (1985-1994).
- Wilson, R. (1991). The conflict in Rwanda and its impact on the mountain gorilla. *Oryx* 25: 119-120.



RWANDA

50 km

0

Virunga
Mountains

Giswati - Mukura

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Giswati-Mukura	Giswati Forest	1°46'S/ 29°26'E	No
	Mukura Forest	1°58'S/ 29°32'E	No
Nyungwe Forest	Nyungwe Forest	2°30'S/ 29°20'E	Yes
Virunga Mountains	Volcans	1°28'S/ 29°33'E	Yes
Total No. of CF Regions= 3	Total No. of CF Sites= 4	Total No. of CF Sites with an element of protection = 2	

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

Cloud Forest Region Summaries: Rwanda

Gishwati-Mukura

Gishwati and Mukura forests are located in the west of Rwanda, on the Zaire-Nile Divide, at an altitude of 2000-2900m. Whilst the forests have been repeatedly degraded, actual areas are estimated at 6000ha for Gishwati and 2100ha for Mukura. The vegetation in both forests is typical of montane forest habitats and includes *Crysophyllum*, *Entandophragma* and *Newtonia* at lower altitudes, and *Syzygium guineense*, *Carapa grandiflora*, *Parinari excelsa*, *Strombosia* and *Symphonia* in mature forest. The fauna and flora are typical of the Albertine Rift montane forest ecosystems. These forests hold many species of conservation concern, including the rare african tree species *Podocarpus*, and primates such as *Pan troglodytes*, *Cercopithecus lhoesti* and *Cercopithecus mitis* sp., and a number of Albertine Rift endemic bird species. However, only occasional surveys have been conducted in Gishwati and further assessment is needed. As with other forest reserves in the country, Gishwati and Mukura were established in 1993. However, they have been degraded and reduced significantly in size, due to a high demand for agricultural land and grazing.

Nyungwe Forest

Nyungwe forest lies in the south of Rwanda and runs into the smaller Kibira forest in Burundi. It is subdivided from the north to the south by the Zaire-Nile massif (2600-2900m) leading to two distinctive areas in terms of pedology, vegetation, water flow and as a result, biodiversity. The western section is schistose, with a very dense forest at 1700-2000m. The eastern section, which is granitic, lies higher (2200-2500m) and is dominated by many clearings and secondary forest. The highest peak, Mt. Bigugu (2950m) is located in the mid-west of the forest. The annual average rainfall is 1500-2500mm, with most of the cloud forest found in the wetter south-western zone. Close to Nyungwe, Cyamudongo forest (1700-2400m altitude) is a western relict forest of 300ha which was certainly part of Nyungwe in the past, but the vegetation is more dense, with less openings. Nyungwe has high floral diversity, with more than 250 tree species including the rare african *Podocarpus*, and more than 100 species of orchids. A total of 13 species of primates, representing 25% of Africa's total are found in Nyungwe, some of them listed as rare or endangered (*Pan troglodytes*, and *Cercopithecus lhoesti*), or as endangered subspecies (*Colobus angolensis ruwenzorii*). Nyungwe also holds many endangered mammals which are endemic to the Albertine Rift, including species of bats and squirrels. Two forest species of butterfly are also endemic to Nyungwe: *Belearica* sp., and *Acraea turlini*. Around 275 bird species occur in Nyungwe, 25 endemic to the Albertine Rift mountains. After the Itombwe forests in eastern Zaire, Nyungwe is the most important forest for the conservation of montane forest birds in the region. The variety of habitat leads to a high diversity of species,

including *Glaucidium capense albertinum*, *Indicator pumilio*, *Kupeornis rufocinctus*, *Zoothera tangangicae*, *Apalis rufogularis argentea*, *Cryptospiza shelleyi* and *Bradypterus graueri*, which are all Albertine Rift endemics and considered as vulnerable or threatened. Logging has reduced the lowland forest from 114,000 ha in 1958 to 97,000 ha in 1979. Nyungwe also suffers from the exploitation of firewood, charcoal and timber for woodwork. Goldmining poses problems, as small alluvial gold lodes worked by local people require the cutting of forest along mineralized watercourses, and mining is often accompanied by poaching. Several mammals, mainly ungulates, have suffered from overhunting. A conservation plan was established in 1984 (MINAGRI, 1984), with different zones, including a core area (40%) for integral protection. Cyamudongo forest also hosts a number of typical Albertine bird species, including *Musophaga rosae* which is not found in Nyungwe. The forest sparrowhawk *Falco erythropus* has only been recorded in Cyamudongo forest, which also hosts the chimpanzee *Pan troglodytes* and is recognized for a high diversity in butterfly species. The forest has suffered much fragmentation as a result of clearance for agriculture. The remaining forest is under protection by local public administration, with one guard covering all the forest.

Virunga Mountains

The Parc National des Volcans covers an area of 15,000ha in the Virunga Mountains, which are located in the north-west of Rwanda, at the border with Uganda and Zaire. The park contains eight pleistocene volcanic peaks belonging to the chain which forms part of the watershed between the Nile and Zaire river systems. The full altitudinal range is from 2400 to 4507m, including Mt. Karisimbi, one of the highest mountains in Africa (4507m). The terrain is difficult and broken with steep slopes, and rainfall is high, with between c.2000-2400mm per year (at Karisoke area). Forest is transitional with altitude. A reduced montane forest with *Neoboutonia* is found at low altitudes (2400-2500m), with bamboo forest *Arundinaria alpina* at 2500-3200m, replaced by *Haegenia-Hypericum* forest on the more humid slopes in the west and the south of the park, up to 3500m. The park is best known for the mountain gorilla *Gorilla gorilla beringei*, a threatened subspecies endemic to the Virunga Mountains and Bwindi Forest in Uganda. Other threatened mammals include the elephant *Loxodonta africana*, and the leopard *Panthera pardus*, but there have been no records since 1979. Whilst no endemic bird species are known to the site, the park holds many Albertine Rift endemics, including *Bradypterus graueri*, *Francolinus nobilis*, *Musophaga johnstoni*, *Batis diops*, *Ploceus alienus*, *Cryptospiza jacksoni*, and *Cryptospiza shelleyi*. There is very high human pressure around the park, with encroachment for agriculture, illegal wood and bamboo cutting. There are also problems with gorilla poaching and feral dogs. The park has been reduced in area, by half from 1958 to 1973. Recent civil war has disturbed those conservation activities which had been established.

SAO TOMÉ & PRÍNCIPE

The Democratic Republic of Sao Tomé and Príncipe is an island-nation in the Gulf of Guinea in the equatorial east Atlantic, 250kms from the coast of Africa. It consists of two volcanic islands, reaching maximum elevations of 2024m on Sao Tomé, and 948m on Príncipe.

A "Montane Forest Region" is recognised on Sao Tomé particularly, and to a much lesser extent on Príncipe. Occurring between 800-1400m, it is characterised by a distinct flora resulting from lower minimum temperatures, higher rainfall and humidity, and reduced light levels resulting from near-perpetual cloud cover. The forests are notable for their high degree of endemism.

A single protected area (zonas ecologica) has been proposed for each island - one of 245 sq.km. on Sao Tomé, and one of 45sq.km. on Príncipe (Jones and Tye, 1988; WCMC, 1996).

References

- Jones P.J. and Tye A. 1988. *A survey of the avifauna of Sao Tomé and Príncipe*. ICBP Study Report No. 24, Cambridge.
- WCMC 1996. Democratic Republic of Sao Tomé and Príncipe.

Príncipe Island



São Tomé Island



SÃO TOMÉ & PRÍNCIPE



0

25 km

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Principe Island	Principe	1°34'N/ 7°22'E	Yes
Sao Tomé	Pico de Sao Tomé	0°16'N/ 6°35'E	Yes
Total No. of CF Regions= 2	Total No. of CF Sites= 2	Total No. of CF Sites with an element of protection = 2	

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

Cloud Forest Region Summaries: Sao Tomé and Príncipe

Sao Tomé and Príncipe

A "Montane Forest Region" is recognised on Sao Tomé, and to a much lesser extent on Príncipe. Occurring between 800-1400m it is characterised by a distinct flora resulting from lower minimum temperatures, higher rainfall and humidity, and much reduced light levels as a result of near-perpetual cloud cover. The forest is notable for its high degree of endemism. A protected area (Zonas Ecologica) of 245sq.km has been proposed that would incorporate the higher forests. The dwarf olive ibis *Bostrychia bocagei* (indeterminate status, until recently considered extinct) and the maroon pigeon *Columba thomensis*, both endemic, are recorded from the higher forests. There are few threats (Jones and Tye, 1988). The south-facing higher parts of Sao Tomé receive an annual rainfall in excess of 7000mm/annum.

SIERRA LEONE

Sierra Leone lies on the seaward slopes of a series of high plateaux, embracing mountainous regions such as the Wara Wara Mountains, Sula Mountains, Tingi Hills and Loma Mountains to the north and north-east. Mt. Bintimani in the Loma mountain range is one of the highest points of West Africa, at 1948m. The Tingi Hills and Loma Mountains are reported to support limited areas of moist montane forest, but information on the extent of true montane elements is lacking. They are known centres of plant diversity and endemism, and contain tree species such as *Daniella thurifera*, *Terminalia ivorensis*, *Parkia bicolor*, *Parinari excelsa*, *Bridelia grandis* and *Pycnanthus angolensis*. Less than 4% of the country is presently under primary and secondary closed forest.

References

- Commonwealth Institute (?). *Sierra Leone*. Commonwealth Fact Sheet.
- Davies A.G. 1987. *The Gola Forest Reserves, Sierra Leone: wildlife conservation and forest management*. IUCN Gland, Switzerland, and WCMC, Cambridge.
- Phillipson J. 1978. *Wildlife conservation and management in Sierra Leone*. Report prepared for the Ministry of Agriculture and Natural Resources, Sierra Leone.
- World Bank 1993. *Ecologically sensitive sites in Africa. Volume IV: West Africa*. Compiled by the World Conservation Monitoring Centre for The World Bank, Washington, DC, USA.

SIERRA LEONE



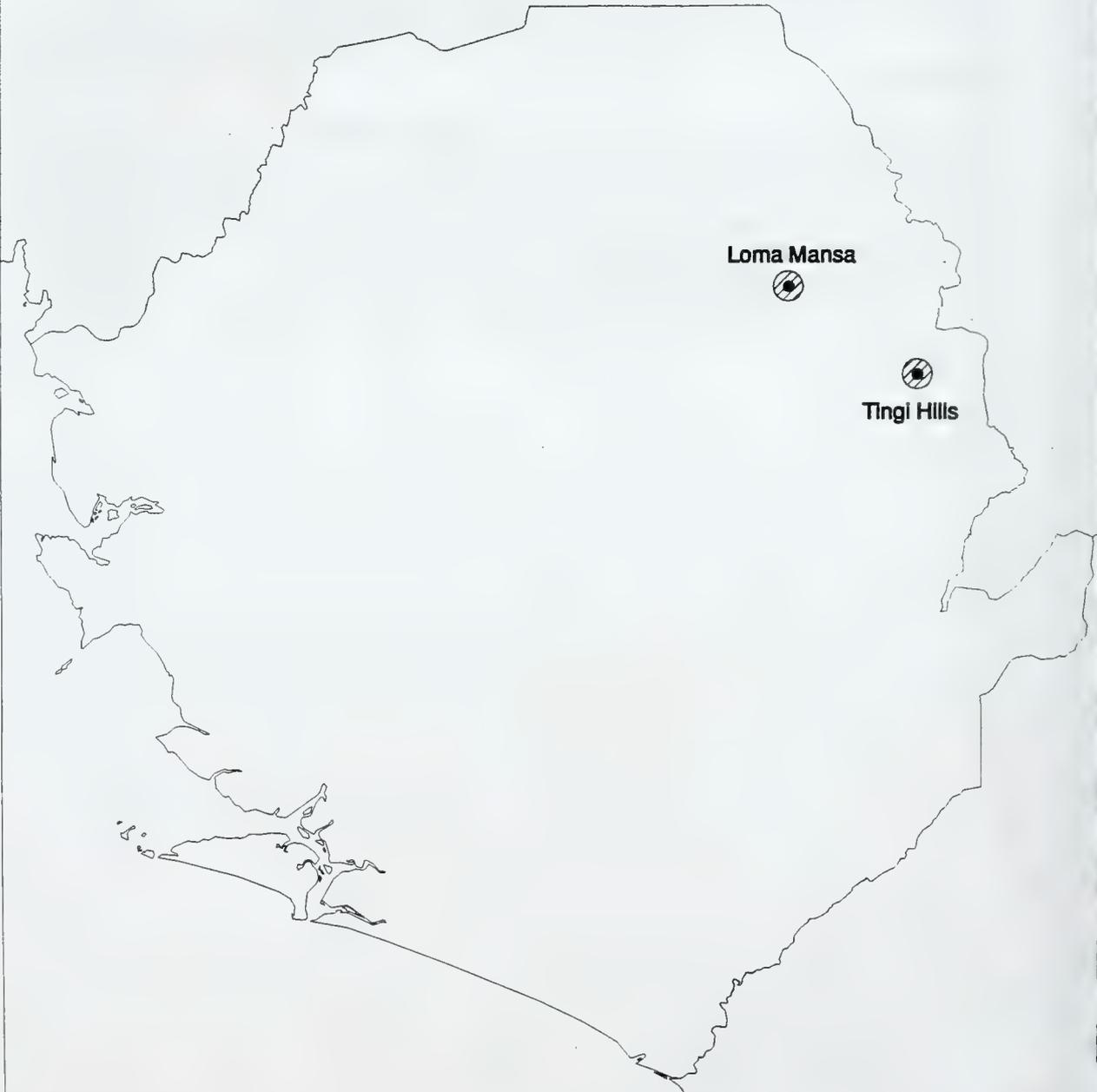
0

100 km

Loma Mansa



Tingi Hills



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Loma Mansa	Mount Bintumani	9°12'N/ 11°09'W	Yes
Tingi Hills	Sankan Biriwa	8°57'N/ 10°47'W	No
Total No. of CF Regions= 2	Total No. of CF Sites= 2	Total No. of CF Sites with an element of protection = 1	

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

Cloud Forest Region Summaries: Sierra Leone

Loma Mansa

The Loma Mountains contain the highest point in Sierra Leone at Mt. Bintimani (1948m). The threatened grey-necked picathartes *Picathartes gymnocephalus* occurs, and the mountains are a known centre of local endemism. Larger mammals that occur include the western black and white colobus *Colobus polykomos*, chimpanzee *Pan troglodytes* and golden cat *Felis aurata*. A national park has been proposed for the area, and extensive hunting occurs below the 800m contour. The Loma Mountains Non-hunting Forest Reserve covers 560sq.km (Davies, 1987; Phillipson, 1978; World Bank, 1993).

Tingi Hills

Located fairly close to the Loma Mountains and supporting similar forest types. The peak of Sankan Biriwa (1715m) is contained by the Tingi Hills Forest Reserve (106sq.km). Animals remaining in the area include buffalo *Syncerus caffer*, bushbuck *Tragelaphus scriptus* and yellow-backed duiker *Cephalophus sylvicultor*. The toad *Bufo cristiglans* is endemic to the Tingi Hills (World Bank, 1993).

TANZANIA

Tanzania is the largest country in East Africa. Most of the country is located on the Central African Plateau, 1000-1500m above sea level, rising from a narrow coastal strip some 15-30km wide. In addition, there are a number of mountain ranges, notably those running parallel to the borders with Rwanda and Zambia, and along the shores of Lake Tanganyika and at the head of Lake Malawi. The Pare and Usambara Mountains form part of the "Eastern Arc" in the north-east close to the border with Kenya. Kilimanjaro, an isolated volcanic massif rising to 5895m in the north-east of the country, is the highest peak in Africa.

Forest covers 40% of the land area. Over 98% of this is natural miombo woodland, the remainder being closed tropical forest which covers less than 1% of the total land area. This includes scattered patches of forest on mountain slopes where the cloud forest is found, a few lowland forests in the mountain foothills, coastal forests and mangrove swamps. Although small in area, these forests are of great importance ecologically and in terms of biodiversity – the eastern mountain and coastal forests contain large numbers of endemics which are attracting increasing interest.

The mountains are also an important water catchment area and the forest cover needs to be maintained to safeguard regular runoff (Bensted-Smith and Msangi, 1989). Major environmental problems include loss of top soil and lowering of productivity, notably in the high population areas, which frequently leads to deforestation and expansion of agriculture in other areas, even within protected areas (Mwalyosi, 1986).

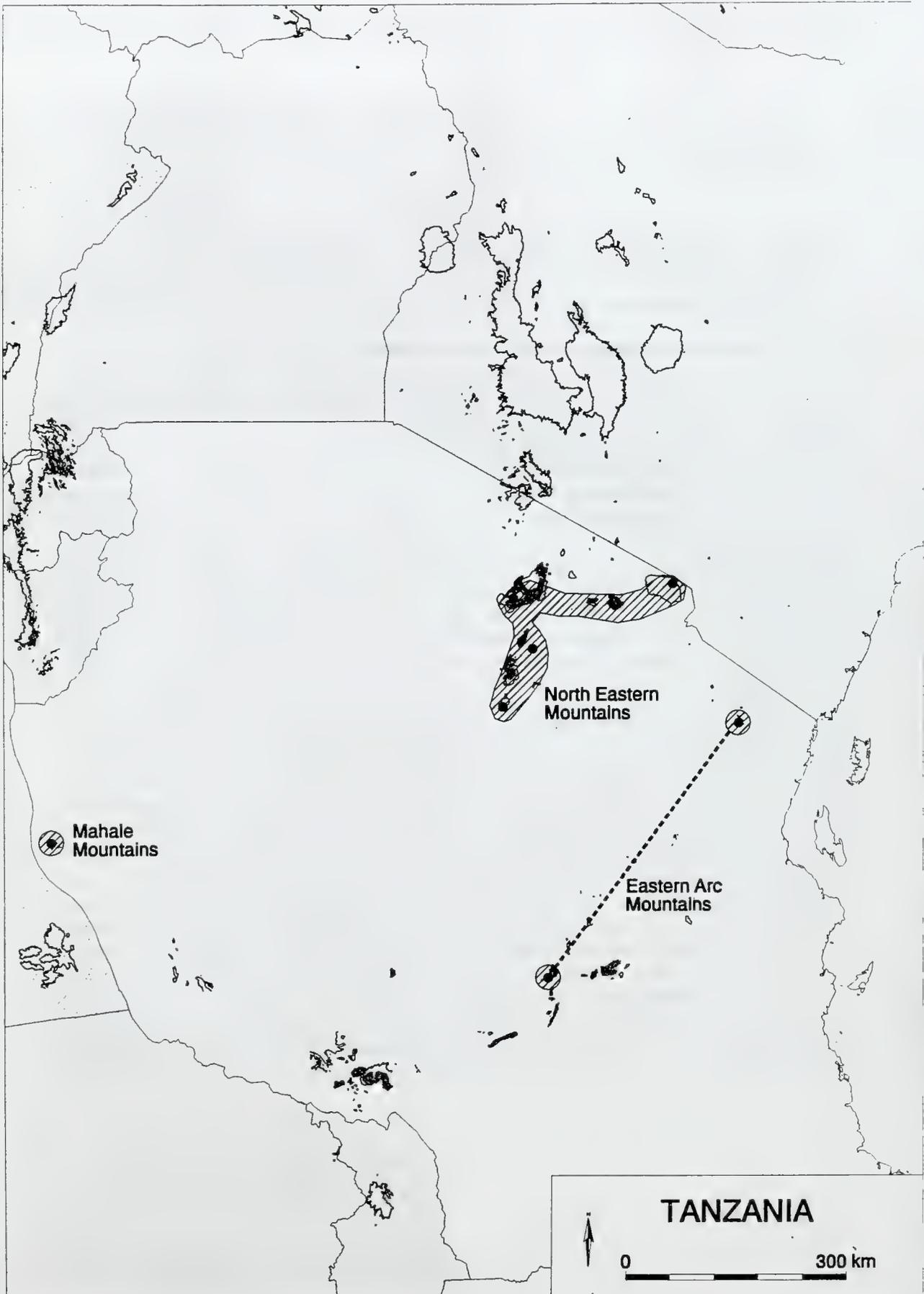
The protected areas network currently comprises national parks, Ngorongoro Conservation Area, game reserves, forest reserves, and game controlled areas, which together cover nearly 40% of Tanzania's surface area. Of the forest reserves, just over half serve a production function, and the remainder serve a protection function (WD, 1991). The Udzungwa Mountains are in the process of being gazetted as a national park and greater protection has been proposed for the Uluguru and Usambara mountains.

References

- Bensted-Smith, R. and Msangi, T.H. 1989. Report on the conservation of ecosystems and genetic resources. Tropical Forestry Action Plan, United Republic of Tanzania. Unpublished report for the Forest and Beekeeping Division of the Ministry of Lands Natural Resources and Tourism.

A GLOBAL DIRECTORY OF TROPICAL MONTANE CLOUD FORESTS

- Davis, S.D., Droop, S.J.M., Gregorson, P., Henson, L., Leon, C.J., Villa-Lobas, J.L., Syngé, H., and Zantovska, J. 1986. *Plants in danger: What do we know?* IUCN, Gland, Switzerland and Cambridge, U.K. Pp. 351-353.
- Hughes, R.H. and Hughes, J.S. 1991. *Directory of African wetlands*. IUCN, Gland, Switzerland and Cambridge, UK/UNEP, Nairobi, Kenya/WCMC, Cambridge, UK. Pp. 227-253.
- ITC 1989. United Republic of Tanzania: development and promotion of wildlife utilisation. International Trade Centre Project No. URT/87/004. (Unseen)
- IUCN 1987. *Action strategy for protected areas in the Afrotropical Realm*. IUCN, Gland, Switzerland and Cambridge, UK. Pp. 47-49.
- Lovett, J. 1985. An overview of the moist forests of Tanzania. Final report of the Tanzania forest habitat evaluation project. WWF. Tanzania National Scientific Research Council Research Monographs.
- MacKinnon, J. and MacKinnon, K. 1986. *Review of the protected areas system in the Afrotropical Realm*. IUCN, Gland, Switzerland and Cambridge, UK/UNEP, Nairobi, Kenya. Pp. 244-246.
- Mosha, G.T. and Thorsell, J.W. 1984. Training Protected Area Personnel: Lessons from the College of African Wildlife Management. In: McNeely, J.A. and Miller, K.R. (Eds), *National parks, conservation and development: The role of protected areas in sustaining society*. Smithsonian Institution Press, Washington, DC.
- Mwalyosi, R.B.B. 1986. *Tanzania, natural resources expertise profile*. Conservation for Development Centre – International Union for the Conservation of Nature and Natural Resources, Gland, Switzerland. 71 pp.
- Rogers and Homewood 1978
- Schmithüsen, F. 1986. *Forest legislation in selected African countries*. FAO Forestry Paper 65. Food and Agricultural Organisation, Rome. Pp. 92-94; 290-307.
- Stuart, S.N., and Adams, R.J. 1990. *Biodiversity in sub-saharan Africa and its islands: conservation, management and sustainable use*. IUCN, Gland, Switzerland. Pp. 204-214.
- SWARA 1989. Conservation of the Mara area. *SWARA* 12(2): 19.
- TWCM 1990. *Conservation monitoring news*. No. 1, May 1990. Tanzania Wildlife Conservation Monitoring, Arusha. 8 pp.
- UNEP/IUCN 1988. *Coral reefs of the world. Volume 2: Indian Ocean, Red Sea and Gulf*. UNEP Regional Seas Directories and Bibliographies. IUCN, Gland, Switzerland and Cambridge, UK/ UNEP, Nairobi, Kenya. Pp. 363-369.
- WD 1991. Elephant conservation plan – Tanzania. Wildlife Division, Ministry of Tourism, Natural Resources and the Environment, Dar-es-Salaam. 152 pp.



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Eastern Arc Mountains	Nguru	/	No
	Ukaguru	/	No
	Uluguru	/	No
	Usambara Mountains	4°42'S/ 38°16'E	No
Mahale Mountains	Uzungwa Mountains	7°50'S/ 35°55'E	No
	Mahale Mountains	6°10'S/ 29°50'E	No
North Eastern Mountains	Hanang	4°30'S/ 35°22'E	No
	Malundwe	3°47'S/ 35°44'E	No
	Mount Kilimanjaro	2°59'S/ 37°27'E	Yes
	Mount Meru	3°15'S/ 36°45'E	No
	Ngorongoro	3°10'S/ 35°30'E	Yes
Total No. of CF Regions= 3	Total No. of CF Sites= 11	Total No. of CF Sites with an element of protection = 2	

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

Cloud Forest Region Summaries: Tanzania

Eastern Arc Mountains

Running north-east, from south-west Tanzania to the east coast border with Kenya, the Eastern Arc Mountains are linked to the North Eastern Mountains which includes Mt. Kilimanjaro. However in terms of cloud forest distribution the two regions appear quite separate. The Eastern Arcs include the Nguru, Uluguru, Ukaguru, Usambara and Uzungwa mountain ranges.

The very dissected orography, with steep slopes, deep valleys, high summits, rocky cliffs, and wide range of climatic and soil conditions have resulted in a wide range of vegetation types. Montane forest generally occurs between 1400 and 2200m with moss covered upper montane forest at higher altitudes. The upper montane forest is dominated by *Balthasaria schliebenii*, *Garcinia volkensii*, *Ocotea usambarensis*, *Podocarpus milanjanus*, *P. latifolius*, *P. ensiculus*, *Schefflera myriantha* and *S. barteri*. The tree trunks are covered in mosses and epiphytes are common, including *Stolzia viridis*, *Mystacidium nguruense*, Lycopodiums and filmy ferns. In the ground flora among the many ferns, *Cincinnobotrys oreophilum* and *Cincinnobotrys ranarum* are common. Elfin forest, commonly up to 4m tall covers the summits and ridges above 2000m. These trees are covered by mosses and ferns, and the ground is also covered with cushions of *Mastigophora dicladus*, *Sphagnum* spp., *Dicranoloma billarderi* and *Syrrhopodon stuhlmannii*. These montane forests are especially rich in endemic herbs, and many orchids, including the Nguru and Uluguru endemic, *Tridactyle brevifolium*. Along streamlets large stands of the tree fern *Cyathea manniana* occur. In Uluguru the subendemic *C. pumila* and endemic *C. fadenii* and *C. schliebenii* are found. The Usambara Mountains support what is probably one of the richest biological communities in Africa, in terms of plant and animal species and endemic taxa. More than 276 forest tree species have been recorded, of which some 50 are endemic or of very restricted range, such as the monotypic genera *Cephalosphaera usambarensis*, *Englerodendron usambarensis*, and *Platypterocarpus tanganyikensis*. The avifauna includes two threatened endemic species, the Usambara ground robin *Dryocichloides montanus* and the Usambara eagle owl *Bubo vosseleri*, and several threatened species only found in a few montane forests in Tanzania. In the Uzungwas, animal species of conservation concern include two endemic to the mountains, the Iringa red colobus *Colobus badius gordonorum*, and crested mangabey *Cercocebus galeritus*. There are eight threatened bird species. Three, Mrs Moreau's warbler *Bathmocercus winifredae*, banded green sunbird *Anthreptes rubitorques* and the Tanzanian mountain weaver *Ploceus nicolli* are endemic to a few forests in eastern Tanzania. Another four have very limited distributions, the dappled mountain robin *Modulatrix orostruthus*, Iringa ground robin *Dryocichloides lowei*, Amani sunbird *Anthreptes pallidigaster* and Swynnerton's forest robin *Pogonocichla swynnertonii*, the subspecies *rodgersi* of the latter being endemic to the Uzungwas. One species, the rufous-winged sunbird *Nectarinia rufipennis* is endemic to the Uzungwas, being only recently

discovered in the Mwanihana Forest (Stuart and Jensen, 1981). There are also many endemic species of invertebrate. The forests in this region serve a critical watershed protection role, which is helped by a thick covering of bryophytes on the forest floor in many areas. This is particularly important as many large scale commercial agricultural developments are dependent on a reliable source of water, and hydro-electric schemes are planned. In Kanga FR, the forests are relatively undisturbed in comparison to the nearby Nguru South FR, probably due to traditional cultural values which restrict access. The bark of *Entandrophragma excelsum* and *Myrica salicifolia* trees is harvested for medicinal purposes. Current pressures on the forests include logging and use by the local population for firewood and building poles.

Mahale Mountains

Located near Gombe, on the western side of the country close to the border with Zaire, the Mahale Mountains run in a chain from north-north-west to south-south-east for some 50km with Mt. Nkungwe, the highest peak at 2462m. The western slopes of the main ridge drop precipitously with many ravines running into the lake, whilst hilly country (below 1700m) extends to the east of the main ridge.

There are three major vegetation types: Kasoge Forest (780m at lake level to 1300m) which is a well developed lowland forest on the western slope of the Mahale Mountains; wet and more verdant forest from 1500-2400m which comprises a mosaic of montane forest, grassland and alpine bamboo bush; and miombo forest on the eastern slopes and north and south of the Kasoge Forest, covering some 75% of the park area.

The Mahale Mountain National Park was established in 1985, and contains 55 recorded mammal species, with nine primates, including a large population of chimpanzee *Pan troglodytes*. The 120 recorded bird species include: crested malimbe *Malimbus rubricollis* and white-spotted pygmy crane *Coturnicops pulchra*.

North Eastern Mountains

This group of mountains cover a large area from north-central Tanzania up to Mt. Kilimanjaro, which lies on the border with Kenya. Forest occurs between 1980m and 3300m with montane and upper montane forest tending to lie on the wetter southern, eastern and northern slopes, and dry montane forest on the western slopes. Above the forest, grassland and moorland is found above about 2500m.

Patches of cloud forest are found within the montane and upper montane forests at Hanang, Malundwe, Ngorongoro, Nou, and on Mounts Meru and Kilimanjaro. The montane forests commonly include *Albizia gummifera*, *Podocarpus* sp., and *Prunus africana*, which is also

found in the upper montane zone along with *Cassipourea malosana*, *Ilex mitis*, and *Ocotea usambarensis*. On Kilimanjaro, the wetter southern slopes are dominated by *Podocarpus* spp. and camphorwood *Ocotea usambarensis* with an understory of ferns such as tree ferns *Cyathea* spp. and the long-spiked *Lobelia gibberoa*. Mammal species found above the treeline but which also use the montane forest habitat include the grey duiker *Sylvicapra grimmia*, red duiker *Cephalophus natalensis* and elephant. On Kilimanjaro, three species of primate are found within the montane forests, the blue monkey *Cercopithecus mitis*, black and white colobus *Colobus polykomos abyssinicus*, and *Galago crassicaudatus*. Sunbirds in the highland forest around Ngorongoro include the golden winged sunbird *Nectarinia reichenowi* and eastern double collared sunbird *N. mediocris*. The butterfly *Papilio sjoestedti*, sometimes known as the Kilimanjaro swallowtail, flies in the montane forests of Mt. Meru, Mt. Kilimanjaro and Ngorongoro.

The upland forests perform a critical watershed function, protecting the catchments of many rivers. Meru is the most important catchment reserve in the country as it supplies water to Arusha town and the densely populated surrounding area. Although most of the cloud forest is contained in Forest Reserves, grazing and fires set by hunters and beekeepers in the subalpine heath cause extensive damage. Human impact is relatively limited, although there has been serious encroachment for cultivation in some areas, and intensive pit sawing for Loliondo is carried out in some areas. Cutting of trees for firewood is another potential threat.

UGANDA

Uganda is a landlocked country covering about 236,000 sq.km. In the west of the country the landscape is dominated by the rift valley and its associated mountains and lakes, and in the east the international border with Kenya follows a line of raised land associated with the large Miocene volcanoes of Mount Elgon (Howard, 1988).

Ecologically, Uganda is very diverse, with a range of altitude from 600m in the bottom of the rift valley, to over 5000m at the top of the Rwenzori, Africa's third highest mountain range. Seven of mainland Africa's 18 phytochoria (plant kingdoms) are represented in Uganda.

Cloud forests occur along the mountains on the western border with Zaire and Rwanda, and on Mount Elgon which is on the eastern border of the country with Kenya. The cloud or moist montane forest generally lies between altitudes of 2000 and 3500m, although there is considerable variation.

Uganda is a predominantly agricultural nation, and there is great pressure on these forests along with other forest areas. At the turn of the century, forests covered approximately 12.7% of the country's total area. Today this figure is thought to be around 3%, with very little remaining outside government forest reserves (Hamilton, 1984; Struhsaker, 1987). The principal forest reserves were formally gazetted in 1932. These reserves are distributed such that 50% is in savanna woodland and forest plantation, 40% is in tropical high forest and 10% in montane catchment areas (IUCN, 1990).

It has been estimated that only about 50% of forested land within reserves remains essentially undisturbed (IUCN, 1990). The forests are under particular pressure from agricultural encroachment and settlement, illegal or unmanaged exploitation of timber and charcoal, an ever-increasing fuel wood demand, cattle grazing, pollution, and uncontrolled burning. National parks and wildlife sector reserves have been threatened by agricultural encroachment, illegal poaching and a negative public attitude to wildlife conservation. These problems were compounded by political and economic instability in the 1970s and 1980s (Anon., n.d.; Corson and Kux, 1982; Okua, 1991; Pomeroy, 1990; Struhsaker, 1987).

References

- Anon. (n.d.) Conservation of wildlife outside the national parks. Uganda. 11 pp.
- Butynski, T.M. 1984. Ecological survey of the Impenetrable (Bwindi) Forest, Uganda, and Recommendations for its conservation and management. Unpublished report to the Uganda Government.
- Corson, J. and Kux, M. 1982. MAB draft environmental profile – Uganda. Department of State, Washington, DC. 258 pp.
- Hamilton, A. 1969. The vegetation of south-west Kigezi. *Uganda J.* 33: 175-99.
- Hamilton, A.C. 1984. *Deforestation in Uganda*. Oxford University Press, Uganda. (Unseen)
- Hamilton, A.C. and Perrott, R.A. 1981. A study of altitudinal vegetation in the montane forest belt of Mt. Elgon, Kenya/Uganda. *Vegetatio* 45: 107-125.
- Harcourt, A.H. 1979. Conservation of the Bwindi Forest Reserve and its Gorillas, S.W. Uganda. WWF/IUCN Project 1577 Report.
- Harcourt, A.H. 1980. Can Uganda's Gorillas Survive? A survey of the Bwindi Forest Reserve. *Biological Conservation* 19: 269-282.
- Howard, P.C. 1988. Nature conservation in Uganda's tropical forest reserves. Kampala, Uganda. Unpublished draft. 302 pp.
- IUCN/MEP 1986. Uganda natural resources datasets – a preliminary review. IUCN, Nairobi, Kenya and Ministry of Environment Protection, Uganda. Pp. 2-13.
- IUCN. 1990. IUCN Uganda country programme workshop – working group background papers. IUCN, Gland, Switzerland.
- Keith, S., Twomey, A., Friedmann, H. and Williams, J. 1969. The Avifauna of the Impenetrable Forest, Uganda. *Amer. Mus. Novit.* 2389.
- Malpas, R. 1980. Wildlife in Uganda 1980 - A Survey. A Report to the Minister of Tourism and Wildlife, Uganda.
- Okua, M. 1991. The management of protected areas under the Uganda Game Department. A paper presented to the preparatory session for the World Congress on National Parks and Protected Areas, Amboseli National Park, Kenya, 9-16 July. 6 pp.
- Pomeroy, D.E. (Ed.). 1990. Forum II – conservation of biodiversity in Uganda. Proceedings of the Second Conservation Forum, 8-10 February, Kabarole District, Uganda. 63 pp.
- Struhsaker, T.T. 1987. Forestry issues and conservation in Uganda. *Biological Conservation* 39: 209-234.
- Stuart, S.N. and Adams, R.J. 1990. *Biodiversity in Sub-saharan Africa and its islands: conservation, management and sustainable use*. Occasional Paper No. 6. IUCN Species Survival Commission, Gland, Switzerland. Pp. 218-223.

UGANDA



0

150 km



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Bwindi Forest	Bwindi Forest	1°02'S/ 29°42'E	Yes
Mgahinga Forest	Mgahinga Forest	/	No
Mount Elgon Forest	Mount Elgon Forest	1°15'N/ 34°33'E	Yes
Rwenzori Mountains	Rwenzori Mountains	0°15'N/ 29°57'E	Yes
Total No. of CF Regions= 4	Total No. of CF Sites= 4	Total No. of CF Sites with an element of protection = 3	

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

Cloud Forest Region Summaries: Uganda

Bwindi Forest

Bwindi (Impenetrable) Forest is located in south-west Uganda near the border with Zaire, and covers an area of 31,000ha. The reserve is very steep, hilly countryside with an altitudinal range from 1400 to 2400m. The forest includes a wide variety of vegetation types which can be broadly classified as medium altitude moist evergreen forest and high altitude forest. Important constituents are *Prunus africana*, *Newtonia buchananii*, *Syphonia globulifera*, *Chrysophyllum* spp., *Podocarpus* spp. and *Strombosia cheffleria*. The vegetation is more fully described in Hamilton 1969. The fauna is one of the richest communities in East Africa. One-third of the world's population of the mountain gorilla *Gorilla gorilla berengei* (c.400) exists here. There are six other species of diurnal primate recorded, including chimpanzee *Pan troglodytes*, and three nocturnal primates. Several threatened birds with limited ranges are among the diverse avifauna. These include the African green broadbill *Pseudocalyptomena graueri*, Grauer's swamp warbler *Bradypterus graueri*, and Chapin's flycatcher *Muscicapa lendu*. A threatened butterfly species, the cream-banded swallowtail *Papilio leucotaenia*, is also found in this reserve. Together with some remnant lowland forest outside the boundary, the montane forest in this reserve constitutes an important water catchment area for many rivers supplying the agricultural land of the surrounding region. Where trees are cleared the soils are very susceptible to erosion, due to the steepness of the slopes. However the forest also lies in one of the country's most densely populated areas, and the main threats to this forest are posed by the hunting of its large mammals, and uncontrolled timber cutting. Fortunately these threats have been moderated due to the Ugandan Government's commitment to the protection of this forest (Howard, 1988).

Mgahinga Forest

Mgahinga forest is found on the mountain range which forms the Gorilla Game Reserve (or Kigezi Gorilla Game Reserve) and is located in the extreme south-west corner of Uganda on the borders with Zaire and Rwanda. Here the altitude ranges varies from 2700 to 4127m including parts of three volcanic mountains Muhavura, Mgahinga, and Sabinio. The alpine summit areas are dominated by *Hypericum* spp. and dwarf heaths which merge into broadleaved montane forest and bamboo *Arundinaria alpina*. The forest is rich in lichens and mosses. On the lower slopes is a high altitude type of savanna woodland. The reserve was established to protect the chimpanzee *Pan troglodytes* and the mountain gorilla *Gorilla gorilla berengei*. Other mammals include: the distinctive golden monkey *Cercopithecus mitis kandti* (a rare subspecies of the diademed monkey), leopard *Panthera pardus*, and elephant *Loxodonta africana*. The abundant bird life includes the Ruwenzori turaco *Tauraco johnstoni*, and the yellow-billed barbet *Trachyphonus purpuratus*. The threatened butterfly species *Papilio leucotaenia* may also

inhabit the reserve. There is severe disturbance from agricultural and pastoral activities and poaching. The area seems to be less well protected than neighbouring protected areas in Zaire and Rwanda. There are about 400 gorillas in this whole region, but only one group is found in the Ugandan sector and may have disappeared recently.

Mount Elgon Forest

Located on the border between Uganda and Kenya with portions of its slopes in both countries, Mount Elgon is a solitary extinct volcano, with one of the largest craters in the world, 8km across. The altitude varies from 1460m to 4320m at the rim of the crater. Four broad classes of vegetation occupy different altitudinal zones on Mount Elgon: 1) a community of mixed montane forest below 2500m, 2) a broad belt of bamboo and low canopy montane (Hagenea-Rapanea) forest between 2400m and 3000m, 3) a zone of high montane forest between 3000m and 3500m, a high moorland community above 3500m (Hamilton and Perrott, 1981). The wetter southern and western slopes of the mountain support a montane forest community dominated by species such as *Prunus africana*, *Aningeria adolfifriedericii*, and *Olea welwitschii*, whilst the drier north-east supports a coniferous forest dominated by *Podocarpus gracilior*, *Juniperus procera*, and *Ejobergia capensis*, with an understorey of *Ilex mitis*, *Olea* sp. and *Teclea nobilis*. The most important areas of Mount Elgon for plant species conservation lie in the high montane heath and moorland zones. Most of the animal species found here are widely distributed in suitable montane habitats throughout East Africa, but in many cases Mount Elgon represents the western range limits of species or races that occur in the highlands of Kenya and northern Tanzania, meaning that it has considerable importance in terms of conservation, particularly for bird species. The mountain is the only site record for *Francolinus jacksoni* in Uganda, and *Colomba delegroegui*, *Tauraco hartlaubi* and *Nectarinia tacazze* are restricted to Elgon and a few other mountains along the eastern border. The African elephant *Loxodonta africana* and the leopard *Panthera pardus* have also been recorded. The area is officially protected by the Mount Elgon Forest Reserve in Uganda and Mount Elgon National Park in Kenya which together cover approximately 90,000ha. Both sides of the mountain are important for water catchment protection, and to maintain viable populations of many of the larger and rare species such as elephant and leopard. However, a high human density in the lands bordering the reserve means that encroachment is a constant pressure. Poaching activities and timber harvesting also pose significant threats. *Juniperus procera*, an important timber tree is considered to be endangered in this area (Howard, 1988).

ZAIRE

The Republic of Zaïre extends from a narrow (40km) Atlantic seaboard in the west to the lake system of the western branch of the Rift Valley in the east. The high mountain ranges are restricted to the eastern border with Zambia and Uganda. Along the entire mountain chain, a total of more than 4275,000ha lies above 1500m. The highest peak, Margherita (5119m) lies in the Ruwenzori Range on the Uganda border around which an area of 35,000ha lies above 3000m.

Tropical rain forests cover 1.25 million sq.km (52% of the country), which constitutes almost half of the tropical rain forests of Africa (Mankoto ma Mabaelele, 1987). Cloud forest is found in the east, where a mosaic of montane forest and secondary grassland is interspersed with smaller areas of submontane and transitional rain forest (IUCN, 1985). The eastern montane forest covers an area of approximately 54,100sq.km (Doumenge, 1990) and serves an important watershed protection role, as more than 90% of the country drains into the Zaïre River basin.

Large areas of primary moist forest remain intact, as in general, forest exploitation is moderate. However, there is increased exploitation in the more highly populated and accessible areas (Doumenge, 1990), which include the eastern mountain range. The transitional forests have been largely cleared for agricultural use (Kasali, n.d.; von Richter *et al.*, 1990).

Forests are well represented in the country's protected area system, although a study by Doumenge (IUCN, 1990) identified a number of unprotected forest sites of critical importance for conservation of biological diversity. However, despite official protection forests suffer throughout from encroachment by local villagers, with a lack of alternative economic means and little involvement in reserve management (Kasali, n.d.). Poaching is particularly severe even within some protected areas and management of the national parks varies from a reasonably high level to minimal (IUCN, 1990, De Richter *et al.*, 199).

References

- Anon. (n.d.). Integrated nature conservation in Zaïre. Manuscript submitted to *Parks*. 5 pp.
- Bourlière and Verschuren, J. 1972. *Exploration du Parc national des Virunga*.
- Catterall M.J. 1992. Conservation priorities for the Albertine Rift Endemic Area. Msc. Report, Wye College, University of London.
- Collar, N.J. & S.N. Stuart 1988. Key Forests for Threatened Birds in Africa. International Council for Bird Preservation. Monograph No. 3.

- Doumenge, C. 1990. *La Conservation des Ecosystèmes Forestiers du Zaïre*. IUCN, Gland, Suisse and Cambridge, UK. 242pp.
- Goodall, A.G. 1974. Studies on the ecology of the mountain gorilla of the Mt Kahuzi-Biega region (Zaïre) and comparisons with the mountain gorillas of the Virunga Volcanoes. Unpublished Ph.D. Thesis, University of Liverpool.
- IUCN/WWF 1985. Rapport d'une mission au Zaïre et Rwanda. IUCN/WWF, Gland, Switzerland.
- Marius, C. 1972-3. Vegetation maps of Kahuzi-Biega.
- Michel, F.C. and Kabemba, A. 1986. Enquete sur la chasse aux alentours du parc de Kahuzi-biega (Zaïre). *La Lettre du Reseau Arbres Tropicaux*. April. 20 pp.
- OBICO, 1996. Biodiversité et Conservation dans la zone occidentale du Lac Kivu (est du Zaïre). Rapport de travail. Section OBICO-Zaïre.
- Prigogine, A. 1971. Les Oiseaux de l'Itombwe et de son hinterland. Volume 1. *Annals of the Museum Royal d'Afrique centrale*, 8°, Sci. Zool. 185-298.
- Prigogine, A. 1985. Conservation of the Avifauna of the forests of the Albertine Rift. In *Conservation of Tropical Birds*, eds. A.W. Diamond and T.E. Lovejoy 277-295. International Council for Bird Preservation, Cambridge, Technical Publication. N° 4.
- Spinage, C.A. (1972). The Ecology and Problems of the Volcano National Park, Rwanda. *Biological Conservation* 4: 194-204.
- Verschuren, J. 1988. *Problèmes scientifiques et techniques au parc national des Virunga (Zaïre)*. Institut Zaïrois pour la Conservation de la Nature/Administration Générale Belge pour la Coopération au Développement. 135 pp.

ZAIRE



0

500 km



Virunga
Rwenzori

Kahuzi-Bié
Mountain

Kivu

Itombwe
Mountains

Kabobo
Mountain

Murungu
Highlands



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Itombwe Mountains	Itombwe Mountains	3°25'S/ 28°35'E	No
Kabobo Mountain	Kabobo Mountain	5°08'S/ 29°03'E	No
Kahuzi-Biega Mountains	Kahuzi-Biega Mountains	2°03'S/ 28°50'E	Yes
Kivu	Bushenyi Forest	2°21'S/ 28°57'E	Yes
	Mitumba	1°57'S/ 28°55'E	No
	Shushu	2°07'S/ 29°05'E	No
Marungu Highlands	Marungu Highlands	7°30'S/ 29°59'E	No
Virungas/Rwenzoris	Mount Tshiaberimu	0°10'S/ 29°25'E	Yes
	Rwenzori Mountains	0°30'N/ 29°50'E	Yes
	Virunga Volcanoes	1°28'S/ 29°10'E	Yes
Total No. of CF Regions= 6	Total No. of CF Sites= 10	Total No. of CF Sites with an element of protection = 5	

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

Cloud Forest Region Summaries: Zaire

Itombwe Mountains

The Itombwe Mountain range comprise a large number of mountains oriented north-south, in south-western Zaire. Most reach above 2000m, and altitude ranges from 1500m to 3475m. A montane lake (Lake Lungwe) is located in the north at 2700m. The range represents the largest area above 2500m altitude in the Central African mountains, and montane marshes have developed over a large area. There is transition forest at 1200-1500m, with montane forest dominated by *Parinari* sp. *Carapa* sp. *Homalium* sp. *Syzygium* sp. *Fagara* aff. *inaequalis*. *Sapium ellipticum*. *Ocotea michelsonii*, *Croton megalocarpus* from 1800m to 2200m and by *Hirtella* sp. *Syzygium* sp. *Parinari* sp. *Symphonia* sp. *Olea hoschtetteri*, *Crysophyllum* sp. *Ficalhoa laurifolia* above 2000m. The forest holds a rich fauna, including *Gorilla gorilla graueri* and *Afropavo congensis*. Among 36 endemic species occurring in the Central African Highlands, 32 are found in Itombwe. These mountains have the greatest bird diversity among all the afro-montane forests, including 2 local endemics *Phodilus prigoginei*, recently recorded after only one specimen in 1954 (Prigogine 1954) and *Schoutedenepus schoutedeni*. There is also high diversity in Amphibians including *Hyperolius castaneus consellatus*. *H. leleupi*. *Chrysobatrachus cupreonites*, and *Rana* sp. which are endemic to Itombwe. The site is state property but is not officially protected despite repeated recommendations in the past. The long-term survival of Itombwe mountains is uncertain, as there is very high pressure from mining and grazing, which is affecting the montane and bamboo forest.

Kabobo Mountain

An isolated peak to the west of the northern half of Lake Tanganyika in south-eastern Zaire, with altitudinal ranges from 1500m to 2700m. The site holds a rich avifauna, with around 60 species recorded, including *Apalis kaboboensis*, which is endemic to the forest, *Turdus tanganjicae* and *Lioptilus rufocinctus*. The forest has no official protection despite a number of recommendations for its conservation (Prigogine 1985).

Kahuzi-Biega Mountains

The Kahuzi-Biega Mountains are located in Eastern Zaire, 50km west of the town of Bukavu near the Rwanda and Burundi borders. The area takes its name from two extinct volcanoes, and is part of the Parc National de Kahuzi-Biega (total area, 600,000ha). Altitude ranges from 1800m to 3400m, with annual maximum temperatures of 18°C and minimum temperatures of about 10.4°C. Mean annual rainfall is 1800mm with wide variation, and humidity varies

between 50% and 85%. Two-thirds of the mountain forest is dense primary forest with *Podocarpus* and *Prunus* spp. intermixed with bamboo, especially at higher altitudes in upper montane or cloud forest areas. Some patches of more open vegetation occur at lower altitudes. The remaining area is mainly mesophytic woodland including *Hagenia* trees and areas of *Cyperus* swamp and peatbog. The park was established to protect 200-300 mountain gorilla *Gorilla gorilla graueri* occurring mainly in the forests at 2100m-2400m, but also in the lower rain forest. The 'mosaic' of biotypes makes the area an excellent gorilla habitat. Other primates include chimpanzee *Pan troglodytes*, owl-faced monkey *Cercopithecus hamlyni*, including black and white colobus monkey *Colobus guereza* and red colobus *C. badius*. Other mammals include the elephant *Loxodonta africana*, forest hog *Hylochoerus meinertzhageni* and many antelope and duiker. Avifauna include the endemic Rockefeller's sunbird *Nectarinia rockefelleri*, African green broadbill *Pseudocalyptomena graueri* and Grauer's swamp warbler *Bradypterus graueri*. The National Park was accepted as a World Heritage site in 1980, as was the Virungas in 1979. A system of four zones has been proposed (Anon., 1989), comprising administration etc., tourism, extensive use and strict conservation, and there is a forested buffer zone. Cloud forest is therefore subject to relatively low pressure. Agricultural activities, especially tea-growing, occur on the periphery and, in the past, slash and burn rotational agriculture was practised throughout the area. Poaching affects most species and the road system has deteriorated to the point where it is not possible for guards to adequately patrol the park. Recent economic problems in Zaïre have resulted in a marked decrease in the effectiveness of management, and thus a decline in tourism, which had previously provided a cash flow for the region. There are a number of villages in the buffer zone and there is regular hunting of game species both for consumption and for sale, which has threatened species populations both in surrounding the park and within it.

Kivu

Small areas of montane forest are found in a number of locations around Lake Kivu in the east of the country, close to the border with Rwanda. These include Bushenyi forest reserve on Kivu Island, Shushu forest which is on two small islands off Idjwi Island in Lake Kivu, and fragmented transition forests between Kahuzi-Biega and Masisi on the western edge of Lake Kivu. In Bushenyi altitude ranges from 1460m (lake level) to 2260m, with sub-montane forest up to 1700m, and a montane forest above. In Shushu altitude ranges from 1460m to 1500m with a montane forest dominated by *Neoboutonia buchananii*, isolated *Albizia grandibracteata*, and *Ficus* spp. The forest in Mitumba is dominated by *Lebrunia bushaie* and important for the conservation of some Albetine Rift endemics including *Pseudocalyptonema graueri*, *Nectarinia rockefellerii*, *Columba albinucha*, *Indicator pumilio*, *Phyllastrephus lorenzi*, *Turdus tanganyicae*, *Lioptilus chapini*, *Terpsiphone bedfordi*, *Cryptospiza shelleyi*. Bushenyi has been under legal protection since 1939, Shushu is privately managed and Mitumba has no protection. However, much of the original forest has been cleared in all three cases, and the

remaining forest is important for maintenance of ecological processes and for the conservation of two species endemic to the islands, *Apalis argentea eidos*, and *Cercopithecus mitis schoutedeni*. Mitumba is also under pressure from poaching.

Marungu Highlands

The extensive area of the Marungu lies to the west of the southern half of Lake Tanganyika in Eastern Zaire. The area consists of two main land masses separated by the low-lying Mulobozi river, the smaller northern section (also called the Malimba mountains) rising to c. 2100m, and the larger southern section, reaching c. 2460m. Grassland and scrub are the major habitats but there is also dense forest including *Parinari excelsa*, *Teclea nobilis*, *Polysias fulva*, *Ficus storthophylla* and *Turraea holstii* in ravines, and more importantly, a narrow riparian forest, with *Syzygium cordatum*, *Ficalhoa laurifolia* and *Ilex mitis* along streams. The Marungu Highlands are a centre of endemism for plants, with over 300 endemics species (IUCN 1985). The Marungu Sunbird *Nectarinia prigoginei* is restricted to the riparian forest. The area is not protected although the forests bordering the Mulobozi and Lufuko rivers have been proposed as conservation belts (Prigogine 1985), as they are under severe threat from timber-felling and from erosion of stream banks by cattle.

Virungas/Rwenzoris

Virunga National Park covers a large area in North-east Zaire on the border with Uganda and Rwanda. It includes the Rwenzori mountains, an extremely steep and rugged mountain range, where the altitude ranges from 1700m up to Africa's third highest mountain, Margharita at 5119m, and mountain peaks are permanently snow covered. The southern area of the park belongs to the Virunga Volcanoes complex and contains two active peaks: Nyamuragira and Nyiragongo. The considerable altitudinal range results in marked climatic variations which affect the overall biological and geographical diversity of habitats. Cloud forest is found in the Rwenzoris, the Virunga Volcanoes and on Mount Tshiaberimu to the west of Lake Edward. The montane forest is composed of bamboo and *Hagenia* forest on the mountain slopes including some areas of very dense moist forest, with *Neoboutonia macrocalyx* forest on the lava plains. Alpine heath vegetation dominates about 3500m consisting of *Podocarpus milanjianus* and *Hagenia abyssinica* with alpine forests of *Dendrosenecio* and giant *Lobelia*. Above 4300m there is sparse vegetation, mainly lichens and spermatophyta. Mount Tshiaberimu (Tshabirimu) is a high altitude forest dominated by bamboo. With regard to fauna, whilst none of the recorded species are endemic to this area, there are a number of endemic subspecies. In Rwenzori, these include the colobus monkey *Colobus angolensis ruwenzorii*, Rwenzori hyrax *Dendrocybus arboreus ruwenzorii*, and the Rwenzori leopard *Panthera pardus ruwenzorii*. In addition many Albertine Rift endemics occur. Other species of interest include elephant *Loxodonta africana*,

chimpanzee *Pan troglodytes*, l'hoest monkey *Cercopithecus lhoesti*, with gorilla *Gorilla gorilla berengei* on the slopes of the Virunga mountains (about 140 were recorded in the Zaire Virungas in 1980 and 280 in 1986 (Verschuren, 1988)). Bird species include Nahan's francolin *Francolinus nahani*, forest ground thrush *Turdus oberlaenderi*, leopard bamboo warbler *Bradypterus alfredi* and Shelley's crimsonwing *Cryptospiza shelleyi*. The mountains of the Virunga National Park belong to a network of protected areas including Rwenzori Forest Reserve (99,600ha), Rwenzori National Park (197,800ha) and Biosphere Reserve (220,000ha), Kigezi Game Reserve (32,830ha), Kyambura Game Reserve (15,700ha), and Kibale Forest Corridor Game Reserve (33,910ha). It is an important trans-boundary conservation area, as about 50km of international boundary runs through the centre of the massif. The main threat to the integrity of the forest is posed by high levels of hunting which are having a severe impact on many of the larger mammals. Poaching of elephant and gorilla has been almost completely stopped, although there remains localised poaching of hippopotamous, buffalo and certain antelopes (Verschuren, 1988). There are also localised problems associated with tourist activities such as litter, sanitation, and demand for firewood (Howard 1988) and clearance of forest for agricultural land. The recent civil war in Rwanda has put pressure on the area due to a high demand for firewood and increased poaching.



PART TWO

LATIN AMERICA : CENTRAL

**Belize
Costa Rica
El Salvador
Guatemala
Mexico
Panama**

BELIZE

The mountains of Belize are located in the largely forested Maya Mountain range, which occupies about half of the land area of Belize. The highest known point is Victoria Peak at 1120m. One of the forest types known to occur in the Maya Mountains is lower montane forest (International travel map productions, 1992; Zisman, 1996).

References

- Faust, B. 1995. *Help save a Belize cloud forest and help locals farm sustainably*. Unpubl. email to WCMC.
- International travel map productions. 1992. *Traveller's reference map of Belize*. International travel map productions, Canada.
- Zisman, S. 1996. *The directory of Belizean protected areas and sites of nature conservation interest*. Second Edition. NARMAP. pp.186.

BELIZE

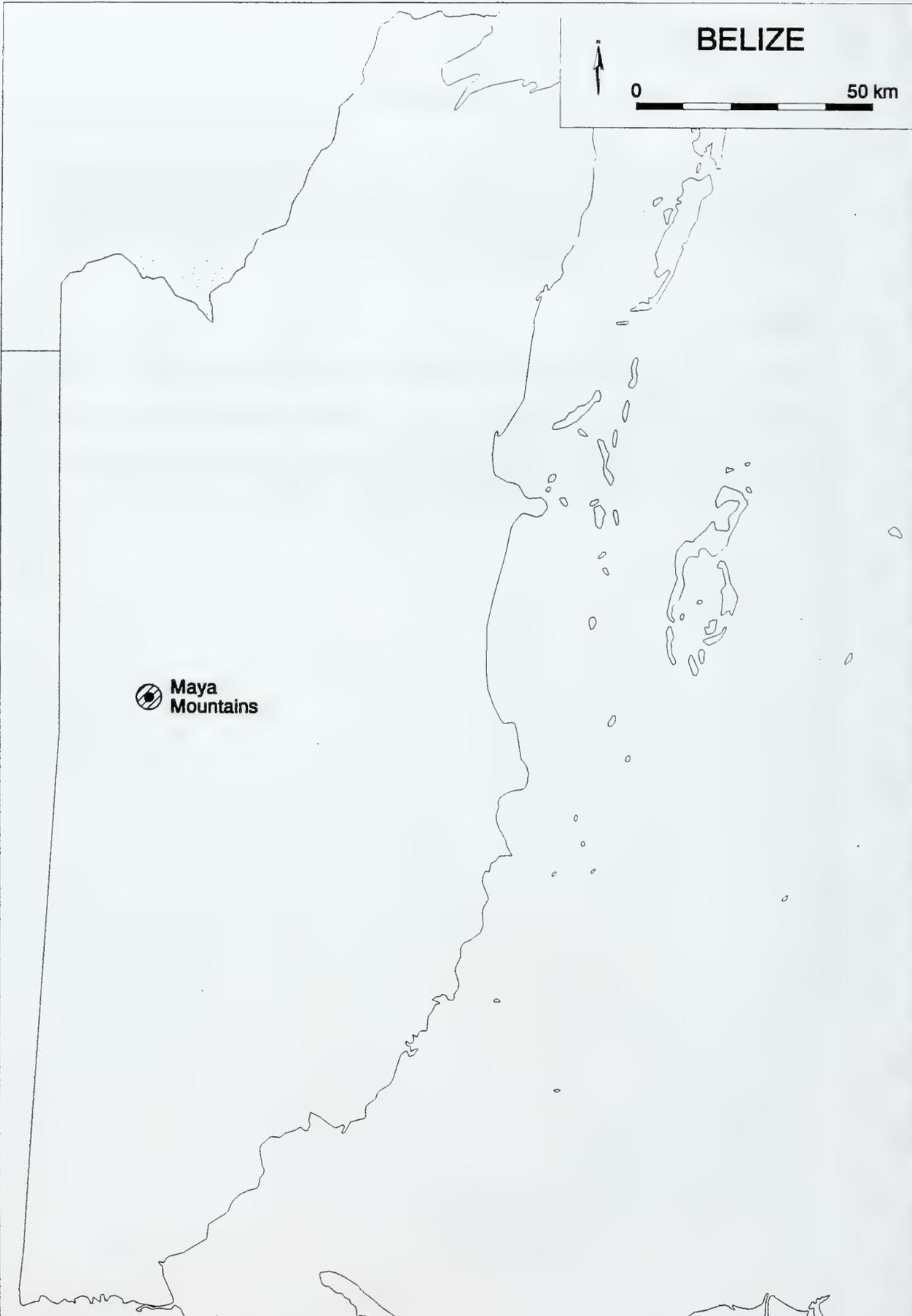


0

50 km



 **Maya Mountains**



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Maya Mountains	Slate Creek Preserve	17°07'N/ 88°58'W	Yes
Total No. of CF Regions= 1	Total No. of CF Sites= 1	Total No. of CF Sites with an element of protection = 1	

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

Cloud Forest Region Summaries: Belize

Maya Mountains

Currently, one cloud forest site has been reported in the Maya Mountains. Specifically, on the pine ridge Caracol Road in Cayo. It is described as a newly formed private forest preserve (364ha) of karst cloud forest, which is said to contain Mayan ruins as well as endangered wildlife. Pressures mentioned include fires started by refugee farmers. No further details are known for this site (Faust, 1995).

COSTA RICA

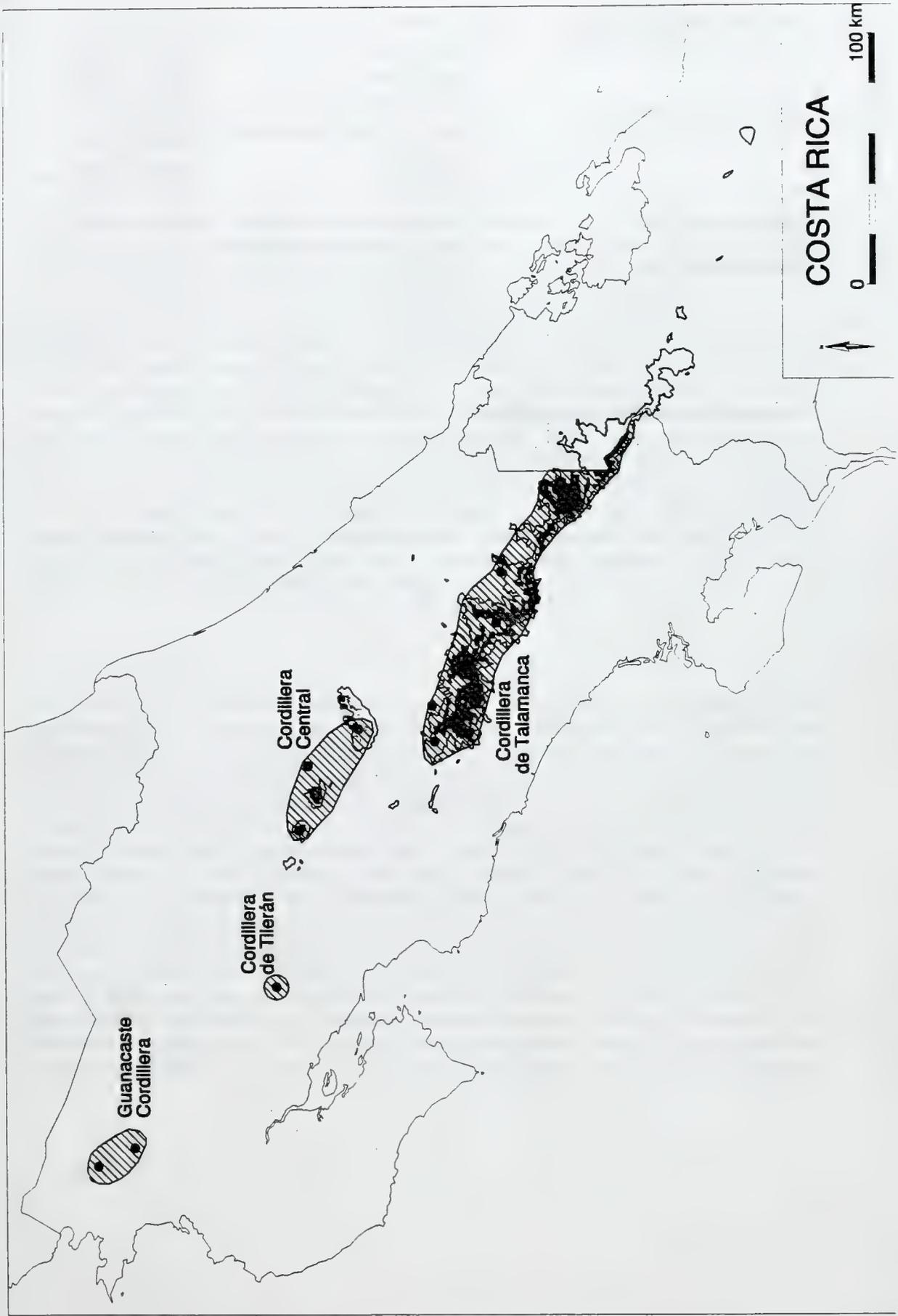
Known cloud forest sites are located in four mountain ranges. From north to south they are: Guanacaste Cordillera, Tilarán Cordillera, Cordillera Central and Cordillera de Talamanca. One of the most famous cloud forest sites in the world is found in Tilarán Cordillera - the Monteverde Cloud Forest Reserve. Cloud forest sites in Costa Rica occur between approximately 1000m and 3000m. Many of the sites are protected. This does not, however, make them immune to certain pressures, in particular deforestation for agriculture and pasture land.

References

- Boza, M.A. 1986. *Parques Nacionales: Costa Rica: National Parks*. Fundacion de Parques Nacionales, Costa Rica. 95pp.
- Boza, M.A. & Mendoza, R. 1981. *The national parks of Costa Rica*. INCAFO, Madrid. 310pp.
- Echeverria, J., Hanarahan, M. & Solorzano, R. 1995. Valuation of nonpriced amenities provided by the biological resources. *Ecological Economics* 13:43-52.
- Harcourt, C.S. & Sayer, J.A. (Eds.). 1996. *The conservation atlas of tropical forests*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- IUCN. 1982. *IUCN directory of neotropical protected areas*. Tycooly International Publishing Ltd., Dublin. pp.436.
- Janzen, D.H. 1986. *Guanacaste National Park: tropical, ecological and cultural restoration*. Editorial Universidad Estatal a Distancia, San José. 103pp.
- Kappelle, M. & Juárez, M.E. 1995(a). The Los Santos Forest Reserve: a buffer zone vital for the Costa Rican La Amistad Biosphere Reserve. *Environmental Conservation* 21:166-169.
- Kappelle, M. & Juárez, M.E. 1995(b). Agroecological zonation along an altitudinal gradient in the montane belt of the Los Santos Forest Reserve in Costa Rica. *Mountain Research and Development* 15:19-37.
- Lawton, R. & Dryer, V. 1980. The vegetation of the Monteverde Cloud Forest Reserve. *Brenesia* 18:101-116.
- Lober, D.J. 1992. Using forest guards to protect a biological Reserve in Costa Rica: one step towards linking parks to people. *Journal of Environmental Planning and Management* 35:17-41.
- Menkhaus, S. & Lober, D.J. 1996. International ecotourism and the valuation of tropical rain-forests. *Journal of Environmental Management* 47:1-10.

A GLOBAL DIRECTORY OF TROPICAL MONTANE CLOUD FORESTS

- National Park Service Ministry of Agriculture and Livestock and FAO. 1974. Plan maestro para la proteccion y uso parque nacional volcán poás. *Documento Técnico de Trabajo No.10 (Proyecto FAO-RLAT/TF 199)*.
- Pound, J.A. 1991. The secret sahara. *BBC Wildlife* June.
- Pound, J.A. & Crump, M.L. 1994. Amphibian declines and climate disturbance - the case of a the golden toad and the harlequin frog. *Conserv. Biol.* 8:72-85.
- Tobias, D. & Mendelsohn, R. 1991. Valuing ecotourism in a tropical rain-forest reserve. *Ambio* 20:91-93.



COSTA RICA

0 100 km

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Cordillera Central	Braulio Carrillo	10°10'N/ 84°00'W	Yes
	Irazu Volcano	9°59'N/ 83°52'W	No
	Volcán Poás	10°12'N/ 84°14'W	Yes
Cordillera de Talamanca	Chirripó	9°29'N/ 83°29'W	Yes
	Genesis II Cloud Forest Preserve	9°42'N/ 83°54'W	No
	La Amistad	9°28'N/ 83°18'W	Yes
	Los Santos	9°35'N/ 83°53'W	Yes
	Río Macho	9°35'N/ 83°37'W	Yes
	Tapantí	9°43'N/ 83°47'W	Yes
Cordillera de Tilarán	Monteverde Cloud Forest Reserve	10°17'N/ 84°48'W	Yes
	Santa Elena Cloud Forest Reserve	/	No
Guanacaste Cordillera	Volcán Cacao	10°56'N/085°27'W	Yes
	Volcán Orosí	/	Yes
	Volcán Rincón de la Vieja	10°48'N/ 85°23'W	No
Total No. of CF Regions= 4	Total No. of CF Sites= 14	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: Costa Rica

Cordillera Central

The Cordillera Central comprises three main areas of montane forest. Two of these areas are included in the National Parks of Braulio Carrillo and Volcán Poás. The third locality includes the small protected area of Irazu Volcano, which is the highest mountain in the Cordillera Central (3432m). The flora and fauna of the upper part of the Irazu Volcano have suffered considerable alterations due to volcanic eruptions and to deforestation to create cattle pasture land and to cultivate potatoes. Though wildlife is scarce, patches of cloud forest mainly made up of *Quercus* formations are found between 2000m and 3100m. Likewise, the wildlife is impoverished on Volcán Poás in this case partly due to isolation caused by intensive agriculture at lower elevations. However cloud forest, described as *Didomopanax-Weinmannia-Clusia* forest, does occur between 2450m and 2700m. Endemics to this active volcano include *Syntheosciurus poasensis* (Poás mountain squirrel) and *Escallonia poasana* (cipreso). A third species is endemic to Volcán Poás, *Otus clarkii* (Clark's screech owl) and also to the extinct volcano Barba located in the Braulio Carrillo National Park. In Braulio Carrillo National Park, an area of abrupt terrain and extinct volcanoes, the fauna is extremely diverse, as is the flora (Boza, 1986; Boza & Mendoza, 1981; Harcourt & Sayer, 1996; IUCN, 1982; FAO, 1974; WCMC unpubl. data).

Cordillera de Talamanca

The Cordillera de Talamanca has been recognised as an extremely valuable site for biodiversity due to intermigrations from both North and South America resulting in considerable diversity and many endemics in the area. The mountain range, therefore, has been declared a Biosphere Reserve and World Heritage Site and has been given the name Reserva de la Biosfera de la Amistad. This Reserve comprises a range of protected areas, five of which are known to include cloud forest sites: Hitoy Cerere Biological Reserve, La Amistad National Park, Chirripó National Park, Tapanti National Park and Genesis II Cloud Forest Preserve. In Chirripó National Park, Cerro Chirripó at 3820m is not only the highest point within the Reserve, but also in southern Central America. Los Santos and Rio Macho Forest Reserves also include tracts of cloud forest. Most of the main crest of the Cordillera de Talamanca lies within montane rain forest and detailed botanical inventories in the montane forest zones have shown that there are at least 477 woody species in 223 genera and 90 families. Ericaceae, Rosaceae, Poaceae and Asteraceae dominate the Upper Montane Forest zone. Likewise, the fauna in the Biosphere Reserve is extremely diverse. (Endemics to the Reserve include one species of fish, 20 species of amphibian and reptile, 15 bird species and 13 mammal species.) Pressures on the montane forest include deforestation for charcoal

production and low income cultivation of potatoes, carrots and cabbages (Kappelle & Juárez, 1995(a), 1995(b); WCMC unpubl. data).

Cordillera de Tilarán

Cloud forest sites occur along the crest of the Cordillera de Tilarán and are included in a number of private parks (including the Santa Elena Cloud Forest Reserve...) the most famous of which is the Monteverde Cloud Forest Reserve. It comprises six forest types: cove forest, leeward cloud forest, oak ridge forest, windward cloud forest, elfin forest and swamp forest. This forest has inspired a considerable number of studies, especially on vegetation and birds. It is therefore valued in particular for research and also for tourism (over 20,000 tourists visited the Reserve in 1990). A well-known indigenous resident of the Monteverde Cloud Forest is the brilliantly plumed quetzal (*Pharomachrus mocinno*). However, in spite of being protected as a Strict Nature Reserve, the vulnerability of this site as a safe haven for biological diversity has been illustrated through the decline of amphibians, including the extinction of the world's only population of golden toads (*Bufo periglenes*) through climate fluctuations coupled with habitat fragmentation. In addition to habitat loss, other pressures on the Reserve include hunting (particularly as adjacent lands are deforested and animals retreat into the Reserve) squatting and agricultural encroachment on the lower slopes (Echeverría, Hanarahan & Solorzano, 1995; Harcourt & Sayer, 1996; Lawton & Dryer, 1980; Lober, 1992; Menkhaus & Lober, 1996; Pound, 1991; Pound & Crump, 1994; Tobias & Mendelsohn, 1991; WCMC unpubl. data)

Guanacaste Cordillera

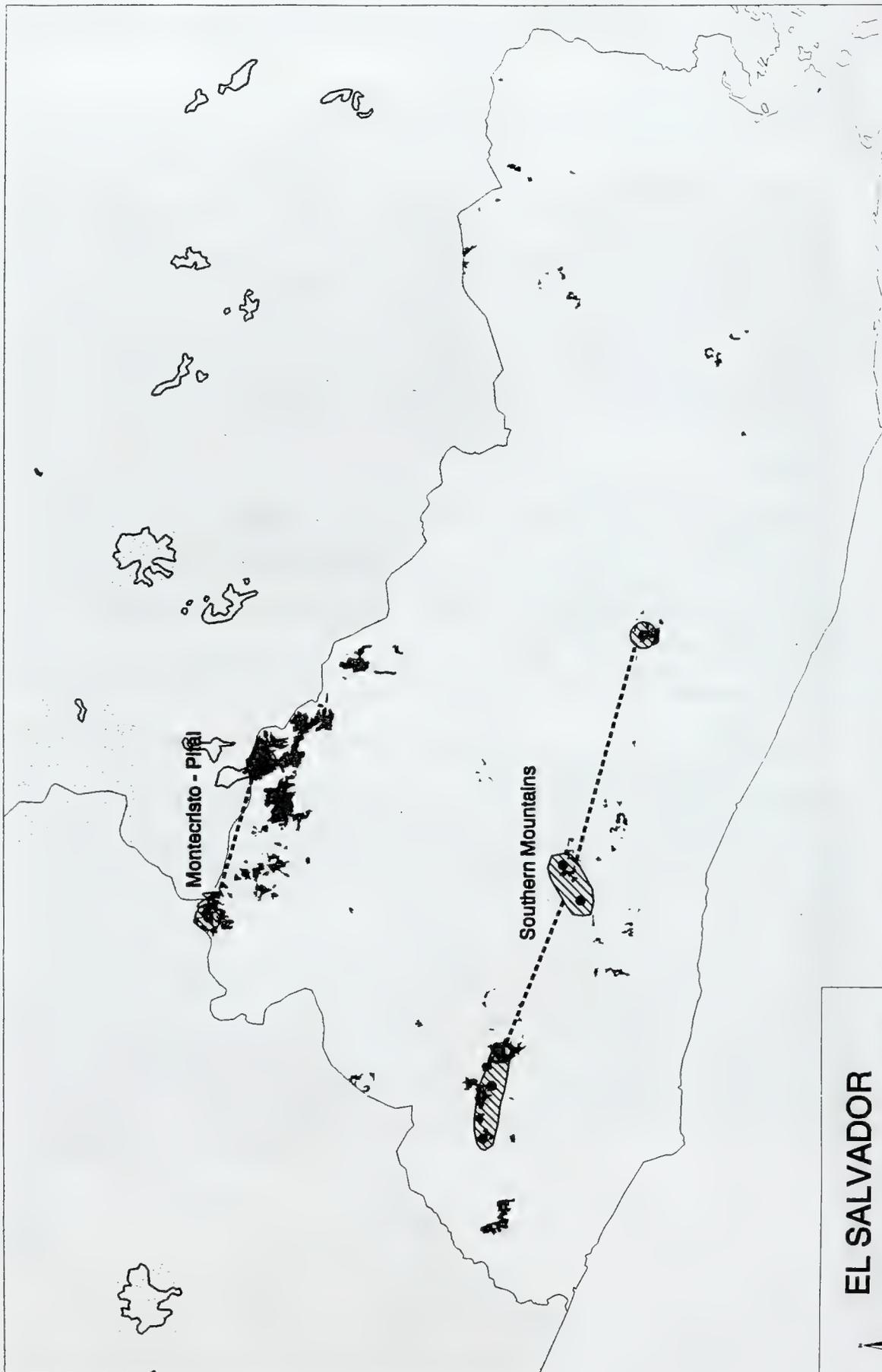
Cloud forest occurs around the volcanic summits in the Guanacaste Cordillera. These include Volcan Orosi, Volcan Cacao and Volcan Rincón de la Vieja. (These volcanoes are three of five that compose the Guanacaste Mountain Range.) Volcan Orosi and Volcan Cacao are located within the Guanacaste National Park and contain the smallest habitat islands of cloud forest in Costa Rica. They are also the lowest, occurring between 1000m and 1500m (cloud forest normally starts above 1800m in Costa Rica). Volcan Rincón de la Vieja has an altitude of 1898m and though it is an active volcano last erupting in the 1970s, its summit is covered with lower montane rain forest comprising either a very homogeneous growth of *Clusia rosea* (copey clusia) or a mixed forest of copey clusia, bayberry, suitea of the palm family, scandent bamboo and several species of the Araceae family. This forest is exposed to strong winds and is covered almost all year long with mist and rain. One of the major benefits of this National Park is the conservation of the vast hydrographic system of the volcano, which comprises 32 rivers and 16 water-collecting gorges in the park alone. The main threat to the forests of the Guanacaste Cordillera is deforestation for agriculture and pasture (Boza, 1986; Boza & Mendoza, 1981; Janzen, 1986).

EL SALVADOR

El Salvador, the smallest country with the highest population density (300 sq.km) and the most degraded biodiversity resources in Central America, largely consists of rugged volcanic highlands of moderate elevation. The country is in an advanced state of deforestation, with only 3% of the forest remaining in its natural state. As a result, approximately 77% of the country has been seriously affected by soil erosion. The network of protected areas has yet to be finalised on paper and put into practice on the ground. El Salvadorean cloud forests, valued for biological diversity and watershed protection, are reported to be found above 1800m, be 20-30m tall and be dominated by the families Fagaceae and Lauraceae. Epiphytes, including bromeliads and orchids, mosses, lichens and ferns are reported to be abundant (Hilty, 1982; Harcourt & Sayer, 1996; IUCN, 1982, 1992; WCMC unpubl. data).

References

- Daugherty, H.E. 1972. The impact of man on the zoogeography of El Salvador. *Biol. Conserv.* 4:273-278.
- Daugherty, H.E. 1973. The Montecristo cloud-forest of El Salvador - a chance for protection. *Biol. Conserv.* 5:227-230.
- Hilty, S.L. (Comp.) 1982. *Draft environmental profile of El Salvador*. USMAB, Washington, DC. viii+137pp
- Harcourt, C.S. & Sayer, J.A. (Eds.). 1996. *The conservation atlas of tropical forests the Americas*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. 335pp.
- IUCN. 1982. *IUCN directory of Neotropical protected areas*. Tycooly International Publishing Ltd, Dublin. 436pp.
- IUCN. 1992. *Protected areas of the world: a review of national systems. Vol.4: Nearctic and Neotropical*. IUCN, Gland, Switzerland and Cambridge, UK. 460pp.
- Ministerio de Agricultura y Ganadería. 1987. *Elaboracion del plan y estrategia del sistema nacional de areas silvestres protegidas de El Salvador*. Unpubl.



Montecristo - Pijal

Southern Mountains

EL SALVADOR

0 50 km

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Mountains of El Salvador	Cerro El Pital	14°24'N/ 89°08'W	Yes
	Laguna Las Ninfas	13°54'N/ 89°48'W	Yes
	Las Granadillas	/	No
	Las Mercedes	/	No
	Los Andes	13°52'N/ 89°38'W	No
	Montecristo	14°25'N/ 89°23'W	Yes
	San Isidro	/	No
	San José Miramar	/	No
	San Rafael Los Naranjos/El	13°53'N/089°42'W	No
	San Salvador	13°45'N/089°17'W	No
	San Vicente	13°36'N/088°51'W	No
	Santa Ana	13°52'N/089°38'W	No
	Santa María	13°43'N/089°21'W	No
Total No. of CF Regions= 1	Total No. of CF Sites= 13	Total No. of CF Sites with an element of protection = 3	

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

Cloud Forest Region Summaries: El Salvador

Mountains of El Salvador

The cloud forest in El Salvador have not escaped degradation and there is conflicting evidence as to the number of sites, their quality and the are occupied. According to Harcourt and Sayer (1996) cloud forest sites are estimated to cover approximately 39 sq km and to be best developed in the northwest of the country in Montecristo National Park (which includes the peaks Cerro Brujo (2140m), Cerro Miramundo (2394m), Cerro Redondo (?) and Cerro Montecristo (2418m)) and on Cerro El Pital, which is the highest peak in the country (2730m). They also note that cloud forest can be found on the volcanoes Santa Ana, San Salvador and San Vicente. A list compiled by the Ministerio de Agricultura y Ganadería (1987) states that cloud forest may be found in the following additional areas: Los Andes, San Isidro, San José Miramar, San Rafael Los Naranjos (El Campanil), Las Granadillas, Santa María, Las Mercedes and Laguna Las Ninfas. According to Daugherty (1973), however, the original cloud forests of El Salvador are said to have been almost totally cut by peasant agriculturalists and firewood cutters, with the only remaining ecologically-viable cloud forest of El Salvador being the 12 sq km Montecristo cloud forest. However, more than half of this forest has also been cut. This forest adjoins the cloud forest of Trifinio National Park in Guatemala. The Montecristo cloud forest contains what is thought to be the last remaining patch of virgin forest in the country and the last remaining habitat for species of wildlife that have been exterminated in the lowlands. Examples of birds that are in danger of extinction, but are present in this site include: quetzal *Pharomacrus moccino*, black chachalaca *Penelopina nigra* and El Salvador hairy woodpecker *Dryobates villosus*.

Regardless of the above conflicting reports the message is clear: cloud forest in El Salvador is in a very vulnerable state (Daugherty, 1972, 1973; Harcourt & Sayer, 1996; IUCN, 1982, 1992; Ministerio de Agricultura y Ganadería, 1987; WCMC unpubl. data).

GUATEMALA

Guatemala forms a bridge between two continents and two oceans. Large parts of the country are highland with 15.9% comprising montane forests. Cloud forests have been recorded in two of Guatemala's four main physical biogeographic regions: the Pacific mountain chain (including Sierra Madre and Trifinio) which consists of a chain of 33 volcanoes running parallel to the Pacific Ocean and the Interior Highlands (including Sierra de Mico, Sierra de las Minas and University Biotope for the conservation of the Quetzal), which reaches altitudes of 4000m and are quite heavily populated. The Guatemalan cloud forests have around 70% endemism amongst animal species, but as a result of colonisation, timber extraction and agriculture they represent some of the most endangered ecosystems in the country (Harcourt & Sayer, 1996; IUCN, 1992; Nations *et al.* 1988).

References

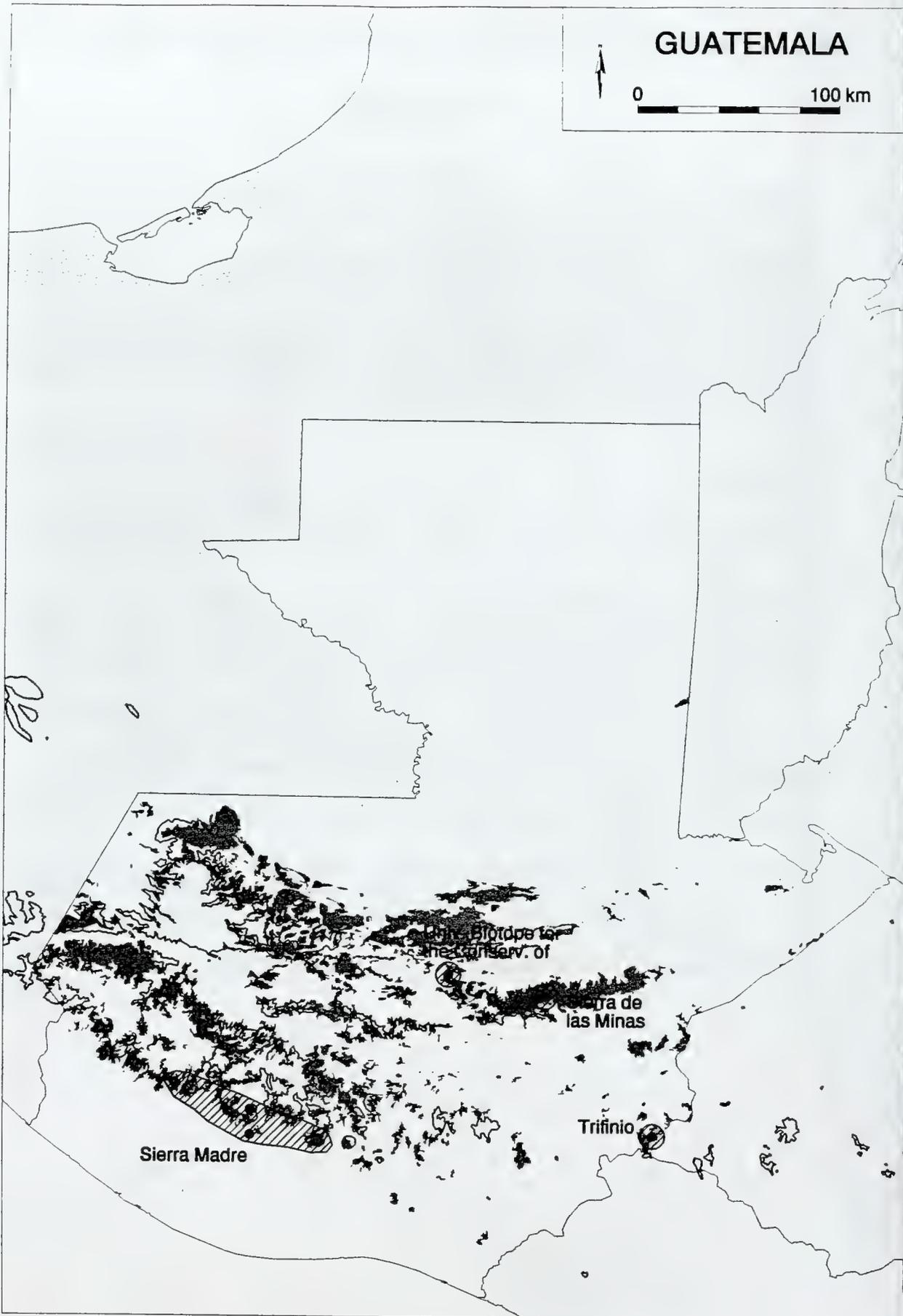
- Harcourt, C.S. & Sayer, J.A. (Eds.). 1996. *The conservation atlas of tropical forests the Americas*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. 335pp.
- Instituto Nacional Forestal Guatemala. 1975. *Plan preliminar de manejo para el parque nacional (monumento natural): Trifinio Guatemala: Documento tecnico de trabajo No. CA 5 proyecto FAO/PNUD RLA/72/028*. Oficina Subregional Centroamericana.
- IUCN. 1982. *IUCN directory of Neotropical protected areas*. Tycooly International Publishing Ltd, Dublin. 436pp.
- IUCN. 1992. *Protected areas of the world: a review of national systems. Vol.4: Neartic and Neotropical*. IUCN, Gland, Switzerland and Cambridge, UK. 460pp.
- LaBastille, A. 1973. Establishment of a quetzal cloud forest reserve in Guatemala. *Biol. Conserv.* 5:60-62.
- Mardones S., C. 1988. Trifinio: un desafio de conservacion para tres paises. *Flora Fauna y Areas Silvestres* 3:18-22.
- Nations, J.D., Houseal, B., Ponciano, I., Billy, S., Godoy, J.C., Castro, F., Miller, G., Rose, D., Rey, M. and Azurdia, C. 1988. *Biodiversity in Guatemala: biological diversity and tropical forests assessment*. Center for International Development and Environment, World Resources Institute, Washington D.C., USA, December 1988. 110pp.

GUATEMALA



0

100 km



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No
Sierra Madre	Finca Mocca Private Reserve	14°30'N/ 91°12'W	Yes
	Quetzal Cloud Forest Reserve	/	No
	Volcán Acatenango	14°29'N/ 90°53'W	No
	Volcán Atitlán	14°37'N/ 91°12'W	Yes
	Volcán San Pedro	14°40'N/ 91°45'W	Yes
	Volcán Santa María	14°44'N/ 91°33'W	No
	Volcán Tolimán	14°35'N/ 91°50'W	Yes
	Volcán de Fuego	14°28'N/090°53'W	No
Sierra de Mico	Sierra de Mico	/	Yes
Sierra de las Minas	Sierra de las Minas	15°09'N/ 89°50'W	Yes
Trifinio	Trifinio	14°30'N/ 89°20'W	No
Univ. Biotope for the Conserv. of	Univ. Biotope	15°15'N/ 90°17'W	No
Total No. of CF Regions= 5	Total No. of CF Sites= 12	Total No. of CF Sites with an element of protection = 6	

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

Cloud Forest Region Summaries: Guatemala

Sierra Madre

Sierra Madre includes a number of cloud forest sites, such as: Volcán Acatenango, Volcán Atitlán, Volcán de Fuego, Volcán Santa María, Volcán San Pedro and Volcán Tolimán. On Volcán Atitlán, there is a lower montane wet forest belt and a 405ha reserve of virgin cloud forest has been established on private land in this belt in order to protect the resident population of quetzal *Pharomachrus mocinno mocinno* and horned quans *Oreophasis derbianus*. This protected area lies between 1707m and 2438m and is run by a Guatemalan association of landowners called the "Association Atitlán for the protection of the quetzal". It is known as the "Quetzal Cloud Forest Reserve" (LaBastille, 1973).

Sierra de Mico

Cloud forest, likely to be located in what is described as the low montane wet forest, is thought to occur on the Sierra de Mico. Most of this area is protected by the Río Dulce National Park, which extends from sea level to 1267m and includes the Sierra de Mico, Lake Izabel and the mouth of the Río Dulce. The area is considered to be rich in amphibian and reptilian fauna (IUCN, 1982; WCMC, unpubl. data)

Sierra de las Minas

The cloud forests of the Sierra de las minas cover approximately 1300sq. km, of which more than 65% is thought to be virgin. All of the area is protected by the Sierra de las Minas Biosphere Reserve. The mountain range is said to include two thirds of the cloud forest left in Guatemala and also to be the largest unbroken extension of cloud forest in Central America (see Cordillera de Talamanca). The geographical isolation and the variety of elevations and climates have made Sierra de las Minas an area of high biological and zoological endemism, and also the most biologically diverse area in the country. For example, there are 885 species of reptiles, birds and mammals recorded in the area. Endangered species include the golden-cheeked warbler *Dendroica chrysoparia*. The area is also considered to be a unique genetic reservoir for conifer species. Sierra de las Minas cloud forest is valued as an important water catchment area by the local communities, since it gives rise to 62 permanent rivers. Pressures on the area include expansion of the agricultural frontier, logging, roads and hunting (Harcourt & Sayer, 1996; WCMC, unpubl. data).

Trifinio

The cloud forests of Trifinio, the majority protected by a National Park, abutt onto the cloud forests of Honduras and Montecristo National Park, in El Salvador. The cloud forests are found at altitudes greater than 1800m and are dominated by species of oak tree and laurel. A number of endemics may be found in the site including *Gregia santaemartae*. The area is valued as a water catchment area and also for its archeological remains, which are of cultural importance (Instituto Nacional Forestal Guatemala, 1975; Mardones, 1988).

Univ. Biotope for the Conserv. of the Quetzal

This 900ha protected area is owned by the University of San Carlos. It ranges in altitude from 1580m to 2348m and includes two mountains: Cerro Quisis/Geomaya (2348m) and Cerro Carpintero, also known as La Cumbre (2011m). The vegetation type in this protected area is lower montane rain forest also described as cloud forest. The dominant vegetation in the area is broadleaf but there are scattered small stands of two pine species: *Pinus pseudostrabus* and *Pinus oocarpa*. Approximately 60 species of birds and 24 species of mammals have been recorded in the reserve, but the area is valued for the protection of the quetzal *Pharomacrus moccino* (WCMC unpubl. data).

MEXICO

As a result of its latitudinal range and topography, México contains a remarkable climatic complexity and biotic richness that make it one of the most ecologically diverse countries in the world. Tropical montane cloud forests occur along the Pacific and Gulf slopes from Sonora and Tamaulipas, respectively, southeast to Oaxaca and Chiapas, with some isolated patches in the Transverse Neovolcanic Belt in the centre of the country. The most extensive cloud forests in México occur on the coastal-facing slopes and ridge tops of the mountain chains. They occur at altitudes between 700m (some areas in eastern México) and 4000 m (Volcán Tacaná, Chiapas) and total annual rainfall ranges from 1000mm in the driest areas to over 5000mm in the wettest (Volcán Tacaná, Chiapas). They are typically a dense mixture of temperate and tropical broad-leaved tree species with canopy heights average between 20m and 35m, and contain many epiphytes and tree ferns. Tree genera characteristic of cloud forests in México are *Quercus*, *Podocarpus*, *Juglans*, and specially *Chiranthodendron* on the western slopes and *Liquidambar* on the eastern slopes (Rzedowski, 1986).

The cloud forest is one of the country's rarest ecosystems and although it occupies only about 0.07% of the land area, it contributes highly to the biological diversity of the country (Flores *et al.* 1971; Flores-Villela and Gerez, 1994; Gómez-Pompa *et al.* 1995). These forests hold about 1000 plant species which are endemic to the country. In addition 28 species of amphibians, 21 species of reptiles, 9 species of mammals and 9 species of birds are endemic (Flores-Villela and Gerez, 1994).

Some important areas of cloud forest are considered within the Mexican scheme of Natural Protected Areas, such as El Triunfo, La Sepultura and Sierra de Manantlán. Other important regions, however lack any kind of protection, such as the cloud forests located in Sierra Madre Occidental and eastern México.

Cloud forest is naturally fragmented in México because of its geological history, but further fragmentation has occurred because of human activities and settlements. Current pressures include the expansion of the agricultural and grazing areas, logging and forest fragmentation by roads. These causal factors, however, are driven by economic, social and political forces in a broader context of political economy.

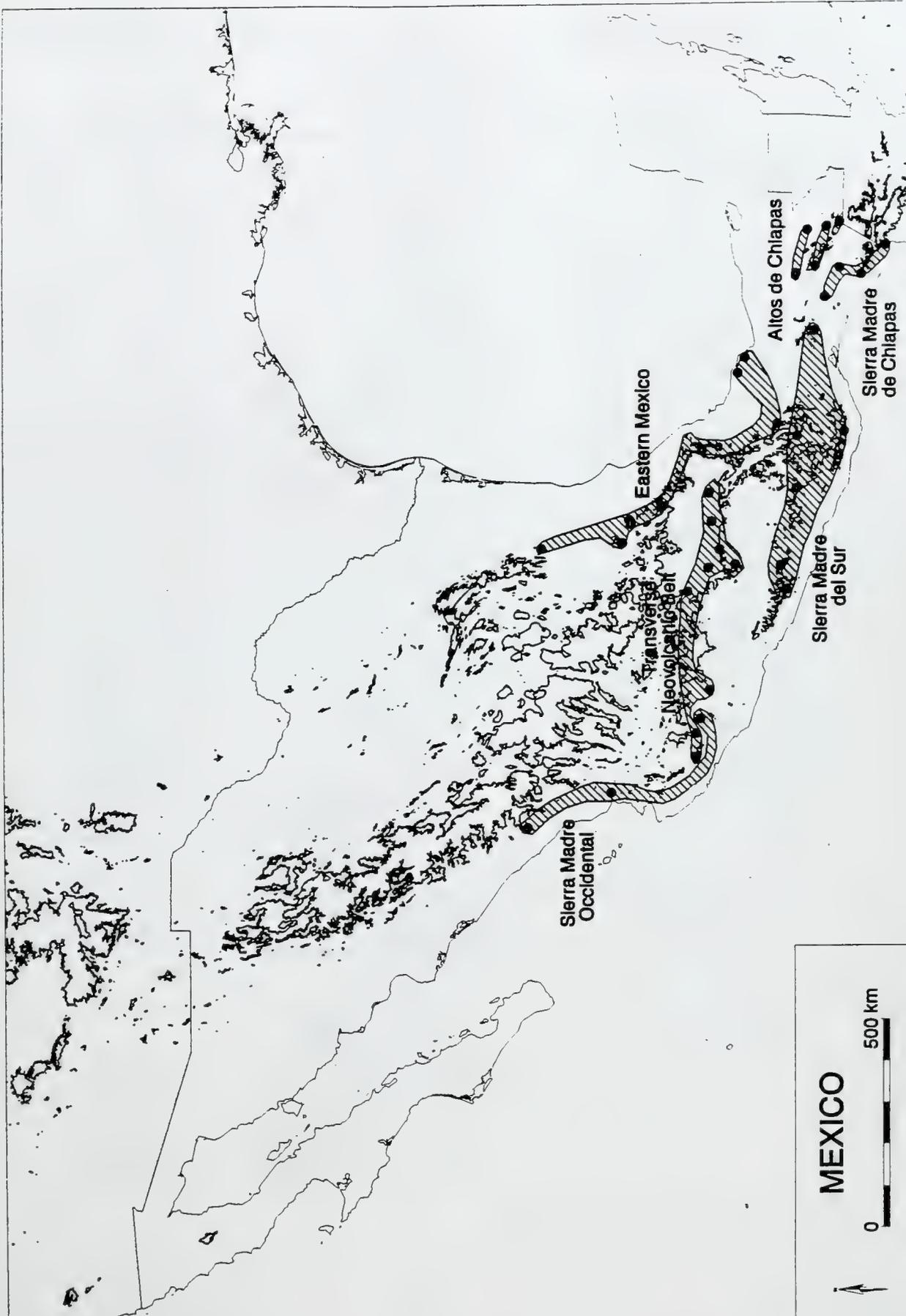
Ecological and socio-economic values include the protection of watersheds for several rivers, lakes and springs, which provide water to human populations and are important for the production of electricity. Cloud forests also play an important role in the protection of soils from erosion, since they normally occur in areas with steep slopes. They also have important aesthetic and cultural values for many local inhabitants and ethnic groups.

References

- Breedlove, D. E. 1978. The phytogeography and vegetation of Chiapas (México). In: Graham, A. (ed.). *Vegetation and vegetational history of northern Latin America*. 150-165 pp.
- Bubb, P. 1991. The current situation of the cloud forest in northern Chiapas, México. Final Report. Ecosfera, Pronatura, The Linnean Society of London, and Fauna and Flora Preservation Society. Unpublished manuscript.
- Collar, N. J., M. J. Crosby and A. J. Stattersfield. 1992. Birds to Watch 2. The world list of threatened birds. BirdLife Conservation Series No. 4. BirdLife International. Cambridge, UK. 407 pp.
- Flores, M. G., J. Jiménez L., X. Madrigal S., F. Moncayo R., and F. Takaki T. 1971. Memoria del mapa de tipos de vegetación de la Republica Mexicana. Secretaría de Recursos Hidráulicos. México. 59 pp.
- Flores-Villela, O. and A. Muñoz-Alonso. 1993. Anfibios y reptiles. In: Luna-Vega, I. and J. Llorente-Bousquets (eds.). *Historia natural del Parque Ecológico Omiltemi, Chilpancingo, Guerrero, México*. UNAM. México. pp. 411-442.
- Flores-Villela, O. and P. Gerez. 1994. Biodiversidad y conservación en México: vertebrados, vegetación y uso del suelo. CONABIO-UNAM. México. 439 pp.
- García-Rendón, M. 1993. Vegetación. In: Luna-Vega, I. and J. Llorente-Bousquets (eds.). *Historia natural del Parque Ecológico Omiltemi, Chilpancingo, Guerrero, México*. UNAM. México. pp. 39-56.
- Gómez-Pompa, A., R. Dirzo, A. Kaus, C. R. Noguerón-Chang, and M. de J. Ordoñez. 1995. Reservas de la biósfera y otras áreas naturales protegidas de México. SEMARNAP-INE-CONABIO. México. 159 pp.
- Hernández-Baños, B. E., A. T. Peterson, A. G. Navarro-Sigüenza, and B. P. Escalante-Pliego. 1995. Bird faunas of the humid montane forests of Mesoamerica: Biogeographic patterns and priorities for conservation. *Bird Conservation International*. 5:251-277.
- Howell, S. N. G. and S. Webb. 1995. A guide to the birds of México and northern Central America. Oxford University Press. New York, USA. 851 pp.
- Jiménez-Almaraz, T., J. Juárez-Gómez, and L. León-Paniagua. 1993. Mamíferos. In: Luna-Vega, I. and J. Llorente-Bousquets (eds.). *Historia natural del Parque Ecológico Omiltemi, Chilpancingo, Guerrero, México*. UNAM. México. pp. 503-549.
- León-Paniagua, L. and I. Luna-Vega. 1993. Asentamientos humanos. In: Luna-Vega, I. and J. Llorente-Bousquets (eds.). *Historia natural del Parque Ecológico Omiltemi, Chilpancingo, Guerrero, México*. UNAM. México. pp. 19-22.
- Long, A. and M. Heath. 1991. Flora of the El Triunfo Biosphere Reserve, Chiapas, México: A preliminary floristic inventory and the plant communities of Polygon I. *Anales del Instituto de Biología de la UNAM, Serie Botánica*. 62(2):133-172.
- Martínez, A. L. and J. Llorente-Bousquet. 1993. Mariposas. In: Luna-Vega, I. and J.

A GLOBAL DIRECTORY OF TROPICAL MONTANE CLOUD FORESTS

- Llorente-Bousquets (eds.). *Historia natural del Parque Ecológico Omiltemi, Chilpancingo, Guerrero, México*. UNAM. México. pp. 307-385.
- Navarro-S., A. G. and P. Escalante-Pliego. 1993. Aves. In: Luna-Vega, I. and J. Llorente-Bousquets (eds.). *Historia natural del Parque Ecológico Omiltemi, Chilpancingo, Guerrero, México*. UNAM. México. pp. 443-501.
- Rzedowski, J. 1986. *Vegetación de México*. Limusa. México.
- SARH (Secretaría de Agricultura y Recursos Hidráulicos). 1992. *Compendio de información sobre áreas naturales protegidas*. México. 147 pp.
- Vázquez-García, J. A. 1993. Cloud forest archipelagos: preservation of fragmented montane ecosystems in tropical America. In: Hamilton, L. S., J. O. Juvik, and F. N. Scatena (eds). *Tropical montane cloud forest*. East-West Center, Program on Environment. pp. 203-216.
- Wege, D. C. and A. J. Long. 1995. Key areas for threatened birds in the Neotropics. BirdLife Conservation Series No. 5. BirdLife International. Cambridge, UK. 311 pp.



MEXICO



Cloud Forest Region	Cloud Forest Site	Protected*	
		Yes	No
Altos de Chiapas	Huitepec	16°44'N/ 92°41'W	No
	Lagunas de Montebello	16°10'N/ 91°40'W	Yes
	Las Margaritas	16°28'N/ 91°46'W	No
	Ocosingo, Chiapas	16°55'N/ 91°51'W	No
	Region Norte, Chiapas	17°11'N/ 92°52'W	No
	Volcán Tacaná	15°06'N/ 92°12'W	Yes
Eastern México	Cañon del Río Blanco, Veracruz	/	No
	Cempoaltépetl, Oaxaca	17°08'N/ 96°01'W	No
	Chapulhuacán	/	No
	Cuetzalan-Pahuatlán, Puebla	/	No
	El Cielo	23°08'N/ 99°18'W	No
	Huachinango, Puebla	/	No
	Huautla	21°03'N/ 98°44'W	No
	Huayacocotla, Veracruz	/	No
	Joya del Hielo	/	No
	Perote, Veracruz	/	No
	Sierra de Alvarez, San Luis	/	No
	Sierra de Juárez, Oaxaca	17°38'N/ 96°23'W	No
	Sierra de Otontepec, Veracruz	/	No
	Sierra de Santa Martha, Veracruz	18°23'N/ 94°50'W	No
	Teocelo, Veracruz	19°23'N/ 97°00'W	No
	Tlanchinol, Hidalgo	21°05'N/ 98°38'W	No
	Volcán San Martín, Veracruz	18°33'N/ 95°12'W	No
Xilitla	21°15'N/ 99°10'W	No	
Zacatlamaya	/	No	
Sierra Madre Occidental	El Batel	23°28'N/105°49'W	No
	El Nayer	21°31'N/105°00'W	No
	Espinazo del Diablo	19°26'N/103°16'W	No
	Saguaribo, Sonora	/	No
	Surotato, Sinaloa	/	No
Sierra Madre de Chiapas	Cerro Tres Picos	16°31'N/ 93°25'W	No
	El Triunfo	15°40'N/ 92°53'W	Yes
	La Sepultura, Chiapas	16°10'N/ 92°44'W	No
	Monte Ovando	/	No
Sierra Madre del Sur	Volcán Tacaná	15°06'N/ 92°12'W	Yes
	Cerro San Felipe, Oaxaca	17°10'N/ 96°40'W	No
	Los Chimalapas	16°46'N/ 94°12'W	No
	Loxicha	16°04'N/ 96°33'W	No
	Omiltempi, Guerrero	17°33'N/ 99°41'W	No
	Qelchultenango-Guerrero	/	No
	San Andrés Chicahuaxtla, Oaxaca	17°11'N/ 97°53'W	No
	Sierra de Atoyac	17°25'N/100°15'W	No
	Sierra de Cuatro Vendados, Oaxaca	/	No
	Sierra de Maihuatlán, Oaxaca	16°12'N/ 97°07'W	No
	Sierra de Yucuañaca, Oaxaca	/	No
Transverse Neovolcanic Belt	Barranca de Cupatitzio, Michoacán	/	No
	Cerra Viejo	20°19'N/ 98°19'W	No
	Cerro de Garnica, Michoacán	/	No
	Coalcomán	/	No
	Cuale-Talpa	/	No
	Iztacihuatl-Popocatepetl	19°10'N/ 98°40'W	Yes
	Los Azufres, Michoacán	/	No
	Nanchititla, State of México	/	No
	Nevado de Colima	19°32'N/103°37'W	No
	Nevado de Toluca, State of México	19°15'N/ 99°45'W	No
	Nevado de Toluca, State of México	19°15'N/ 99°45'W	No
	Ocuilan, State of México	18°59'N/ 99°19'W	No
Pico de Tancítaro, Michoacán	19°13'N/102°36'W	Yes	
Pico de Tancítaro, Michoacán	19°13'N/102°36'W	No	
Sierra Chincua, Michoacán	19°44'N/100°18'W	No	

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No
	Sierra de Manantlán,	19°33'N/104°10'W	No
	Sierra de Taxco, Guerrero	18°37'N/ 99°40'W	No
	Temascaltepec, State of México	/	No
	Volcán la Malinche,	19°14'N/ 98°00'W	Yes
Total No. of CF Regions= 6	Total No. of CF Sites= 64	Total No. of CF Sites with an element of protection = 7	

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

Cloud Forest Region Summaries: Mexico

Altos de Chiapas

This region is located in northern Chiapas (southeast México) and runs southeast to where it joins the highlands of Guatemala, which in turn link Altos de Chiapas with Sierra Madre de Chiapas. All these regions are closely related and allied to the highlands of Honduras and north-central Nicaragua. Altos de Chiapas contains approximately 38 cloud forest fragments of different size which are grouped into three main sub-regions, Región Sun Norte, Ocosingo and Las Margaritas. Cloud forest can be found as low as 1300m, such as in Tumbala and Cordón Jolvit and up to 2800m as in Tzontehuitz (Bubb, 1991). Common tree genera in the canopy include *Abies*, *Acer*, *Chiranthodendron*, *Clethra*, *Drimys*, *Liquidambar*, *Magnolia*, *Olmediella*, *Oreopanax*, *Persea*, *Photinia*, *Pinus*, *Quercus*, *Weinmannia*, *Wimmeria*, *Zanthoxylum*, *Saurauia* and *Astronium* (Breedlove, 1978; Bubb, 1991; Gómez-Pompa *et al.*, 1995). Prominent animal species are the jaguar *Panthera onca*, ocelot *Leopardus pardalis*, and puma *Felis concolor*. Notable bird species include the highland guan *Penelopina nigra*, resplendent quetzal *Pharomachrus mocinno* and emerald toucanet *Aulacorhynchus prasinus*. Species endemic to this region are the snake *Bothrops tzotzilorum* and the bearded screech-owl *Otus barbatus*. The cloud forest in this region is very poorly protected; the only protected localities are the Lagunas de Montebello National Park, Montes Azules Biosphere Reserve and the privately protected areas of La Yerbabuena and Huitepec, which encompass a very low percentage of the cloud forest area of the region. As deforestation has occurred in the lowlands, the highlands, where cloud forest is found have become important refuges for several wildlife species (Bubb, 1991). As a result the conservation of these areas is vital. In addition they have an important role influence in the watershed protection of the Grijalva-Usumacinta Basin, and some areas of cloud forest are of local cultural importance. For example, the Cerros de Chalchihuitán are of religious importance for the Tzotzil people (Bubb, 1991). However the cloud forests are threatened by forest clearance leading to further fragmentation. The main causes are for milpa agriculture and associated burning, cattle and sheep ranching, fuelwood gathering and timber extraction. Hunting may also occur in some places. In Chixtontic an additional threat is from oil exploration, with its attendant disturbance, pollution and increased accessibility to the forest from road construction (Bubb, 1991). Since 1994, after the arising of the Zapatista Army, this region has been affected by social struggles which have meant further pressure on the cloud forests of the area.

Eastern México

This region (north of the Isthmus of Tehuantepec) comprises the Sierra Madre Oriental, a mountain chain running parallel to the gulf coast. Close to a third of the cloud forests of the

country are found here (Flores- Villela and Gerez, 1994), located at altitudes between 700m and 1500m, with a total annual rainfall of up to 4900mm (Volcán San Martín). The cloud forests of eastern México tend to have more deciduous elements, such as *Liquidambar*, *Fagus* and *Nyssa* (Vázquez-García, 1993). Canopy tree height typically up to 30m with abundance of epiphytes, tree ferns and palms. Important tree genera are *Quercus*, *Liquidambar*, *Podocarpus*, *Clethra*, *Carpinus*, *Ostrya*, *Persea*, *Meliosma*, *Sapindus*, *Fagus*, *Acer*, *Dendropanax*, *Cercis* and *Magnolia* (Gómez-Pompa *et al.*, 1995). The endemic tree species *Fagus mexicana* is only found in a few localities within this region, in the states of Tamaulipas, Hidalgo and Puebla (Flores-Villela and Gerez, 1994). Endemic bird species include the bearded wood-partridge *Dendrortyx barbatus*, thick-billed parrot *Rhynchopsitta terrisi* and the dwarf jay *Cyanolyca nana* (Hernández-Baños *et al.*, 1995; Wege and Long, 1995). Threatened species occurring in this region include the jaguar *Panthera onca*, ocelot *Leopardus pardalis*, jaguarondi *Herpailurus yaguarundi* and lynx *Lynx rufus*. Most of the cloud forest of eastern México is devoid of protection, except for El Cielo Biosphere Reserve in Tamaulipas and Los Tuxtlas in Veracruz (Volcán San Martín and Sierra de Santa Martha). The conservation of El Cielo Biosphere Reserve is essential as the northern limit of many tropical species is found the north of this region (Gómez-Pompa *et al.*, 1995). Other currently unprotected areas also have important cultural value for several indigenous people, such as the Huastec in the Huasteca region (San Luis Potosí, Veracruz and Hidalgo), and the Chinantec, Mixe and Mixtec in the Sierra de Juárez, who have extensive knowledge and uses of the flora. These forests also contain important ornamental plant species such as tree ferns, cycads, bromeliads and orchids. However control of extraction is poor and commercial collection of plant species with ornamental value, such as camedora palm *Chamaedora* spp. (Gómez-Pompa *et al.*, 1995) and tree ferns is often unsustainable. Other areas are under pressure from logging for wood, pulp and cellulose, slash and burn agriculture, cattle ranching, and hunting.

Sierra Madre Occidental

The Sierra Madre Occidental is a mountain chain running north-south parallel to the Pacific coast, making contact with the Transverse Neovolcanic Belt in Jalisco state in the centre of Mexico. The cloud forests of this region are not extensive because they are located in the northern limit of the Neotropical region. For this reason they have been poorly studied to date. Some endemic birds occurring in this region are the thick-billed parrot *Rhynchopsitta pachyrhyncha*, the black-throated magpie-jay *Calocitta colliei* and the tufted jay *Cyanocorax diickeyi* (Hernández-Baños *et al.*, 1995; Howell and Webb, 1995). The cloud forests of this region, together with other forest types have an important influence for the protection of the watersheds of several rivers that provide water to human population, agricultural areas and for the generation of electricity. Pressures upon the cloud forests of this region include forest conversion to agricultural areas, logging and illegal planting of narcotics.

Sierra Madre de Chiapas

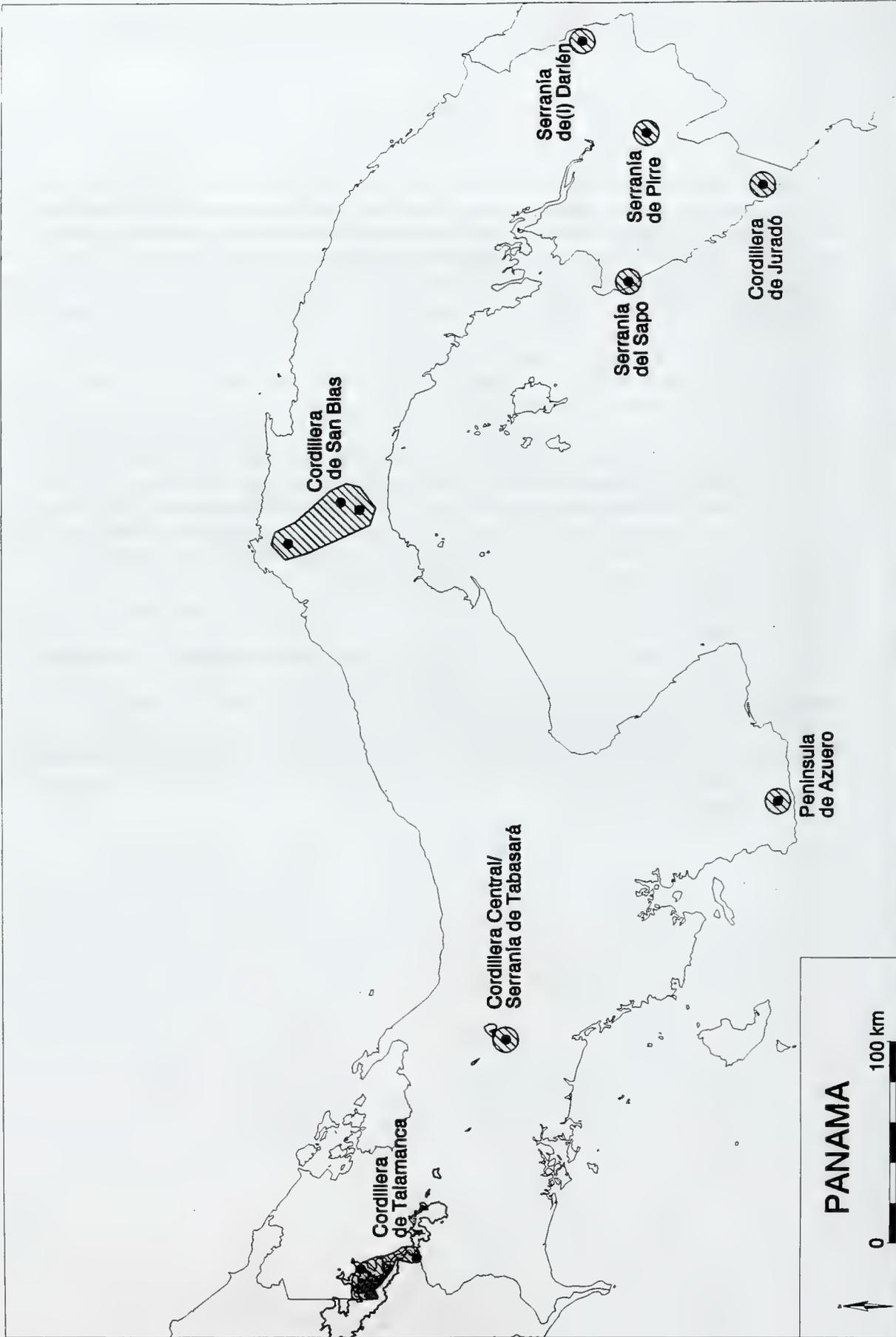
This mountain chain in south eastern México, runs parallel to the Pacific coast from the southern end of the Isthmus of Tehuantepec through Chiapas into Guatemala. It contains the largest area of cloud forest in México, occupying an area of about 144,396ha in an almost continuous band. It occurs at altitudes between 750m and 4000m, with a total annual rainfall range from 2500mm (El Triunfo) to 5250mm (Volcán Tacaná). Canopy trees are normally 25m to 30m high, but can be up to 40m high. Common tree genera include *Quercus*, *Matudaea*, *Dendropanax*, and *Ocotea* (Gómez-Pompa *et al.*, 1995). Important vegetation communities are *Quercus-Matudaea-Hedyosmum-Dendropanax*, *Liquidambar-Quercus-Pinus*, *Cupressus-Pinus*, and *Ficus-Coccoloba-Dipholis-Sapium* (Long and Heath, 1991). Epiphytes such as orchids, bromeliads, mosses and ferns are very abundant (Gómez-Pompa *et al.*, 1995). Threatened flora include some species of bromeliads, orchids and the cicada *Ceratozamia matudae*; threatened fauna includes the jaguar *Panthera onca*, ocelot *Leopardus pardalis* and bird species such as the highland guan *Penelopina nigra*, resplendent quetzal *Pharomachrus mocinno* and the black-throated jay *Cyanolyca pumilo*. There are at least two endemic bird species, the horned guan *Oreophasis derbianus* and cabanis' tanager *Tangara cabanisi* (Hernández-Baños *et al.*, 1995). Two important protected areas, La Sepultura and El Triunfo Biosphere Reserves have been decreed in this region, but more urgently require protection. In addition to the high biodiversity these forests are also important for the protection of three major river basins. The region also has high tourist potential because of its beautiful scenery and the occurrence of outstanding faunal species such as the resplendent quetzal. The main causes of further clearance and fragmentation are from coffee plantations, slash and burn agriculture, cattle ranching, logging of *Pinus* and *Quercus* and some localised hunting.

PANAMA

Panama contains the lowest cloud forest sites in Central and South America. In addition, endemism is a striking feature of the high cloud forests that reach 2000m and above in western Panama. Some correlation in Panama has been shown between animal distribution, in particular frogs of the genus *Eleutherodactylus*, and cloud forest zonation. Many of the cloud forests in Panama are included in protected areas. Colonization, deforestation and encroachment, however, seem to be major threats (Myers, 1969; Lewis, 1971; WCMC unpubl. data).

References

- Cavelier, J., Solis, D. and Jaramillo, M.A. 1996. Fog interception in montane forests across the Central Cordillera of Panama. *J. of Trop. Ecol.* 12:357-369.
- IUCN. 1992. *Protected areas of the world: a review of national systems. Vol.4: Neartic and Neotropical.* IUCN, Gland, Switzerland and Cambridge, UK. 460pp.
- LaBastille, A. 1973. An ecological survey of the proposed Volcano Baru National Park, Republic of Panama. *IUCN Occasional Paper No.6.*
- Lewis, W.H. 1971. High floristic endemism in low cloud forests of Panama. *Biotropica* 3:78-80.
- Myers, C.W. 1969. The ecological geography of cloud forest in Panama. *Amer. Mus. Novit.* 2396:1-52.
- Olson, D.M. 1994. The distribution of leaf litter invertebrates along a Neotropical altitudinal gradient. *J. of Trop. Ecol.* 10:129-150.
- Porter, D.M. 1973. The vegetation of Panama: a review. In: *Vegetation and vegetational history of northern Latin America* (A. Graham, ed.) pp.167-201. Elsevier Scientific Publishing Company.



PANAMA



Cloud Forest Region	Cloud Forest Site	Protected* Yes/No?
Cordillera Central/Serrania de	Cerro Campana	/
	Cerro Santiago	08°30'N/081°46'W
	Cerro Trinidad	/
	North of El Valle de Antón	/
Cordillera de Juradó	Cordillera de Juradó	7°21'N/ 77°57'W
Cordillera de San Blas	Cerro Azul	09°09'N/079°24'W
	Cerro Bruja	09°28'N/079°33'W
	Cerro Jefe	09°14'N/079°22'W
Cordillera de Talamanca	Cerro Pando	08°54'N/082°45'W
	La Amistad	9°09'N/ 82°48'W
	Volcán Barú/Volcan Chiriqui	9°09'N/ 82°48'W
Peninsula de Azuero	Cerro Hoya	07°17'N/080°42'W
Serrania de Pirre	Cerro Pirre	07°52'N/077°43'W
Serrania de(l) Darién	Cerro Malf	/
	Cerro Tacarcuna	08°09'N/077°18'W
Serrania del Sapo	Cerro Sapo	07°57'N/078°23'W
Total No. of CF Regions= 8	Total No. of CF Sites= 16	Total No. of CF Sites with an element of protection = 9

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

Cloud Forest Region Summaries: Panama

Cordillera Central/Serranía de Tabasará

The Central Cordillera or the Serranía de Tabasará (as it is also known) is continuous with the Cordillera de Talamanca (see below) and likewise contains cloud forest sites, including Cerro Santiago, Cerro Campana, Cerro Trinidad and north of El Valle de Antón. Some of these sites are protected by the Altos Campana National Park, which protects a sizeable population of the rare golden frog *Atelopus zeteki* (Myers, 1969; Porter, 1973; IUCN, 1992; Olson, 1994; Cavelier, 1996).

Cordillera de Juradó

This Cordillera is protected by the Darién National Park (see below) and is thought to contain cloud forest (Myers, 1969).

Cordillera de San Blas

There are thought to be many cloud forests, including some of Panama's lowest cloud forest, in region of the Cordillera de San Blas, for example Cerro Azul, Cerro Bruja and Cerro Jefe. Common endemics, such as *Stemmadenia allenii* are known to occur on both Cerro Azul and Cerro Jefe. Protected areas in the region include Portobelo National Park and Metropolitan Natural Park (Myers, 1969; Lewis, 1971; IUCN, 1992).

Cordillera de Talamanca

The Panamanian-Costa Rican boundary bisects this mountain range and as in Costa Rica, the Cordillera de Talamanca in Panama has been declared part of the La Amistad Biosphere Reserve (also a World Heritage Site). The cloud forest in the Cordillera de Talamanca is reputed to be the largest expanse of undisturbed cloud forest in Central America (see Costa Rica). Again as in Costa Rica, the Biosphere Reserve includes protected areas, in this case La Amistad International Park and Volcán Barú. The highest point in the rugged topography of this Reserve, and also in Panama, is Cima del Volcán Barú (also known as the Volcán de Chiriqui) at 3400m. Cerro Pando (2290m) is another known cloud forest site in the mountain range. Due to intermigrations from both North and South America, the Reserve is considered to be the most important and biologically diverse natural area within the country and to contain the largest tracts of virgin forest in Panama. Most of the main crest lies within the

montane rain forest life zone and is characterised by mixed oak forest. In altitudes higher than 900m, it is estimated that there are 40 endemic species of birds and also the only Panamanian population of quetzal *Pharomachrus mocinno*. In addition, six species of amphibians have a distribution restricted to the Cordillera de Talamanca. Colonisation and deforestation are major threats to the area (Myers, 1969; LaBastille, 1973; WCMC unpubl. data).

Peninsula de Azuero

Cerro Hoya is one of a few mountains in the southern part of the Peninsula thought to contain cloud forest. The site is protected as part of Cerro Hoya National Park (Myers, 1969; IUCN, 1992).

Serranía de Pirre

Serranía de Pirre is contained by the Darién National Park (see above). Cerro Pirre (also known as Cerro Cana) at 1200m, is the highest peak in the ridge (Myers, 1969).

Serranía de(l) Darién

Part of this mountain range is included in the Darién National Park (also a Biosphere Reserve and a World Heritage Site), which is thought to be the most extensive protected area in Central America and includes an exceptionally diverse flora and fauna with many species being endemic to the Park. The area is both anthropologically and historically rich. Known cloud forest sites are Cerro Tacarcuna and Cerro Malí. *Oenocarpus panamanus*, *Clusia* spp. and *Quercus humboldtiana* are all common species associated with this habitat. The Serranía de Darién is remarkable for containing some of the lowest known cloud forests. The region is, however, thought to be under pressure from road building, colonisation and associated problems (Porter, 1973; WCMC unpubl. data).

Serranía del Sapo

Serranía del Sapo is included in the Darién National Park (see above). Cerro Sapo (1,145m) is the highest peak (Myers, 1969).



PART TWO

LATIN AMERICA : SOUTH

**Bolivia
Brazil
Colombia
Ecuador
Peru
Venezuela**

BOLIVIA

The combination of an intertropical position and the presence of the Andes results in a wide range of geographical and climatic factors means that Bolivia has a huge variety of ecosystems. These range from very dry lowland forest and desert through very moist tropical rainforest up to snow-covered mountains. Cloud forests are found in high mountain areas known as "Yungas" and down into sub-andean regions. According to a classification developed by Ribera (1992, in Harcourt and Sayer, 1996), highland forests (above 3000m) in the Yungas region make up the upper layer of the very moist cloud forest and Yungas montane semi-moist forest, where the canopy is of medium height and trees are covered with epiphytes. At altitudes below 3000m, forests include the intermediate and lower layers of cloud forest, with trees not exceeding 20m in height. Below this level the forests, which are rich in species are in an advanced state of degradation and pressure on the cloud forests is growing. According to data from Bolivia's Conservation Data Centre the area of cloud forest and Yungas semi-moist forest is estimated at 28,092sq.km (Harcourt and Sayer, 1996).

Latitudinal variations produce wide differences in climate from north to south, with a typical tropical region in the north, a subtropical-temperate region in the south and a wide transitional zone between them. Consequently towards the south, cloud forest tends to include more subtropical-temperate species. The forests are characterised by a great structural complexity and enormous diversity of flora, much of which has not been scientifically described, with the richest concentration of flowering plants found in the sub-andean and montane cloud forests. There is also great diversity of fauna, although many vertebrates are endangered or threatened with extinction.

Under the General Forest Act of 1974, the Centre for Forest Development (CDF) was established with full power to protect and manage the forest system. However despite legislation, implementation is poor and many forest areas, including those set aside for protection have been harvested unsustainably or cleared for cultivation. In addition, until recently the legal foundation for protected areas was incomplete, and many ecosystems and species have inadequate protection. However recent efforts have been made to develop and establish a National Protected Areas System (NPAS) under the administration of a single organisation, the National Secretariat for the Environment, (SENMA).

The cloud forests have an important role in watershed protection, and many local communities depend on them for a variety of resources. However, they remain under severe pressure from the expansion of agriculture and colonisation, as in many other South American countries. The development of Community Forestry programmes in the highlands with local populations have aimed to reduce the removal of tree cover, by illustrating how trees can be managed as part of farming systems to provide both environmental and social benefits.

References

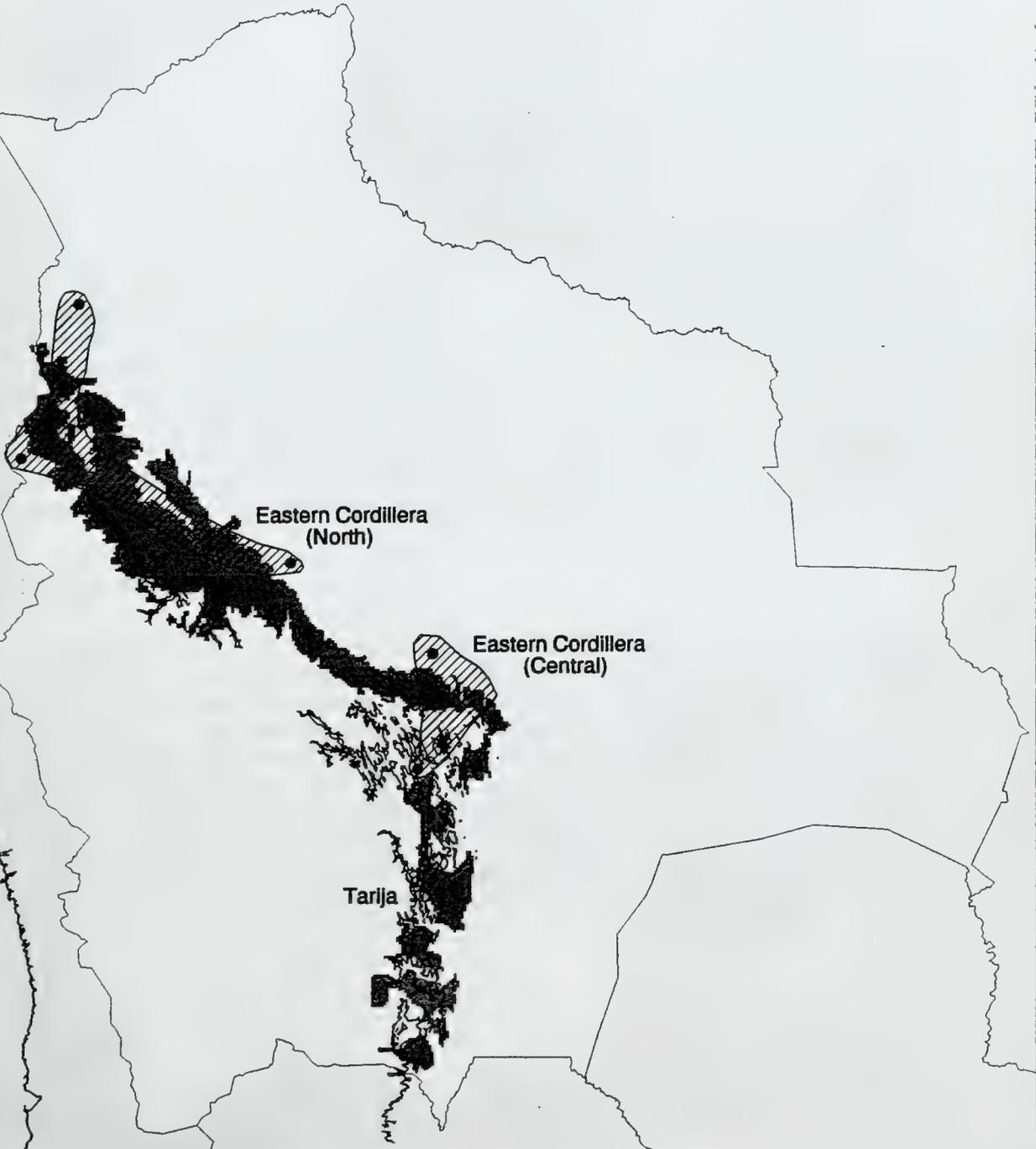
- DNCB. 1995. Sistema Nacional de Areas Protegidas (SNAPO). Unpublished.
- Ergueta, P., Galarza, Y., Liberman, K. and Liberman, C. 1995. Catálogo de áreas protegidas de Bolivia, VI. Directorio de Consulta sobre Areas Protegidas. La Paz. Bolivia.
- Harcourt, C.S. and Sayer, J.A. (ed.) 1996. *The Conservation Atlas of Tropical Forests: The Americas*. Simon and Schuster.
- Mansour, J. 1995. *Parks in Peril Source Book*. The Nature Conservancy, Arlington. Virginia, USA.
- Wege, D. and Long, A. 1995. *Key Areas for Threatened Birds in the Neotropics*. BirdLife Conservation Series No. 5.

BOLIVIA



0

350 km



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Eastern Cordillera (Central)	Amboró	17°45'S/ 63°52'W	Yes
	Carrasco	17°16'S/ 64°24'W	Yes
Eastern Cordillera (North)	Isiboro Sécure	16°12'S/ 66°03'W	Yes
	Madidi	13°10'S/ 68°30'W	Yes
	Palmares de Pasopaya-Presto-Rodeo	18°37'S/ 64°35'W	No
	Ulla Ulla	14°58'S/ 69°11'W	Yes
Tarija	Tariqufa	20°00'S/ 64°30'W	Yes
Total No. of CF Regions= 3	Total No. of CF Sites= 7	Total No. of CF Sites with an element of protection = 6	

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

Cloud Forest Region Summaries: Bolivia

Eastern Cordillera (Central)

Like the northern section, the central portion of the Andean Cordillera possess a rugged relief with mountains and deep, narrow valleys. Cloud forest lies on the upper eastern slopes between 2200 and 3500m. However vegetation is transitional between moist and dry montane forests moving towards the subtropical-temperate zone to the south. As a result it is very diverse. Typically cloud forest containing tree species such as *Weinmannia boliviana*, *Alnus acuminata*, and *Podocarpus* spp., along with tree ferns *Cyathea* spp. is found adjacent to palms and temperate cactus woodland in arid intermontane valleys (DNCEB, 1995; Wege, D. and Long, A., 1995). Large numbers of mammals are found, including threatened species such as spectacled bear *Tremarctos ornatus*, jaguar *Panthera onca* and giant anteater *Myrmecophaga tridactyla*. Between 600 and 700 hundred bird species have been recorded, amongst them threatened species such as the red-fronted macaw *Ara rubrogenys* and both ashy *Myrmotherula grisea* and yellow-rumped *Terenura sharpei* antwrens. As a result these forests have provided income to the area through small-scale ecotourism, in addition to their value for local use and water regulation. Protection of cloud forest in this area is variable, ranging from the cloud forest of Siberia in the publicly owned Amboró National Park, through the privately owned Carrasco Ichilo (National Park) to currently unprotected areas such as Palmares de Pasopaya-Presto-Rodeo, which is considered a priority site for conservation. However forests in all these areas are threatened by a combination of incoming settlers, hunting and logging, often at unsustainable levels. The logging of timber concession areas for mahogany *Swietenia macrophylla* exacerbates the problem by opening up new roads, which in turn attract colonisers further up towards the fragile cloud forests. Recent correspondence claims that half a million acres (including all the cloud forest) of forest has been cleared with Government approval (Robin Clarke Gemuseus, pers. comm).

Eastern Cordillera (North)

Running south-east from the Peruvian border the northern end of the Eastern Cordillera is where the more tropical forest is found in Bolivia. This region has a very rugged relief mountain peaks separated by deep, narrow river valleys. Cloud forest is found in the high mountain or 'Yungas' portion, usually above 2600m on both western slopes which run down to the Atliplano, and eastern slopes which lead into the Amazon basin. The main tree species include *Juglans boliviana*, *Alnus acuminata* and *Podocarpus* spp. and *Polylepis racemosa* above the closed forest line. In addition to high plant diversity, many mammals are found in association with cloud forest areas including the Jaguar *Panthera onca* and Spectacled Bear *Tremarctos ornatus*. Hundreds of bird species have been recorded, including the Southern Helmeted Curasow *Pauxi unicornis* and Yellow-rumped Antwren *Terenura sharpei* (Erguata

et al. 1995) which are both threatened. Some of the cloud forest is within larger protected areas which include a range of habitats across the Cordillera, such as Ulla Ulla which borders Perú, and Isiboro-Secure, whilst other areas have been proposed for protection such as Madidi. Ownership is variable, some public, some privately or local community owned, as a wide range of Indian groups or "Cultures" inhabit the area. Some areas contain archaeological sites of importance, and in addition to sustaining local populations, the cloud forests regulate water supply and protect the headwaters of numerous rivers. Colonisation by illegal settlers is poorly controlled, leading to excessive forest exploitation, illegal hunting and fishing. Overgrazing by domestic livestock and the spread of fire from adjacent high altitude grassland are constant threats, and there is a risk of pollution from the activities of oil exploration and gold mining.

Tarija

The central valley of Tarija lies in the south of Bolivia, close to the border with Argentina. Within the tropical belt the climate is rather arid, although forests on the humid eastern slopes can be referred to as cloud forest. At altitudes up to 3500m the forest dominated by *Alnus acuminata* reflects the sub-tropical to temperate climate. A valuable habitat for both mammals, including spectacled bear *Tremarctos ornatus* and north andean huemul *Hippocamelus antisensis*, and threatened birds such as the rufous-throated dipper *Cinclus schulzi* and rufous-bellied saltator *Saltator rufiventris* much of the forest is within the Tariquía National Reserve. Cloud forest in this area plays an important role in watershed protection for a number of rivers and supports several adjacent communities, although encroachment is causing problems and several road projects which threaten the reserve are under consideration (Mansour, 1995).

BRAZIL

Information on the biogeography of the tropical mountains of Brazil is very restricted and fragmented (Ab'Saber (1989), in Falkenberg and Voltolini, 1993). However the information available suggests that cloud forest is found in two main areas within Brazil. The majority is found in the mountain ranges which run along the south-eastern Atlantic coast, with a small amount in the Guyana Highlands which border Venezuela and Guyana to the north. In small patches or narrow strips, many are an intermediate forest type between more extensive forest or grassland ecosystems.

Environmental legislation appears to give good protection to these forests within conservation codes or under the Forest Code (1965). However, in practice the legislation is rarely obeyed. As part of a national conservation strategy some cloud forests have been demarcated for protection, but many only exist as "paper reserves" which have no funding or site protection.

References

- Falkenberg, D. and Voltolini, J. 1993. The Montane Cloud Forest in Southern Brazil. In L. Hamilton *et al.* (Eds.) Tropical Montane Cloud Forests: Proceedings of an International Symposium. East-West Center, Hawai'i, USA.

BRAZIL



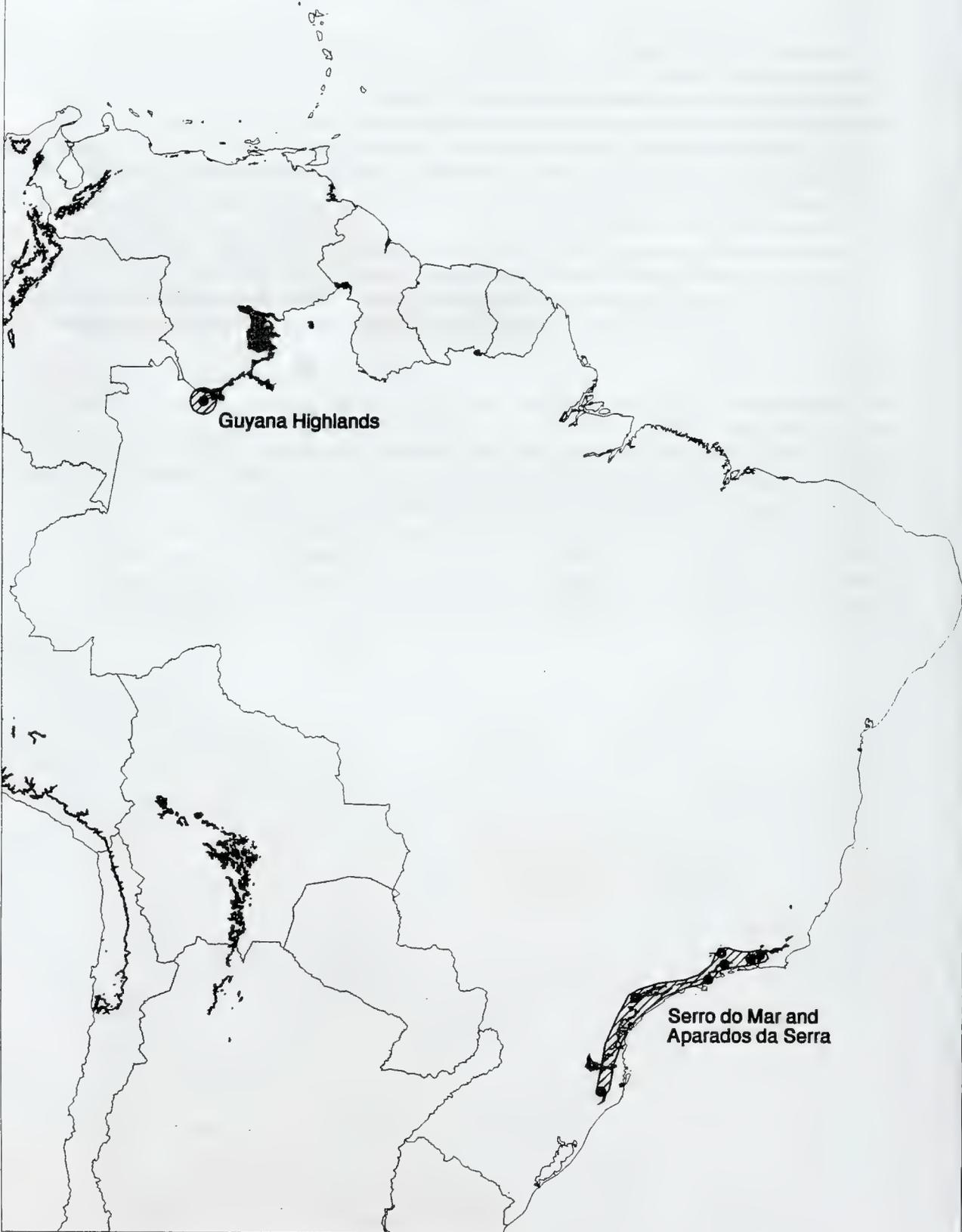
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1000 km



Guyana Highlands

Serro do Mar and
Aparados da Serra



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Guyana Highlands	Pico da Neblina	0°20'N/ 66°02'W	Yes
Serro do Mar and Aparados da Serra	Bairro de Corcovado	23°28'S/ 45°10'W	Yes
	Fazenda Intervalas	24°14'S/ 48°09'W	Yes
	Itatiaia	22°23'S/ 44°38'W	Yes
	Sao Joaquim	28°08'S/ 49°33'W	Yes
	Serra do Bocaina	22°50'S/ 44°30'W	No
	Serra do Tinguá	22°36'S/ 43°25'W	Yes
	Serra dos Orgaos	22°28'S/ 43°03'W	Yes
Total No. of CF Regions= 2	Total No. of CF Sites= 8	Total No. of CF Sites with an element of protection = 7	

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

Cloud Forest Region Summaries: Brazil

Serro do Mar and Aparados da Serra Geral

The high elongated mountain ridge of Serro do Mar is found on the south-east Atlantic coast of Brazil in the states of Santa Catarina and Paraná. It is composed of metamorphic rocks dating back to the Precambrian age. The Serra Geral is further south in the states of Santa Catarina and Rio Grande do Sul, and is formed from volcanic rocks of the Cretaceous age. A vast plateau, its easternmost limit is characterised by vertical cliffs and deep, steep-walled valleys.

Both areas are covered almost daily by orographic cloud or fog ("cerração" or "viração"), formed by the ascent of warm and moist oceanic winds that cool and condense at higher altitudes. Annual rainfall is generally above 1500mm (Falkenberg and Voltolini, 1993).

Areas of cloud forest are found in both locations, either as a narrow belt, or as small spots. Rarely differentiated as a single vegetative type, the cloud forest is often found as a transition between hillside Atlantic forest and *Araucaria* pine forest, or as an intermediary belt between Atlantic forest and the high altitude fields where grassland with isolated shrubs replaces forest (Falkenberg and Voltolini, 1993).

Sites in the Serro do Mar locality include Serra dos Orgaos, Serra do Tingua, Serra do Bocaína, Itatiaia, Bairro de Corcovado and Fazenda Interales. Generally in this area, the forest changes at 1150m into cloud forest up to 1350m where the grassland begins. Further south on the Aparados and within the Sao Joaquim National Park, the cloud forest forms a narrow belt between 700 and 1100m.

In general, these forests are dominated by small trees (6-8m) and shrubs which have an incredible abundance and diversity of epiphytes (including orchids and bromeliads). However there are floristic differences between the two areas, with Serro do Mar supporting a number of south Brazilian endemic tree species, including *Myrcia rupicola* and *Psidium spathulatum*. Aparados has endemics of its own, including *Mimosa balduinii* and *Euplassa nebularis*. Fifteen species of ferns are considered exclusive to the southern cloud forest, including one endemic, *Polyodium subinaequale*. Large numbers of mosses, lichens and lianas are also found, and play a vital role in water retention in the canopy. No published faunal surveys exist, but some highly endangered species use this forest as a refuge, including puma *Felis concolor*, harpy eagle *Harpia harpyja* (Falkenberg and Voltolini, 1993).

Many of the cloud forests appear to be under some sort of protection, within the boundaries of national parks or other "reserves". However few actually receive effective protection and

the only relatively well-established reserve is the Parque Nacional de Aparados da Serra. Pressures include clearance for pasture and pine plantations, firewood cutting and damage from fire which has spread from burning of the adjacent grasslands. In some areas there has been heavy extraction of tree fern *Dicksonia sellowiana* for floriculture and gardening purposes (Falkenberg and Voltolini, 1993).

Guyana Highlands

Found on the frontier with Venezuela and Guyana, this area contains the only true Amazonian "montane" formations, at altitudes above 1800m. The main cloud forest area is found on the slopes of Pico da Neblina, and has high floral diversity and a huge degree of endemism. The stunted forest is carpeted with mosses, *Sphagnum* spp. and contains carnivorous plants, *Heliamphera* spp and several species of orchid.

COLOMBIA

In Colombia, the Andes form three cordilleras - Occidental (western), Central and Oriental (eastern) - with their axes running parallel south to north. They are separated by the long, deep longitudinal valleys of the Magdalena and Cauca rivers. Most of the country's remaining montane forests are found in the western and eastern cordillera regions, although there are other important areas in more isolated mountain ranges. There has been considerable deforestation over the last 50 years, at its greatest in the Central Cordillera, with the main causes being shifting cultivation and colonisation. Despite this, the country has large areas of pristine forest and there is recent evidence of some highly innovative forest conservation programmes (Harcourt and Sayer, 1996).

The upper montane forests which remain are found on steep areas of the cordilleras and other mountain ranges at altitudes over 2000m up to between 3200 and 3800m depending on their location. It is largely due to their elevation and inaccessibility that they remain. These include cloud forests - in many cases mist is frequent, and there are abundant epiphytes and Angiosperms such as Bromeliaceae, Orchidaceae and Begoniaceae which cover the trunks and branches of the trees. Biotic diversity in these forests is high, including 15 percent of all orchid species found in the world. Over 1500 bird species are recorded of which 46 moist forest species are threatened (WCMC, 1992; Collar *et al.* 1992).

In addition isolated low-altitude cloud forests with the physiognomy of upper montane forests, are found on the Caribbean coast both in Colombia and Venezuela on summits of mountains less than 1000m high.

A particular threat to the remaining primary montane forests is the illegal cultivation of *Papaver somniferum* for the production of opium, morphine, and heroin. It is estimated that c.50,000 ha was deforested during 1991-92 (Cavelier and Etter, 1995).

Despite the existence of legislation relating to forest conservation, in reality there is no effective strategy for its implementation. The forests are still at risk as private ownership is possible within the parks and regulations are often poorly enforced. In particular, specific measures for conservation of cloud forest or montane forest areas are lacking, and the importance of sustainable management is only slowly being realised. It is widely felt that the acquisition of areas by committed private people or NGOs is the only safeguard for conservation (Wolf, 1994). Indeed an increasing number of private reserves are being established and protected from colonisers, and efforts are being made to work with the owners of these areas to set up a network of private reserves.

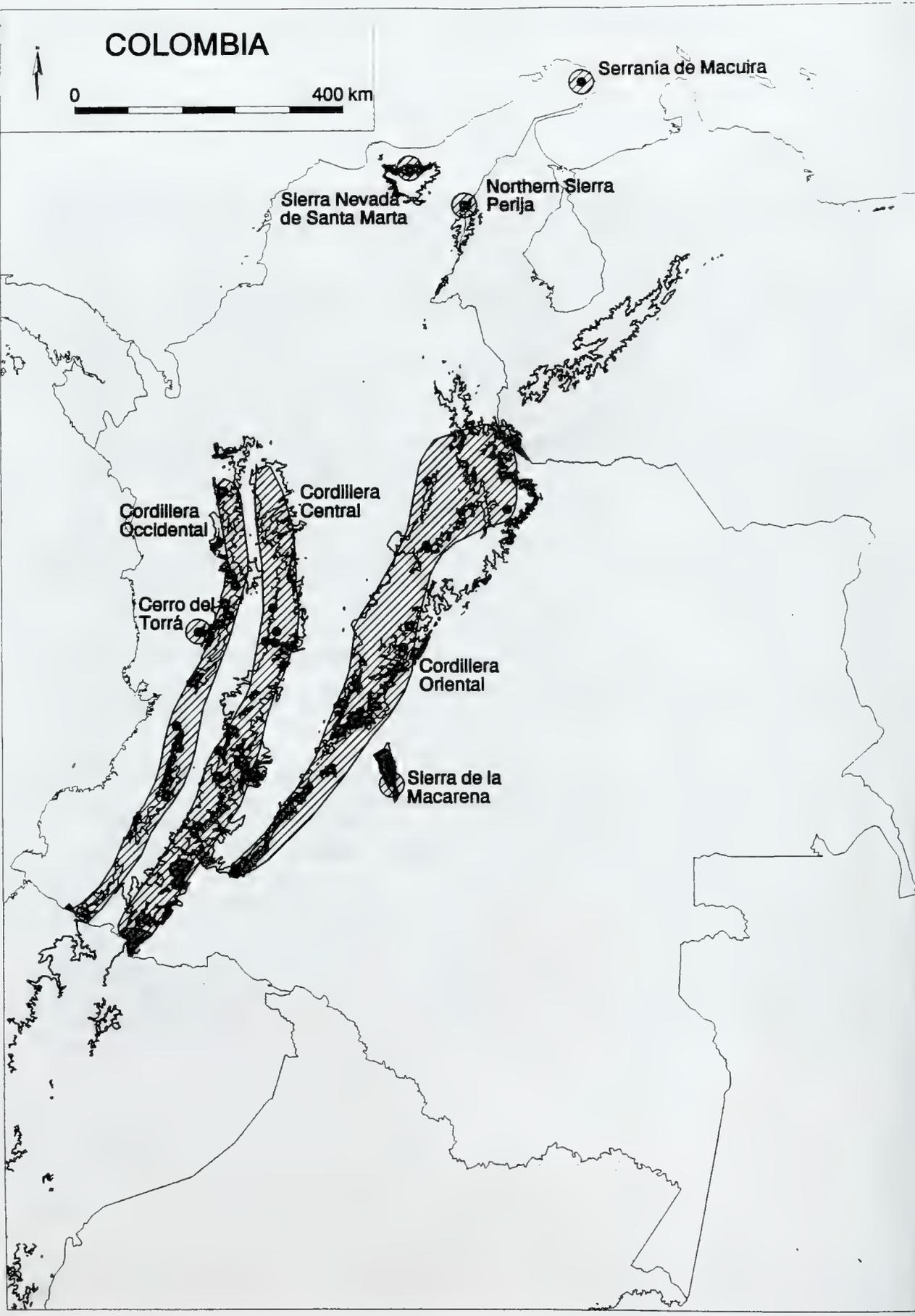
References

- Cavelier, J. and Etter, A. 1995. Deforestation of Montane Forests in Colombia as a result of illegal plantations of Opium. *Biodiversity and Conservation of Neotropical Montane Forests*, pp.541-550, Edited by Steven P. Churchill et al. New York Botanical Garden.
- Cavelier, J. and Mejia, C.A. 1990. Climatic factors and tree stature in the elfin cloud forest of Serrania de Macuira, Colombia. *Agricultural and Forest Meteorology* 53: 105-123.
- Harcourt, C.S. and Sayer, J.A. (Eds.). 1996. The Conservation Atlas of Tropical Forests: The Americas. Simon and Schuster.
- Hofstede, R.G.M., Wolf, J.H.D. and Benzing, D.H. 1993. Epiphytic biomass and nutrient status of a Colombian Upper Montane Rain Forest. *Selbyana* 14: 37-45.
- Kattan, G.H., Alvarez-López, H. and Giraldo, M. 1994. Forest Fragmentation and Bird Extinctions: San Antonio Eighty Years Later. *Conservation Biology* 8(1): 138-146.
- INDERENA, 1984. Colombia: Parques Nacionales. Bogotá, Colombia.
- Silverstone-Sopkin, P.A. and Ramos-Perez, J.E. 1995. Floristic exploration and Phytogeography of the Cerro del Torrá, Chocó, Colombia. *Biodiversity and Conservation of Neotropical Montane Forests*, pp.169-186, Edited by Steven P. Churchill et al. New York Botanical Garden.
- Sugden, A.M. 1982a. The ecological, geographical and taxonomic relationships of an isolated Colombian cloud forest, with some implications for island biogeography. *Journal of the Arnold Arboretum* 63: 31-61.
- Webster, G.L., 1995. The Panorama of Neotropical Cloud Forests. *Biodiversity and Conservation of Neotropical Montane Forests*, pp.53-77, Edited by Steven P. Churchill et al. New York Botanical Garden.
- Wege, D. and Long, A. 1995 *Key Areas for Threatened Birds in the Neotropics*. BirdLife Conservation Series No. 5. BirdLife International, Cambridge, UK.
- Wolf, J.H.D. 1994. Towards the Conservation of Montane Cloud Forests and Páramo Vegetation in the Los Nevados area, Central Cordillera, Colombia. Unpublished.

COLOMBIA



0 400 km



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Cerro del Torrá Cordillera Central	Cerro del Torrá	4°46'N/ 76°29'W	No
	Alto Quindío	4°36'N/ 75°28'W	No
	Finca Guayaquil	/	No
	Los Nevados	4°46'N/ 75°27'W	Yes
	Nevado de Huila	2°59'N/ 75°58'W	Yes
	Puracé	2°09'N/ 76°31'W	Yes
	Río Blanco Watershed	5°04'N/ 75°30'W	No
Cordillera Occidental	Ucumari	4°38'N/ 75°36'W	No
	Alto de Pisones	5°23'N/ 76°00'W	No
	Alto de los Galápagos	4°52'N/ 76°12'W	No
	Cerro Tatamá	4°59'N/ 76°05'W	Yes
	Cerro de San Antonio	3°30'N/ 76°48'W	No
	Las Orquídeas	6°39'N/ 76°09'W	Yes
	Los Farallones de Cali	3°12'N/ 76°46'W	Yes
	Munchique	2°33'N/ 76°57'W	Yes
	Santa Helena	3°09'N/ 76°14'W	No
	Cerro Carare	5°54'N/ 73°26'W	No
Cordillera Oriental	Cuchilla del Ramo	6°47'N/ 73°25'W	No
	Cueva de los Guácharos	1°34'N/ 76°00'W	Yes
	Monterredondo	4°17'N/ 73°48'W	No
	Páramo de Chingaza	4°32'N/ 73°44'W	Yes
	Páramo de Tamá	7°24'N/ 72°26'W	Yes
	Sierra Nevada del Cocuy	6°24'N/ 72°21'W	Yes
	Valle de Jesús forest	4°49'N/ 73°40'W	No
	Cerro Pintado	10°29'N/ 72°55'W	No
Northern Sierra de Perija Serranía de Macuira	Serranía de Macuira	12°09'N/ 71°20'W	Yes
	Sierra Nevada de Santa Marta	10°59'N/ 73°38'W	Yes
Sierra de la Macarena	Sierra de la Macarena	2°44'N/ 73°55'W	Yes

Total No. of
CF Regions= 8

Total No. of
CF Sites= 28

Total No. of CF Sites with
an element of protection = 14

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

Cloud Forest Region Summaries: Colombia

Cerro del Torrá

Located in the Departamento del Chocó in Western Colombia, Cerro del Torrá (c. 2800m) is part of the Cordillera de San Miguel, which lies to the west and is distinct from the main Cordillera. However research shows a significant phytogeographical affinity with the Cordillera Occidental (Silverstone-Sopkin and Ramos-Perez, 1995). Being within Chocó, which has the highest floristic diversity per unit area in the world (Gentry, 1986) makes the mountain of particular botanical interest. There are two distinctive cloud forest types. Moist cloud forest is found between 1600 and 2500m, with bryophytes covering trunks and branches, abundant ferns and Clusiaceae. There is also a high diversity of orchids and other epiphytes. Canopy tree height decreases from c. 30m at 1600m to 12m at 2500m, where it is dominated by small trees including *Podocarpus* spp. and palms. At altitudes between 2500 and 2730m on steep terrain below the summit ridge, dwarf cloud forest with a relatively low floral diversity is found, which is dominated by *Clusia* at between 3 and 6m, with emergent *Geonoma* palms and abundant bryophytes (Silverstone-Sopkin and Ramos-Perez, 1995).

Cordillera Central

Fragments of cloud forest are found scattered along the western slopes of the Central Cordillera. Upper montane (cloud) forest is usually found between 2000 and 3700m, bordering the lower edge of the subalpine dwarf forests and paramo.

Cordillera Occidental

Patches of relatively isolated cloud forest remain along the western slopes of the Cordillera Occidental which possess a rugged relief with steep slopes and sharply cut mountains. Bordering the Chocó region, some are pristine areas with high floristic diversity, whilst others are more fragmented. They range from areas within larger National Parks such as Cerro Tatamá, Las Orquídeas, Los Farallones de Cali and Munchique, to smaller unprotected areas including Alto de los Galapagos, Alto de Piscones, Cerro de San Antonio and Santa Helena. Mainly broadleaved, the cloud forests are commonly found between 1500 and 3500m and include *Quercus humboldtii* along with species of *Podocarpus*, *Cinchona* and *Weinmannia*. In Las Orquídeas there are many species of orchids, particularly of the genera *Angulosa*, *Elleanthus* and *Cattleya*. Bird diversity is high, including threatened species such as the long-wattled umbrellabird *Cephalopterus penduliger* and *Buthraupis* spp. (Wege and Long, 1995). Other highly diverse fauna include bats, marsupials, primates and mammals,

amongst them endangered species such as the spectacled bear *Tremarctos ornatus* and the red howler monkey *Alouatta seniculus*. Cloud forest areas, including those in the Parks, are under pressure from illegal settlement and subsequent conversion of areas for agricultural land. Some, including those around Cerro de San Antonio are isolated forest fragments in a matrix of small farms and suburban houses (Kattan *et al.* 1994). Munchique and the adjacent Tambito private reserve are also threatened by construction of a hydroelectric plant and proposed highway development (Wege and Long, 1995). Almost total destruction of forest in the valleys below means that remaining forest is of great value in terms of biodiversity and watershed conservation, in addition to sustainable use by local communities.

Cordillera Oriental

Cloud forests are commonly found on the eastern slopes of the Oriental or eastern Cordillera, which is one of the main areas where primary forest remains (Cavalier and Etter, 1995). In the north where the highest peaks are found, two areas, Sierra Nevada del Cocuy and Páramo de Tamá (adjacent to El Tamá National Park in Venezuela) contain cloud forest at altitudes between 2300 and 3700m. Main tree species include *Podocarpus respligiosii* and *Weinmannia* spp. and these areas harbour numerous plant and animal species endemic to Colombia. Mammals include brazilian tapir *Tapirus terrestris* and the common woolly monkey *Lagothrix lagothrica*. The endangered northern helmeted curassow *Pauxi pauxi* is also found Cocuy. Both areas contain the sources of important rivers, and are under legal protection as National Parks in theory, although in practice there is little control (Wege and Long, 1995). Small fragments of humid subtropical and temperate oak-Lauraceae forest such as Cuchilla del Ramo and Cerro Carare (both unprotected) are found on the western slopes. These are habitat for threatened bird species, and under pressure from surrounding crop cultivation (Wege and Long, 1995). In the central portion of the eastern slopes, close to Bogota a belt of cloud forest is found which includes Valle de Jesús communal reserve, Páramo de Chingaza (containing Chingaza National Park) and unprotected areas close to Monterredondo. Found extending down to a slightly lower altitude, c.2000m the main tree species in these areas include *Weinmannia macrophylla* and the endangered *Podocarpus oleifolius*. Chingaza especially, is rich in bird species, some threatened such as the rusty-faced parrot *Hapalopsittaca amazonia* and flame-winged parakeet *Pyrrhura calliptera*. Only the truly inaccessible areas are truly safe as private ownership and encroachment threaten effective protection, and an enlargement of the Chingaza National Park has been proposed by Fundación Natura to include adjacent reserves (Wege and Long, 1995). Further south on the western slopes of the eastern Andes, cloud forest forms an important part of Cueva de los Guácharos National Park which protects the headwaters of the Suaza River. The area contains the last stand of nearly pristine broadleaf montane forest in Colombia which contains *Quercus humboldtii* and *Cedrela* spp., moving through cloud forest to páramo at 2600m (INDERENA, 1984). Mammals include the threatened spectacled bear *Tremarctos ornatus*, mountain tapir *Tapirus pinchaque* and the common woolly monkey *Lagothrix lagothrica*. The area is

increasingly threatened by human encroachment and opium production, and there is illegal logging (Wege and Long, 1995).

Northern Sierra de Perija

In Northern Colombia, the Sierra de Perijá is contiguous with the National Park of the same name in Venezuela, although in Colombia it is not under any protection. It contains relatively intact cloud forest on the upper slopes of Cerro Pintado (3000m), which is a valuable habitat for the threatened bird species, the northern helmeted curassow *Pauxi pauxi* which is under pressure from local hunters (Wege and Long, 1995).

Serranía de Macuira

The Guajira Peninsula forms the north-eastern tip of Colombia on the Caribbean coastline. An unusual "dry" elfin cloud forest is found on the coastal range of the Serranía de Macuira which contains three peaks, the highest at 865m. This cloud forest is divided into three islands at relatively low altitude, 500-550m on the windward side and 600-650m on the leeward side of the mountains and is surrounded by a dry deciduous forest (Cavelier and Mejia, 1990). It is also unusual because rainfall is very low, and virtually all the precipitation is due to condensation from clouds. During the daytime the clouds remain above the highest peaks, decreasing radiation, air temperature, relative humidity and evaporation in relation to the surrounding lowlands. At night the clouds come into contact with the forest canopy surrounding water through mist and fog interception. The constant cloud cover provides the high humidity which allows relatively mesophilous plants to survive (Sugden, 1982a, 1982b in Webster, 1995). Prominent tree species include *Croton xanthochloros* and *Terminalia amazonia* with a canopy height of 12-15m. There are numerous epiphytes, but floral diversity is low, with only one endemic species *Cordia macuirensis*. The cloud forest areas are contained within the Macuira National Park, and although there is some pressure from livestock grazing, much of the forest is undisturbed.

Sierra Nevada de Santa Marta

The Sierra Nevada de Santa Marta lies some 250km south-west of Macuira along the Caribbean coast. Often considered as part of the Central Cordillera, it is in fact an isolated massif containing the highest mountain in Colombia, Cerro Simón Bolívar at 5879m. A wealth of biodiversity combined with its isolation have resulted in the evolution of a large number of endemic species, including some found only in montane forest areas. The forest has been under changing pressures, initially from campesinos fleeing violence in other parts

of the country and displaced Indian communities. In the 1970s the area became a guerilla stronghold, and as a result is relatively underexplored (Harcourt and Sayer, 1996). Designated both a National Park and Biosphere Reserve the forests provide important protection for the watersheds of five rivers.

Sierra de la Macarena

Found in a mainly low altitude region to the east of the Andes, which extends into the Amazon Basin, the large isolated massif of Sierra de la Macarena is considered to be the western extreme of the Guyana highlands (Harcourt and Sayer, 1996). Deep valleys are separated by tablelands or tepuis and mountain peaks which rise to 2500m. The major vegetation type is moist broadleaf forest, some of which is considered cloud forest. Fauna is highly diverse with threatened mammals including the long haired spider monkey *Ateles belzebuth* and the giant otter *Pteronura brasiliensis*, and birds such as the spot-winged Parrotlet *Touit stictoptera*. Part of the Sierra de la Macarena National Park, the area is mainly under national ownership, with 10% in private ownership. Under pressure for logging, half the forest has been cut and the remainder, at higher altitudes is highly threatened (Wege and Long, 1995).

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, particularly 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.

References

- Barnett, A. 1988. Rio Mazan - A People's Forest. *The Ecologist* Vol. 18, No. 2.
- Dodson, C. and Gentry, A.H. 1991. Biological extinction in western Ecuador. *Annals of the Missouri Botanical Garden* 78: 273-295.
- Downer, C.C. 1996. The mountain tapir, endangered 'flagship' species of the high Andes. *Oryx*, Vol 30, No 1.
- Harcourt, C.S. and Sayer, J.A. (Eds.) 1996. *The Conservation Atlas of Tropical Forests: The Americas*. Simon and Schuster.
- Horwell, D. 1988. *Galapagos: the enchanted isles*. Dryad Press, London.
- Mansour, J. 1995. *Parks in peril source book*. The Nature Conservancy, Arlington, Virginia, USA.
- Parker T.A. and Carr, J.L. [Eds] 1992 *Status of forest remnants in the Cordillera de la Costa and adjacent areas of south-western Ecuador (Rapid Assessment Program)*. Washington, D.C.: Conservation International.
- Toyne, E.P. and Jeffcote, M. (1996) *Notes on cloud forests in Southern Ecuador* (unpublished).
- Wege, D. and Long, A.(1995) *Key Areas for Threatened Birds in the Neotropics*. BirdLife Conservation Series No. 5.
- Zorrilla, C. (1996) *Notes on the Intag Cloud Forest Reserve* (unpublished).

ECUADOR



GALAPAGOS ISLANDS



Cordillera Occidental

Orientales Cordillera Real de los Andes

 Cordillera de la Costa

Cordillera Oriental

Cajas Mountain

Saraguro

Chilia Mountains

South and West Loja Province

Cordillera del Condor

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°01'S/ 78°38'W	No	
Cordillera de la Costa	Machalilla	1°39'S/ 80°41'W	Yes	
Cordillera del Condor	Chinapinza	3°59'S/ 78°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°21'W	Yes	
Orientales Cordillera Real de los	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/ 79°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: Ecuador

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 recreational 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

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 and 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 3750 on the wetter eastern slopes. The upper half is of low stature, c.5m and is dominated by *Nerolepis* 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 disappearing 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 fluvial 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 Mutilus (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 abundant 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 essentially 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).

PERU

Peru possesses the longest mountain chain in the Andes, running North-South down the length of the country. This central portion, the Sierra, includes three mountain ranges, the Cordillera Occidental, Cordillera Central and Cordillera Oriental, and the valleys and plateau country which run between them. This area has been settled for a considerable time, once the centre of the ancient Inca empire, and now home to much of the country's Indian population. As result of intense and prolonged clearance and cultivation most of the natural forest is degraded or entirely lost (Harcourt and Sayer, 1996).

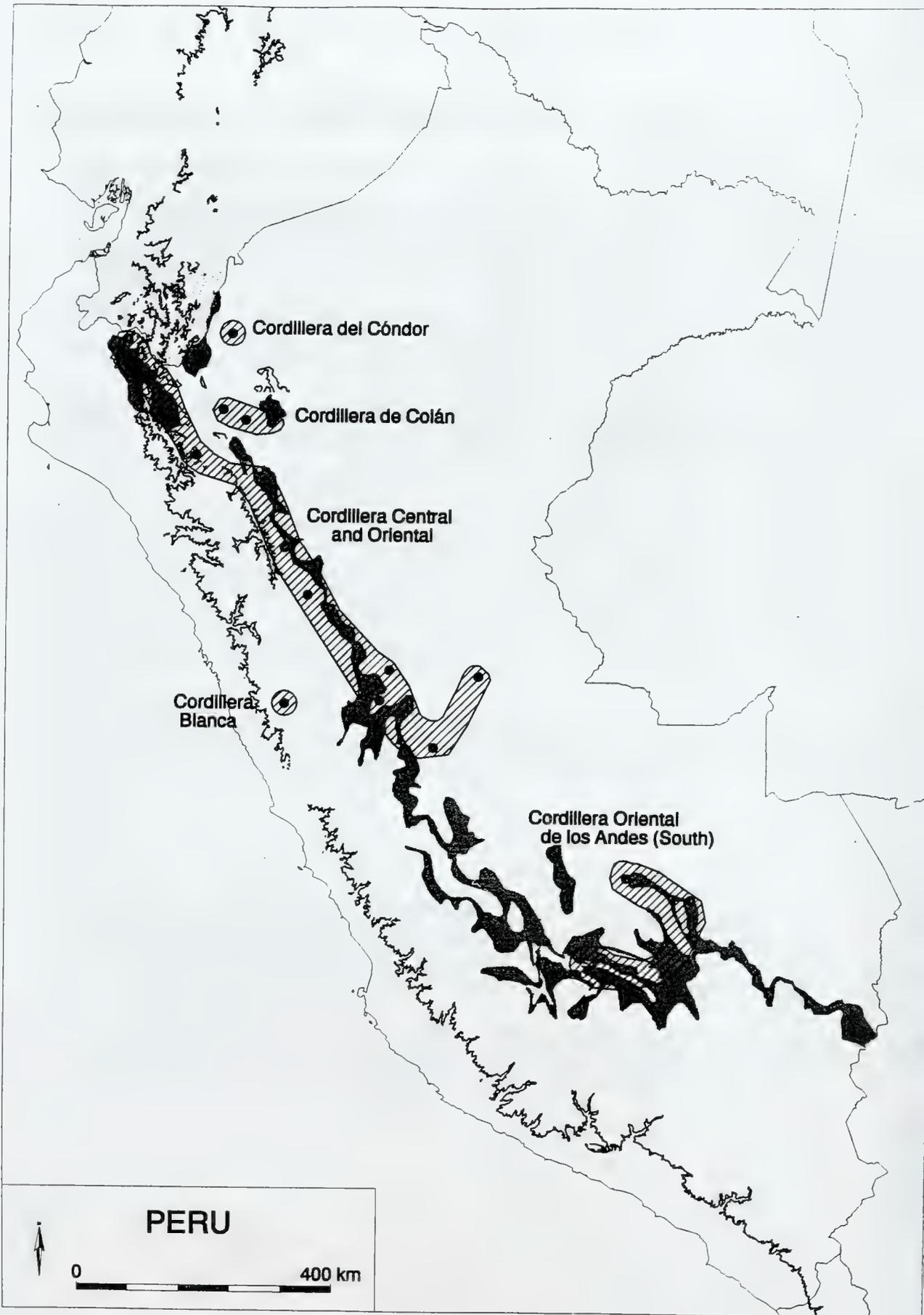
Cloud forests in Peru occur on the eastern slopes of the Andes, at altitudes between 1500 and 3500m. Whilst some fragments lie within the Sierra region, a large proportion are found on the slopes of the Cordillera Oriental in the transitional high Selva which is a belt of forest c.100km wide which runs between the Andes and the lowland rainforest further to the east in the Amazon basin. The cloud forests in the High Selva are exceptionally diverse, and contain a large number of endemic plants (especially orchids), birds and mammals many of which are threatened. However these forests are under intense pressure from poverty-stricken migrant Indians moving into the area from the already deforested Sierra in search of land. Relatively small portions of forest are legally protected in national parks, reserves and sanctuaries, and other categories although in practice the forests are still at risk from unsustainable utilisation. Further priority areas which were proposed for the conservation of biodiversity in 1990 (Harcourt and Sayer 1996), have yet to be gazetted.

The development of sustainably managed communal reserves in which subsistence hunting and extraction by indigenous people are permitted, but logging is forbidden, is required in order that the important functions of the cloud forest in conserving both soil and water are maintained.

References

- Butchart, S.H.M., Barnes, R., Davies, C.W.N., Fernandez, M. and Seddon N. 1995. Threatened mammals of the Cordillera de Colán, Peru. *Oryx*. 29 (4): 275-281.
- Castro, J.M., Silva, V. and Valencia, F.R. 1990. Parque Nacional Huascarán. Plan maestro-resumen ejecutivo. Prepared with the support of the Programa de Desarrollo Forestal Canada-Peru.
- Collar, N.J., Gonzaga, L.P., Krabbe, N., Madroño-Nieto, A., Naranjo, L.G., Parker, T.A. and Wege, D.C. 1992 *Threatened Birds of the Americas: The ICBP/IUCN Red Data Book*. International Council for Bird Preservation, Cambridge, UK.

- Collar, N.J., Crosby, M.J. and Stattersfield, A.J. 1994. *Birds to watch 2: the world list of threatened birds*. BirdLife Conservation Series No. 4. BirdLife International, Cambridge, UK.
- Harcourt, C.S. and Sayer, J.A. (Eds.) 1996. *The Conservation Atlas of Tropical Forests: The Americas*. Simon and Schuster.
- Leo, M. 1980. First field study of the yellow-tailed woolly monkey. *Oryx* 15 (4): 386-389.
- Narvaez, R.S. 1989. Rio Abiseo National Park. World Heritage nomination. Oficina Nacional de Evaluacion de Recursos Naturales. 1976. *Mapa ecologica del Peru y guia explicativa*. ONERN, Lima.
- Young, K.R., Church, W.B., Leo, M. and Moore, P.F. 1994. Threats to Rio Abiseo National Park, Northern Peru. *Ambio* 23 (4-5): 312-314.
- Young, K. and Leon, B. 1989. Vegetacion del a zona alta del Parque Nacional del Rio Abiseo. *Revista Forestal del Peru* 15 (1): 3-20.
- Wege, D. and Long, A. 1995. *Key Areas for Threatened Birds in the Neotropics*. BirdLife Conservation Series No. 5. BirdLife International, Cambridge, UK.



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Cordillera Blanca	Huascarán	9°45'S/ 77°28'W	Yes
Cordillera Central and Oriental	Bosque Unchog	9°42'S/ 76°06'W	No
	Cerro Chacas	4°35'S/ 79°44'W	No
	Cerro Chinguela	5°06'S/ 79°23'W	No
	Cerros de Sira	9°20'S/ 74°43'W	No
	Cumpang and Utcubamba	8°12'S/ 77°09'W	No
	Cutervo	06°14'S/ 78°45'W	Yes
	Leimebamba	6°41'S/ 77°46'W	No
	Río Abiseo	7°32'S/ 77°29'W	Yes
	Tingo Maria	09°16'S/ 75°59'W	Yes
	Yanáchanga Chemillén	10°22'S/ 75°21'W	Yes
Cordillera Oriental de los Andes	Ampay	13°34'S/ 72°52'W	Yes
	Macchu Picchu	12°12'S/ 72°35'W	Yes
	Manú	12°30'S/ 71°40'W	Yes
Cordillera de Colán	Abra Patricia	5°46'S/ 77°41'W	No
	Northern Cordillera del Colán	5°35'S/ 78°22'W	No
	Southern Cordillera del Colán	5°44'S/ 78°03'W	No
Cordillera del Cóndor	Río Comaina and Río Cenepa	4°30'S/ 78°14'W	No
Total No. of CF Regions= 5	Total No. of CF Sites= 18	Total No. of CF Sites with an element of protection = 8	

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

Cloud Forest Region Summaries: Peru

Cordillera Blanca

Located to the west of the main Andes range in the Sierra Central, the Cordillera Blanca is the highest tropical mountain range in the world with 27 snow-capped peaks above 6000m. Cloud forest is found in the valleys of the highest peak, El Huascarán (6768m), between 2500 and 3000m, as relict *Polylepis-Gynoxys* woodlands. The forests form part of an important habitat for bird species such as the andean condor *Vultur gryphus* and mammals including the spectacled bear *Tremarctos ornatus*. Despite being a National Park, Biosphere Reserve and World Heritage Site, confusion over land tenure rights exists and Huascarán faces threats from boundary encroachment, including spread of fire from pasture burning and overgrazing, heavy hunting pressure, and from a major highway along the western side of the reserve (Castro et al 1990).

Cordillera Central and Oriental

Small fragments of cloud forest are found scattered along the eastern slopes of both the Cordillera Central and Oriental. Typically it is found between 1800 and 2500m, although it extends up to 3600m on the higher parts of the range, although much has already been felled or is being actively removed (Best and Clarke, 1991; in Wege and Long, 1995). This is despite the fact that some of the cloud forest is within protected areas, such as Cutervo, Rio Abiseo (described below), Tingo Maria and Yanáchanga Chemillén. These contain some of the most important forest relicts which are dominated with tree species of *Cinchona*, *Cedrela* and *Podocarpus*. Both these areas and those which lack any protection which include Bosque Unchog, Cerros Chacas, Cerros de Sira (which is connected to the East Andes by a low ridge) and Cerros Chinguela, Leimebamba, Cumpang and Utcubamba, are important habitats for a number of threatened bird species and mammals such as the ocelot *Felis pardalis* and the giant anteater *Myrmecophaga tridactyla*. They also play an important role in protecting the watersheds of rivers which run down into the Amazon basin. However, these forests are all under heavy pressure from fuelwood cutting, grazing and clearance for agriculture. A further constraint is that those areas which have been set aside for protection are too small to ensure the long-term viability of the ecosystems within them.

Rio Abiseo The Rio Abiseo National Park (total area 274,000ha) is situated in the northern half of the Cordillera Oriental, to the west of Huicungo on the eastern slopes which run down to the Amazon Basin. It includes the Abiseo River Basin and covers part of the watershed for two other major rivers which are tributaries of the Amazon. Montane forests cover 53% of the park. Forests above 2900m spend most of the year shrouded in fog caused by the cooling

of air uplifted from the Amazon basin (Young *et al.* 1994). Some of the area is renowned for its primary cloud forest, which is reputed to be part of the Huallaga Pleistocene Refugia surviving from before the last glaciation. This has led to a great species diversity and a high degree of endemism (Narvaez, 1989). There is a high abundance of epiphytes with a dense understorey of palms, vines, Bromeliaceae and Orchidaceae. Tree species include *Chusquea* spp. and *Cedrela* spp. (Young and Leon, 1989). The cloud forest supports a huge diversity of birds, including nine threatened endemics and the South American pochard *Netta erythrophthalma* which is in danger of extinction. Notable mammals include the endemic yellow-tailed woolly monkey *Lagothrix flavicauda*, a species originally thought to be extinct by 1926 (Leo, 1980), and protected only in this park. In 1990 the Park was declared a World Heritage Site in recognition of its unique natural and cultural resources. However continued degradation threatens the important archeological sites, and the cloud forest has been under pressure from hunting (now greatly reduced), and grazing pressure and burning from adjacent areas. In addition there are plans to build a highway passing very close to the Park, but to date funding has not been secured (Young *et al.* (1994).

Cordillera Oriental de los Andes (South)

To the south, and further east into the Amazon basin, cloud forest is found on the eastern slopes of the Cordillera protecting watersheds of the rivers below. In addition to patches in Ampay and Macchu Picchu - some of which may already have been lost, cloud forest of remarkable floral and faunal diversity is found within the Manú National Park. Ampay contains the endemic tree species *Podocarpus glomeratus*, whilst almost 200 tree species have been recorded in a one hectare plot near Cocha Cashu in Manú. It is also believed to be rich in orchids, although the flora is poorly known. Declared a World Heritage Site in 1987, Manú has a remarkable diversity of fauna, many of which are endemic.

Cordillera de Colán

This mountain range is in Amazonas Department, northern Peru. It is semi-isolated, surrounded by lowlands except where it is joined to the Cordillera Central in the south-east. Cloud forest is found both in the north, where it is heavily degraded, and in the south, particularly the south-east where large areas remain, including Abra Patricia where the forest appears to be untouched due to its inaccessibility. Montane cloud forest with canopy height of 20-25 metres is found at altitudes between 1800 and 2500m, with elfin ridge-top forest above, up to c.2700m. The area experiences an unusually cool local climate, with frequent rainfall which results in stunted forest at relatively low and thus accessible altitudes (Collar *et al.*, 1992). Tree species are not well documented, but include *Cedrella* spp, along with abundant moss and epiphytes and many tree ferns. The forest is an important habitat for bird species, five of which are threatened with extinction, including the military macaw *Ara militaris*

(Collar *et al.* 1994). Several threatened mammal species have also been recorded, of most significance the yellow-tailed woolly monkey *Lagothrix flavicauda*, Andean night monkey *Aotus micronax* and spectacled bear *Tremarctos ornatus*. The recently rediscovered (previously thought extinct) woolly monkey is found only in undisturbed humid montane forest above 1800m. It is also found in Rio Abiseo National park, but in both areas its survival is threatened by heavy hunting and loss of habitat. In addition to hunting, threats to the cloud forest include cutting of *Cedrella* for timber, and clearance for cattle grazing and lucrative drug cash crops (Davies *et al.* 1994, in Wege and Long, 1995). Despite a number of earlier recommendations for protection of this area, to date it is unprotected. Butchart *et al.* following survey work in the area in 1994 conclude that the conservation situation is critical with many threatened and important species dependent on an area with rapid rates of deforestation. Urgent action should be taken to establish an effective protected area in the southern part of the range (Butchart *et al.* 1995).

Cordillera del Cóndor

This range of mountains spread down from the south of Ecuador with a small portion in the north-west Peru. The forests protect the watersheds of the Comaina, Cenepa and Marañón rivers, with cloud forest at between 1200 and 1500m. Little is known about the fauna although there are important bird species, including the orange-throated tanager *Wetmorethraupis sterrhopteron*. Whilst part of the area is included in the Aguaruna Indian Territory, no legal protection exists and the forests are under great pressure as both Ecuadorian and Peruvian governments have encouraged local people to settle in the area, to support respective territorial claims.

VENEZUELA

Broadly speaking there are three main mountain groups in Venezuela: the Andes in the north west of the country, the Cordillera de la Costa to the north along the Caribbean coast and the Guayana Highlands in the south and on the border with Brazil. The Coastal Cordillera, which is often viewed as an extension of the Andes, is in fact much older (beginning to uplift in the late Cretaceous) and its geological history is quite different (Steyermark, 1979). The Guayana Shield comprises some of the oldest Precambrian mountain formations which range in age from 2000 to 1800 million years (Huber and Frame 1989).

Venezuela is rich in tropical montane cloud forests. The largest tracts are found along the Andes and the Cordillera de la Costa, but there are also important areas in southern Venezuela and some outlying patches on Margarita Island and the Paraguaná Peninsula. Cloud forests are generally encountered at altitudes between 800 and 2500m, although there is much variation within the country. "Typical" cloud forest is found between 1800-2400m in the Andes and would fall within the *Upper Montane Rain Forest* category of Grubb (1974). However, the Cordillera de la Costa and isolated mountains (Cerro El Copey and Cerro Santa Ana) show cloud forest at much lower elevations (even as low as 750m), due to the so-called *Massenerhebung* effect (Grubb, 1971; Grubb and Whitmore 1966). The Guayana shield also has cloud forest at a variety of elevations (including the "typical" 1800-2400m) depending on orographic factors. Finally, it is worth mentioning the microphyllous or nanophyllous elfin forests which are found locally at the summits of small isolated mountains, on tepui summits in Guayana and at the upper limit of forest (3000-3800) in the Andes (and locally in the higher mountains of the Coastal Cordillera). This latter forest corresponds to Grubb's *Subalpine Forest* and typical genera include *Befaria* (Ericaceae), *Brunellia* (Brunelliaceae), *Clusia* (Clusiaceae), *Gynoxys* (Asteraceae), *Miconia* (Melastomataceae), *Rhamnus* (Rhamnaceae) and *Weinmannia* (Cunoniaceae) (Grubb, 1974; Prance, 1989).

These cloud forests are extremely rich in endemism, both in flora (Huber and Frame 1988) and fauna (Cracraft, 1985, Steyermark, 1979).

Regarding threats, protection and management, the cloud forests of Venezuela fall easily into two groups based on a north-south division. Those of northern Venezuela are relatively to extremely well known, and many of them are legally protected; there is intense pressure on these forests and legal provisions are not always sufficient to guarantee protection. Most of the forests outside protected areas have been degraded or destroyed by encroachment, agriculture (including drug production) and livestock raising. One of the most significant areas outside protection is the eastern slopes of the Andes, particularly as this zone has been largely converted throughout the rest of the Andes.

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In comparison the cloud forests of southern Venezuela are not particularly well studied: many of them also fall within existing protected areas, although the management of these areas is minimal. However there is very little threat to these forests.

References

- Berry, P.E., B.K. Holst and K. Yatskievych (Eds.) 1995. *Flora of the Venezuelan Guayana. Volume 1: Introduction*. Missouri Botanical Garden and Timber Press, Portland, USA. 320 pp. + maps.
- Braun, A. 1994. *Palmas de la Selva Nublada de Venezuela*. Impresos Luis Urbina. Caracas, Venezuela. 54 pp.
- Collar, N.J., L.P. Gonzaga, N. Krabbe, A. Madroño, L.G. Naranjo, T. Parker and D.C. Wege 1992. *Threatened Birds of the Americas: the ICBP/IUCN Red Data Book* (Third Edition, Part 2). International Council for Bird Preservation. Cambridge, UK.
- Collar, N.J., M.J. Crosby and A.J. Stattersfield 1994. *Birds to Watch 2: The World List of Threatened Birds*. BirdLife Conservation Series No. 4. BirdLife International. Cambridge, UK.
- Cracraft, J. 1985. Historical biogeography and patterns of differentiation within the South American avifauna: areas of endemism. Pp. 49-84 in Buckley, P.A. *et al.* (Eds.) *Neotropical Ornithology*. Ornithological Monographs No. 36. American Ornithologists' Union. Washington, USA.
- Eisenberg, J.F. 1989. *Mammals of the Neotropics. The Northern Neotropics. Volume 1. Panama, Colombia, Venezuela, Suriname, French Guiana*. Chicago University Press. Chicago, USA. 449 pp.
- Fjeldsa, J. and N. Krabbe 1990. *Birds of the High Andes*. Zoological Museum, University of Copenhagen & Apollo Books. Svendborg, Denmark. 876 pp.
- Grubb, P.J. 1971. Interpretation of the "Massenerhebung" effect on tropical mountains. *Nature* 229:44-45
- Grubb, P.J. 1974. Factors controlling the distribution of forest types on mountains: New facts and new perspective. Pp. 13-46 in Flenley, J.R. (Ed.) *Altitudinal Zonation in Malaysia*. Trans. 3rd Aberdeen-Hull Symposium on Malaysian Ecology, Univ. Hull, Dept. Geography, Miscellaneous Series 16.
- Grubb, P.J. and T.C. Whitmore 1966. A comparison of montane and lowland rainforest in Ecuador II. The climate and its effects on the distribution and physiognomy of the forests. *J. Ecol.* 51:567-601.
- Hoyos, J. 1985. *Flora de la Isla de Margarita, Venezuela*. Sociedad y Fundación La Salle de Ciencias Naturales. Caracas, Venezuela. 927 pp.
- Huber, O. and C. Alarcón 1988. *Mapa de la Vegetación de Venezuela*. Ministerio del Ambiente y de los Recursos Naturales Renovables and BIOMA. Caracas, Venezuela. Map.

- Huber, O. and D. Frame 1989. Venezuela. Pp. 362-374 in Campbell, D.G. and H.D. Hammond (Eds.) *Floristic Inventory of Tropical Countries*. New York Botanical Gardens and World Wildlife Fund.
- Huber, O. (Ed.) 1992. *El Macizo del Chimantá, Escudo de Guayana, Venezuela: Un Ensayo Ecológico Tepuyano*. Oscar Todtman. Caracas, Venezuela.
- Huber, O. 1995. *Guayana Venezolana: Mapa de Vegetación*. CVG-EDELCA and Missouri Botanical Garden. Caracas, Venezuela. Map.
- Johnston, J.R. 1909. Flora of the islands of Margarita and Coche, Venezuela. *Contrib. Gray. Herb. Harv. Univ.* 37:1-149.
- MARNR. 1986. Estudio integral del medio físico-natural del Cerro Turimiquire, Edos. Anzoátegui, Monagas y Sucre, Venezuela. *Serie Informes Técnicos*. Zona 12y13/IT/199. Ministerio del Ambiente y de los Recursos Naturales Renovables. Barcelona-Maturín, Venezuela. 133 pp.
- Prance, G.T. 1989. American Tropical Forests. Pp. 99-132 in Leith, H. and M.J.A. Werner (Eds.). *Tropical Rain Forest Ecosystems. Biogeographical and Ecological Studies*. Ecosystems of the World 14B. Elsevier. Amsterdam, Netherlands.
- Rodríguez, J.P. and F. Rojas-Suárez 1995. *Libro Rojo de la Fauna Venezolana*. Provita & Fundación Polar. Caracas, Venezuela. 444 pp.
- Schubert, C. and O. Huber 1990. *The Gran Sabana: Panorama of a Region*. Lagoven Booklets. Caracas, Venezuela. 107 pp.
- Sharpe, C.J. (in press). Una lista de las aves del Parque Nacional Península de Paria. Sociedad Conservacionista Audubon de Venezuela.
- Steyermark, J.A. 1966. El Cerro Turimiquire y la región oriental adyacente. *Acta Bot. Venez.* 1(3-4):104-168.
- Steyermark, J.A. y G. Agostini 1966. Exploración botánica del Cerro Patao y zonas adyacentes a Puerto Hierro, en la Península de Paria, Edo. Sucre. *Acta Bot. Venez.* 1(2):7-80.
- Steyermark, J.A. 1973. Preservemos las cumbres de la Península de Paria. *Def. Nat.* Año 2:33-35.
- Steyermark, J.A. 1975. Flora de la Sierra de San Luis (Edo. Falcón, Venezuela) y sus afinidades fitogeográficas. *Acta Bot. Venez.* 10(1/4):131-218.
- Steyermark, J.A. 1977. Areas de bosques húmedos de Venezuela que requieren protección. Pp. 83-95 in: Hamilton, L.S. J.A. Steyermark, J.P. Veillon & E. Mondolfi (Eds.). *Conservación de los Bosques Húmedos de Venezuela*. Sierra Club & Consejo de Bienestar Rural. Caracas, Venezuela. 181 pp.
- Steyermark, J.A. 1979. Plant refuge and dispersal centres in Venezuela: their relict and endemic element. Pp. 185-221 in: K. Larsen and L.B. Holm-Nielsen (Eds.). *Tropical Botany*. Academic Press. London, UK and New York, USA.
- Steyermark, J.A. and G.C.K. Dunsterville 1980. The lowland floral element on the summit of Cerro Guaiquinima and other cerros of the Guayana Highland of Venezuela. *J. Biogeogr.* 7:284-303.

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- Steyermark, J.A. y F. Delascio 1985. Contribuciones a la flora de la Cordillera de Perijá. Edo. Zulia-Venezuela. *Bol. Soc. Venez. Ciencias Nat.* 40(143):153-325.
- Sugden, A. 1986. Montane vegetation and flora of Margarita Island. *J. Arnold Arboretum* 67:187-232.
- Tamayo, F. 1941. Exploraciones botánicas en la Península de Paraguaná, Estado Falcón. *Bol. Soc. Venez. Ci. Nat.* 7:1-90.
- Viloria, A.L. 1995. Perijá: Visiones y detalles de la historia, la naturaleza y el hombre. Draft manuscript. ¿PARA PUBLICAR DONDE?
- Wege, D.C. and A.J. Long 1995. *Key Areas for Threatened Birds in the Neotropics*. BirdLife Conservation Series No. 5. BirdLife International Cambridge, UK.



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Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?	
Cerro El Copey	Cerro El Copey	11°00'N/ 64°00'W	Yes	
Cerro Santa Ana	Cerro Santa Ana	11°49'N/ 69°56'W	Yes	
Cordillera de la Costa Central	Cerro Platillón	9°53'N/ 67°32'W	Yes	
	El Avila	10°32'N/ 66°40'W	Yes	
	Guatopo	10°05'N/ 66°29'W	Yes	
	Hato Jaguar	10°24'N/ 68°55'W	No	
	Henri Pittier	10°28'N/ 67°51'W	Yes	
	Macarao	10°22'N/ 67°09'W	Yes	
	Nirgua	/	No	
	Palmichal	10°22'N/ 67°53'W	Yes	
	Pico Codazzi	10°25'N/ 67°19'W	Yes	
	San Esteban	10°20'N/ 68°00'W	Yes	
	Sierra de Aroa	10°25'N/ 68°50'W	Yes	
	Cordillera de la Costa Oriental	Cerro Azul	10°40'N/ 62°00'W	Yes
		Cerro Humo	10°41'N/ 62°38'W	Yes
		Cerro Peonía	10°11'N/ 64°07'W	No
Cerro Turumiquire		10°07'N/ 63°52'W	Yes	
El Guácharo (Cerro Negro)		10°12'N/ 63°36'W	Yes	
Cordillera de los Andes	El Tamá	7°31'N/ 72°15'W	Yes	
	El Zumbador Forest	/	No	
	Guaramacal	9°11'N/ 70°10'W	Yes	
	La Carbonera/San Eusebio	/	No	
	Páramos Molino y Rio Negro	8°30'N/ 71°30'W	No	
	Páramos del Batallón y La Negra	7°54'N/ 72°00'W	Yes	
	Sierra de Barbacoas	9°30'N/ 70°11'W	Yes	
	Sierras de la Culata y Nevada	8°44'N/ 71°05'W	Yes	
	Terepaima	9°53'N/ 69°16'W	Yes	
	Yacambú	9°40'N/ 69°32'W	Yes	
	Duida Subcentre	Autana	/	No
		Cerro Aracamuni	/	No
		Cerro Aratitiope	/	No
Cerro Avispa		/	No	
Cerro Guaiquinima		/	No	
Coro-coro		/	No	
Duida-Marahuaca		3°29'N/ 65°30'W	Yes	
Guanacoco		/	No	
Guanay		/	No	
Huachamacari		/	No	
Ichún		/	No	
Jáua		/	No	
La Neblina		1°14'N/ 65°53'W	Yes	
Marutani		/	No	
Parú		/	No	
Sarisariñama		/	No	
Serranía Vinilla		/	No	
Serranía del Tigre		/	No	
Sierra Curupira		/	No	
Sierra Imera		/	No	
Sierra Migualida		/	No	
Sierra Parima		/	No	
Sierra Tapirapécó		/	No	
Sierra Unturán		/	No	
Sípapo-Cuao		/	No	
Yapacana		/	No	
Yaví		/	No	
Yutajé		/	No	
Gran Sabana		Auyan-Tepuí	5°49'N/ 62°35'W	Yes
		Cerro Venamo	/	No
	Chimanta	5°23'N/ 62°08'W	Yes	
	Kukenan	5°21'N/ 60°58'W	Yes	

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
	Roraima	5°14'N/ 60°47'W	Yes
	Sierra de Lema	5°58'N/ 61°47'W	Yes
Sierra de Perijá	Sierra de Perijá	10°04'N/ 72°45'W	Yes
Sierra de San Luis	Sierra de San Luis	11°10'N/ 69°40'W	Yes
Total No. of CF Regions= 9	Total No. of CF Sites= 64	Total No. of CF Sites with an element of protection = 31	

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

Cloud Forest Region Summaries: Venezuela

Cerro El Copey

On this isolated mountain found on the Isla de Margarita, the annual precipitation reaches only 1000mm, but nevertheless a scrubby cloud forest is found from about 700m to the summit at 930m (Hoyos, 1985).

Cerro Santa Ana

An isolated mountain located on the Peninsula de Paraguaná on the Caribbean coast in the north of the country, Santa Ana supports cloud forest at low altitudes up to 830m. A characteristic and endemic understory palm is *Geonoma paraquanensis* (Braun,

Cordillera de la Costa Central

The Cordillera de la Costa Central extends from the Yaracuy-Barquisimeto Depression in the west to the Unare Depression in the east. The highest peak is Pico Naiguatá in El Avila at 2765m, north of Caracas. Cloud forests are frequent between 1000 and 2000m, sometimes down to 700m (Huber, 1988). Specific sites within this region include Cerro Platillón, El Avila, Guatopo, Henri Pittier, Nirgua, Palmichal, San Esteban, Hato Jaguar and Sierra de Aroa.

The Cordillera de la Costa, unlike the Andes, shows a significant relationship with the Guayana, with elements such as *Froesia* including the rare and endemic tree species *Froesia venezuelensis* (Quinaceae), *Macrocentrum*, *Gloeospermum*, *Stephanopodium*, *Elvasia*, *Cespedesia* and *Roucheria* (Steyermark, 1979). The dominant tree of the transitional cloud forest through the Cordillera is the endemic *Gyranthera caribensis* and at El Avila, *Podocarpus salcifolius* and *Catoblastus praemorsus* are characteristic (Amend, 1991). Typical palms include the emergent *Ceroxylon interruptum*, *C. klopstockia* and *Socratea altissima* and understory species such as *Geonoma* spp. and *Hyospathe pittieri* (Braun, 1994), and *Bactris* and *Euterpe* spp. (Huber, 1986). These cloud forests are also rich in epiphytes including Orchidaceae, Bromeliaceae, Gesneriaceae, Ericaceae, Pteridophyta. Characteristic endemic bird taxa include *Pyrrhura hoematotis*, *Pionus sordidus*, *Synallaxis castanea*, *Grallaria Cloricata*, *Phloscartes venezuelanus*, *Tangara rufigenis* (Cracraft, 1985). The antpitta *Grallaria excelsa*, found elsewhere only in the Andes also occurs. Amongst the mammals, the threatened cats *Leopardus tigrinus* and *L. wiedii* occur.

As with the Cordillera de los Andes, many of the cloud forests in this region have at least partial effective protection, falling within National Park and other protected area boundaries. Pressures and management issues in El Avila are well described in Amend (1991). Some areas however, such as Guatopo still contain valuable cloud forest which is not protected (Steyermark, 1979).

Cordillera de la Costa Oriental

The Cordillera de la Costa Oriental extends from the Unare Depression to the tip of the Península de Paria, and consists of two massifs: the Caripe Highlands and the Península de Paria. The Caripe area includes Cerro Peonía, Cerro Turumiquire (2596m) and El Guácharo (Cerro Negro). These forests include an endemic montypic genus, *Croizatia* (Euphorbiaceae) (Steyermark, 1977) and Turumiquire holds 37 endemic plant species while El Guácharo has 38 (Steyermark, 1979). The threatened *Campylopterus ensipennis*, *Margarornis tatei*, *Diglossa venezuelensis* and *Basileuterus griseiceps* occur, all but the first Venezuelan endemics. Main peaks on the Península de Paria are the Cerros de Humo (1308m), Patao, Olvido and Azul. Cloud forest is split into a western section on Cerro de Humo, and on the other three peaks to the east. Due to the maritime location and the *Massenerhebung* effect, cloud forest is found at 750m on the southern slopes and even lower on the north. These forest support 29 endemic plant species including *Besleria hirsutissima*, *B. mortoniana*, *Heliconia steyermarkii*, *Elvasia steyermarkii*, *Topobea steyermarkii*, *Piper pariense*, *Ixora agostiana* and threatened endemic birds such as *Hylonympha macrocerca*, *Myioborus pariae*, *Camylopterus ensipennis*, *Margarornis tatei*, *Basileuterus griseiceps*, and *Diglossa venezuelensis*. Apart from the endemic element, there is some affinity with Trinidad (*Camylopterus ensipennis*) and with the tepuiparrotlet *Platycentrum clidemoides*, and the fer-de-lance *Lachesis muta* from the Guayana Highlands (Wege and Long, 1995).

Cordillera de los Andes

This region covers the north-eastern branch of the Andes from the border with Colombia to the Yaracuy-Barquisimeto Depression in Edos. Lara and Yaracuy. It includes the highest altitudes in Venezuela, to just over 5000m, and important areas of cloud forest in the Tamá upland, Mérida Andes and Trujillo-Portuguesa-Lara. Cloud forest sites include Guaramacal, Sierras de la Culata y Nevada, Sierra de Barbacoas, Sierra Nevada, Terepaima and Yacambu. Tamá and the Mérida Andes are separated by the 40km arid Táchira depression, a fact which has resulted in notable endemisms and some considerable differences between the two biotas. Typical cloud forest tree species include *Podocarpus* (*P. rospigliosi*, *P. montanus*, *P. pendulifolius*, *P. Coleifolius*), *Escallonia*, *Weinmannia*, *Rubus*, *Chusquea*. In Tamá the fauna and flora show more affinity with the Colombian Cordillera Oriental than with the rest of the Venezuelan Andes: 145 species and 39 subspecies of flowering plant as well as 6 species of

bird reach their north-eastern limit here. The frog *Atelopus tamaense* is endemic, and threatened mammals include *Dinomys branickii*. Threatened bird species include *Pauxi pauxi*, *Haplpsittaca amazonina*, *Grallaria cucullata* and the endemic *Grallaria chthonia* (Wege and Long, 1995). In the Mérida Andes threatened birds include *Coturnicops notata*, and the endemic *Hemispingus goeringi* (Wege and Long, 1995), and there are a number of endangered endemic frog species such as *Atelopus mucubajensis*, *A. oxyrhynchus*, *A. pirangoi* and *A. sorianoi* (Rodríguez and Rojas-Suárez, 1995). This area also includes Zumbador-Páramos Batallón y la Negra, where there are abundant epiphytes and bromeliads, such as *Greigia* (Bromeliaceae), and La Carbonera/San Eusebio which is an unusual Andean forest which has developed on fairly flat terrain and contains magnificent specimens of *Podocarpus* spp., and rare and endemic species such as *Psychotria aristeguietae*, and *Oreopanax veillonii*. In addition the eastern slopes of the Andes hold thousands of hectares of cloud forests with many rare and endemic species such *Guettarda bernardii*. In Trujillo-Portuguesa-Lara, in particular there are many cloud forests with rare plants such as the trees *Talauma dodecocandra* and *Simira myriantha*, and rare orchids, such as *Cyrtidium rhomboglossum*. Many other Andean flora reach their easternmost limit here (Steyermark, 1977; No.32). Characteristic mammalian endemics of the cloud forests of the north-eastern Andes (including Colombia) are *Marmosa dryas*, *Cryptotis thomasi*, spectacled bear *Tremarctos ornatus*, *Nasuella olivacea*, *Oryzomys minutus* (also occurs in the Cordillera de la Costa), *Aepeomys lugens*, *Thomasomys aureus*, *Chilomys instans* and *Agouti taczanowskii* (Eisenberg, 1989).

Many of the cloud forest areas described above have at least partial effective protection, falling within National Park boundaries.

Duida Subcentre

The Duida Subcentre (and Gran Sabana) is part of the Guayana Highlands, the largest mountain formation in the country, which are a Pre-Cambrian sandstone formation characterised by the mountain structures known as "tepui". Cloud forests are located on the mid and upper slopes of these mountains (where these are not sheer vertical) and - in the case of several tepuis - on the summits themselves. The Duida area is found further west and south than the Gran Sabana, moving close to the border with Brazil. It includes the Cerro Guaiquinima (1700m), the summit of which is 40% forested (Steyermark and Dunsterville, 1980), and the large tepui massifs of Jáua, Sarisariñama and Guanacoco, which reach 2000m, along with to the south-east Ichún and Marutani (1500m) and to the north Sierra Maigualida (2400m) (Huber and Alarcón, 1988). In addition it includes part of the mountainous area of eastern Edo. Bolívar and the northern Edo. Aamazonas (1600-2400m). The main massifs are Sipapo-Cuao and Autana in the west (including the southerly Cerro Aracapo, Cerro Gallinero, etc.); and Guanay, Coro-coro, Yutajé and Yaví in the north (Huber and Alarcón, 1988). To the centre, Parú, Duida-Marahuaca, Huachamacari which range from 1600 to 2800m, and the

outlying Yapacana (1200m) and Serranía del Tigre are found. The Sierra Parima extends along the eastern frontier of Edo. Amazonas with Brazil and includes low mountains (to 1500m) (Huber and Alarcón, 1988). Moving to the extreme south of Venezuela on the border with Brazil, the most significant mountains are Sierra de la Neblina (at 3045m, the highest point in the Guayana Highlands), Cerro Avispa, Cerro Aracamuni, Sierra Imeri, Sierra Unturán, Serranía Vinilla, Cerro Aratitiope, Sierra Tapirapecó and Sierra Curupira. The Sierra de la Neblina is the richest and most diverse area of Pantepui (Huber and Alarcón, 1988). Bird species endemic to the Duida Subcentre include *Philydor hylobius* (Cacraft, 1985), and the threatened Guaiquinima Redstart *Myioborus cardonai* is endemic to Cerro Guaiquinima (Collar *et al.* 1994). The frog *Minyobates steyermarki* is endemic to Yapacana. Many of these forests are found within protected areas, either national parks (including the spectacular 3 million ha Canaima National Park and World Heritage Site) or the Tepuis Nature Monument which includes all tepuis. However, the latter often includes only the summits. Despite legal protection, some of these cloud forests have already been degraded by mining activities. For example, although the Jáua-Sarisariñama National Park legally protects the two tepuis massifs of Jáua, Sarisariñama, there are no local personnel and the area is currently being invaded by miners.

Gran Sabana

The Gran Sabana (and the Duida Subcentre) is part of the Guayana Highlands, the largest mountain formation in the country, which are a Pre-Cambrian sandstone formation characterised by the mountain structures known as "tepui". Cloud forests are located on the mid and upper slopes of these mountains (where these are not sheer vertical) and - in the case of several tepuis - on the summits themselves. The Gran Sabana itself includes the high plain between the low tepuis of Sierra de Lema and Cerro Venamo in the north and Sierra Pakaraima in the south; its eastern limit is the border with Guyana and in the west it limits with Ptari-tepui north of Kavanayén (Huber and Alarcón, 1988). Although the area is typically a forest-savanna mosaic, and the presence of true cloud forest is questionable, there are some areas which have high montane forests which are covered in orographic mists during a large part of the year. The surrounding region also includes the Eastern Tepuis: Uei-tepui, Roraima (2723m), Kukenán, Yuruaní-tepui, Ilú-tepui and Tramen-tepui (Huber and Alarcón, 1988), and the Auyán-tepui and Chimantá massifs as well as the outlying tepuis Ptari-tepui, Sororopán-tepui, Los Testigos, Uaipán-tepui, Aprada-tepui, Upuigma-tepui and Angasima-tepui. It also includes the north-facing slopes of the low tepuis Sierra de Lema (La Escalera) and Cerro Venamo. Altitude generally ranges between 1500 and 2650m. The flora of these mountains is extraordinary with a 10-50% endemism per mountain (Steyermark 1977). The Auyán-tepui/Chimantá complex is one of the richest centres in Pantepui (Huber and Alarcón, 1988). The Sierra de Lema-Venamo area alone has numerous endemics including *Phainantha myrteoloides*, *Platycarpum rugosum*, *Sloanea crassifolia*, *Guzmania venamensis*, *G. steyermarkii*, *Ladenbergia venamoensis*, *Cottendorfia gracillima*, *Solanum*

rufistellatum, *S. puberuloba*, and *Cyphomandra bolivarensis* although not all of these are exclusive to cloud forest habitats. Representative endemic avian taxa of the Gran Sabana Subcentre are *Crypturellus ptaritepui*, *Pyrrhura egregia*, *Campylopterus hyperthrus*, *Lipaugus streptophorus*, *Todirostrum russatum*, and *Spordiornis rusticus* (Cracraft, 1985). The threatened *Crypturellus ptaritepui* is apparently endemic to Ptari-tepui (Collar *et al.* 1994). Characteristic mammalian endemics of the cloud forests of the Guayana highlands are *Marmosa tyleriana* and *Sciurusflammifer* (Eisenberg, 1989). Endemic amphibians include frogs of the genus *Stefania* (3 spp.), the frog *Otophryne robusta* and *Oreophrynella quelchii*. Many of these forests are found within protected areas, either national parks (including the spectacular 3 million ha Canaima National Park and World Heritage Site) or the Tepuis Nature Monument which includes all tepuis. However, the latter often includes only the summits. Despite legal protection, some of these cloud forests have already been degraded by mining activities.

Sierra de Perijá

A spur of the Colombian Cordillera Oriental, found on the border with Colombia this mountain range reaches over 3600m. Cloud forests are found between 1200 and 2500m. The flora has a strong Colombian affinity (e.g. *Peperomia discilimba*, *Psychotria erythrocephala*) and is related closely to that of the Sierra Nevada de Santa Marta. A relationship with the Cordillera de la Costa is shown by the presence of *Psiguria racemosa*, a species otherwise restricted to the former mountain range. There is strong endemism including *Miconia limitaris*, *M. perijaensis*, *Calea perijaensis*, *Senecio perijaensis*, *Chimarrhis perijaensis*, *Pterogastra glabra*, *Baskevillea venezuelana*, *Pleurothallis hypocrita*, *Pterichis latifolia*, *Spermacoce perijaensis* (Steyermark, 1979). Endemic butterflies include the browns *Lymanopoda altaselva*, *Pedaliodes cesarensis*, *P. suspiro*, *P. vallenata*, *P. tyrreoides* and *P. zuleta* (Rodríguez and Rojas-Suárez, 1995). Characteristic endemic bird taxa include *Metallura iracunda* and a number of subspecies (Cracraft, 1985). Threatened birds include *Clytactantes alixi*, although this has not been seen for many years. The onoclea *Leopardus tigrinus* and *Oryzomys minutus* also occur. The Venezuelan portion of the range is particularly important for conservation as the Colombian sector has been largely deforested. Although much of the area is protected by the Perijá National Park, cultivation of coca, poppies and marihuana is rife and the Sierra is being deforested from the top down, as well as the bottom up (by ganadería), a rather unique situation. Cordillera de los Andes This region covers the north-eastern branch of the Andes from the border with Colombia to the Yaracuy-Barquisimeto Depression in Lara and Yaracuy. It includes the highest altitudes in Venezuela, to just over 5000m, and important areas of cloud forest in the Tamá upland, Mérida Andes and Trujillo-Portuguesa-Lara. Cloud forest sites include Guaramacal, Sierras de la Culata y Nevada, Sierra de Barbacoas, Sierra Nevada, Terepaima and Yacambu. Tamá and the Mérida Andes are separated by the 40km arid Táchira depression, a fact which has

resulted in notable endemisms and some considerable differences between the two biotas. Typical cloud forest tree species include *Podocarpus* (*P. rospigliosi*, *P. montanus*, *P. pendulifolius*, *P. oleifolius*), *Escallonia*, *Weinmannia*, *Rubus*, *Chusquea*. In Tamá the fauna and flora show more affinity with the Colombian Cordillera Oriental than with the rest of the Venezuelan Andes: 145 species and 39 subspecies of flowering plant as well as 6 species of bird reach their north-eastern limit here. The frog *Atelopus tamaense* is endemic, and threatened mammals include *Dinomys branickii*. Threatened bird species include *Pauxi pauxi*, *Haplopsittaca amazonina*, *Grallaria cucullata* and the endemic *Grallaria chthonia* (Wege and Long, 1995). In the Mérida Andes threatened birds include *Coturnicops notata*, and the endemic *Hemispingus goeringi* (Wege and Long, 1995), and there are a number of endangered endemic frog species such as *Atelopus mucubajensis*, *A. oxyrhynchus*, *A. pirangoi* and *A. sorianoi* (Rodríguez and Rojas-Suárez, 1995). This area also includes Zumbador-Páramos Batallón y la Negra, where there are abundant epiphytes and bromeliads, such as *Greigia* (Bromeliaceae), and La Carbonera/San Eusebio which is an unusual Andean forest which has developed on fairly flat terrain and contains magnificent specimens of *Podocarpus* spp., and rare and endemic species such as *Psychotria aristeguietae*, and *Oreopanax veillonii*. In addition the eastern slopes of the Andes hold thousands of hectares of cloud forests with many rare and endemic species such as *Guettarda bernardii*. In Trujillo-Portuguesa-Lara, in particular there are many cloud forests with rare plants such as the trees *Talauma dodecocandra* and *Simira myriantha*, and rare orchids, such as *Cyrtidium rhomboglossum*. Many other Andean flora reach their easternmost limit here (Steyermark, 1977; No.32). Characteristic mammalian endemics of the cloud forests of the north-eastern Andes (including Colombia) are *Marmosa dryas*, *Cryptotis thomasi*, spectacled bear *Tremarctos ornatus*, *Nasuella olivacea*, *Oryzomys minutus* (also occurs in the Cordillera de la Costa), *Aepeomys lugens*, *Thomasomys aureus*, *Chilomys instans* and *Agouti taczanowskii* (Eisenberg, 1989). Many of the cloud forest areas described above have at least partial effective protection, falling within National Park boundaries.

Sierra de San Luis

The Sierra de San Luis reaches 1300m and its humid forests are separated from both the Andes and the Cordillera de la Costa by 120km of arid lands. This isolation, coupled with an unusual limestone topography, has led to the evolution of endemic species such as *Geonoma paraguayensis* (Palmae), *Epidendrum garcianum* (Orchidaceae), *Urticularia bintingii*, *Melanea sanluisensis*, and *Asketanthera steyermarkii*, amongst others. The avifauna is more closely related to the Cordillera de la Costa than the Andes.



PART THREE

SOUTH EAST ASIA

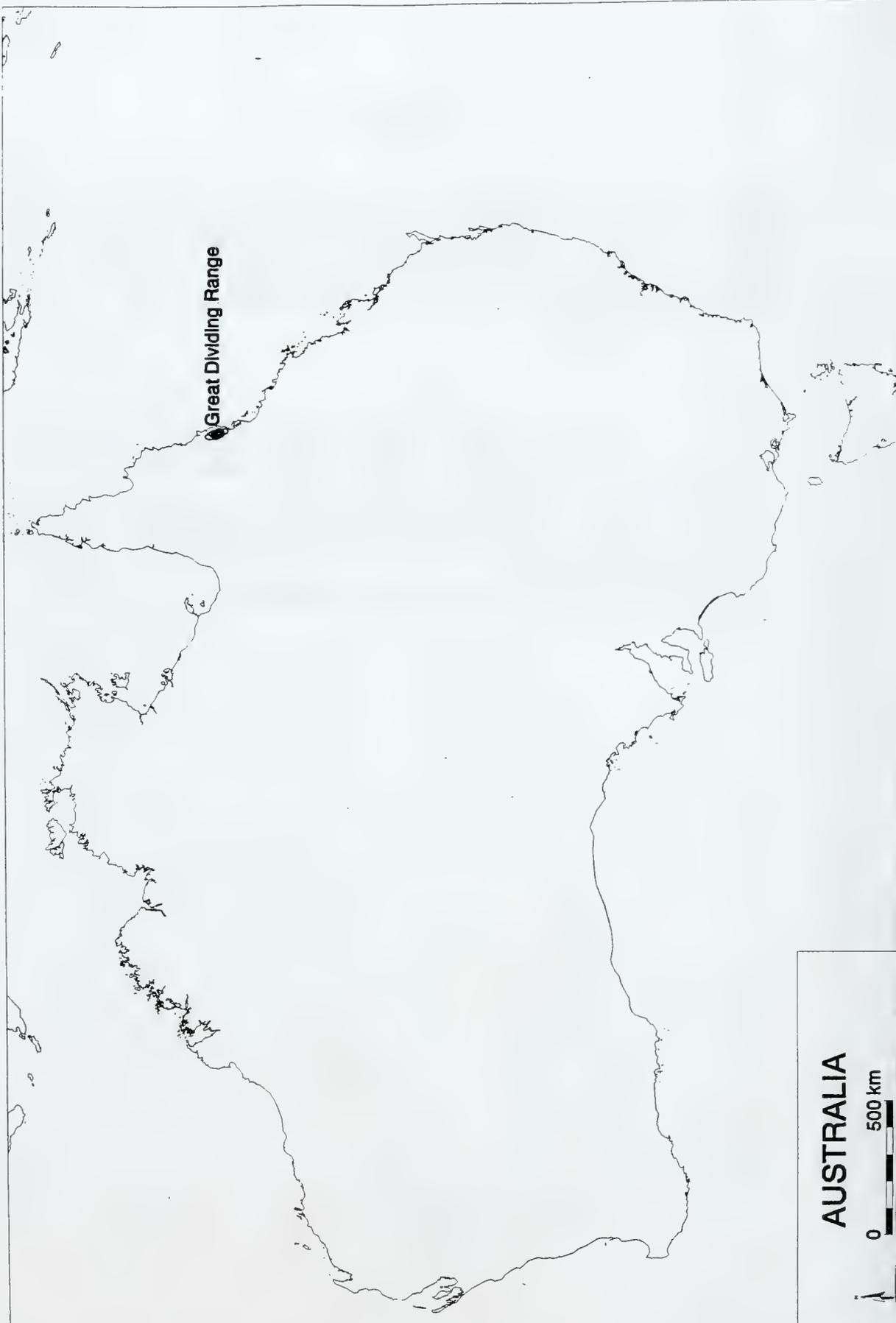
Australia
Brunei Darussalam
Cambodia
China
India
Indonesia
Lao PDR
Malaysia
Myanmar
Papua New Guinea
Philippines
Sri Lanka
Thailand
Viet Nam

AUSTRALIA

Tropical rain forest, including montane forest, in Australia occupies a very small part of the northeast of Queensland. In the hills especially on the Atherton Tableland, much has been removed for cattle farms resulting in scattered patches of forest. In 1988, logging of the rain forest was banned and the bulk of the remaining forested areas were protected. Pressures of the forest include fires escaping from sugar-cane fields (Collins *et al.* 1991; Davis *et al.*, 1995; WCMC unpubl. data).

References

- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (Eds.). 1991. *The conservation atlas of tropical forests: Asia and the Pacific*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.
- Richards, P.W. 1996. *The tropical rain forest: an ecological study*. 2nd ed. Cambridge University Press.



Great Dividing Range

AUSTRALIA

0 500 km



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Great Dividing Range MCF	Mount Bartle Frere MCF	17°35'S/145°48'E	No
	Mount Bellenden Ker MCF	17°43'S/145°52'E	No
Total No. of CF Regions= 1	Total No. of CF Sites= 2	Total No. of CF Sites with an element of protection = 0	

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

Cloud Forest Region Summaries: Australia

Great Dividing Range

The Great Dividing Range lies roughly parallel to the coast and between Townville and Cooktown, an altitude of 900m is reached in many areas. Upper montane rain forest may be found in the highest sites on the range, for example on Mount Bartle Frere (1612m) the highest peak, and also on Mount Bellenden Ker (1561m) (Collins *et al.* Eds.), 1991; Davies *et al.* (Eds.), 1995).

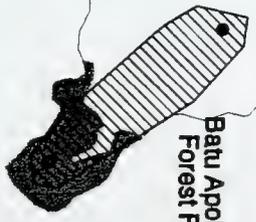
BRUNEI DARUSSALAM

Forest exploitation in Brunei has been limited in the small wealthy Sultanate of Brunei Darussalam. About 59% of the land area, therefore, is still under primary forest. The only montane forest in Brunei is found in Batu Apoi Forest Reserve and covers 1.2 per cent of the land area (Collins *et al.* (Eds.), 1991; Davis *et al.* (Eds.), 1995).

References

- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (Eds.). 1991. *The conservation atlas of tropical forests: Asia and the Pacific*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.

BRUNEI DARUSSALAM



**Batu Apoi
Forest Reserve, Ulu**

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Batu Apoi Forest Reserve, Ulu	Bukit Belalong	4°29'N/115°12'E	Yes
	Bukit Lesong	/	Yes
	Bukit Tudal	/	Yes
	Gunung Pagon	4°20'N/115°19'E	Yes
	Gunung Retak	/	Yes
Total No. of CF Regions= 1	Total No. of CF Sites= 5	Total No. of CF Sites with an element of protection = 5	

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

Cloud Forest Region Summaries: Brunei Darussalam

Batu Apoi Forest Reserve, Ulu Temburong

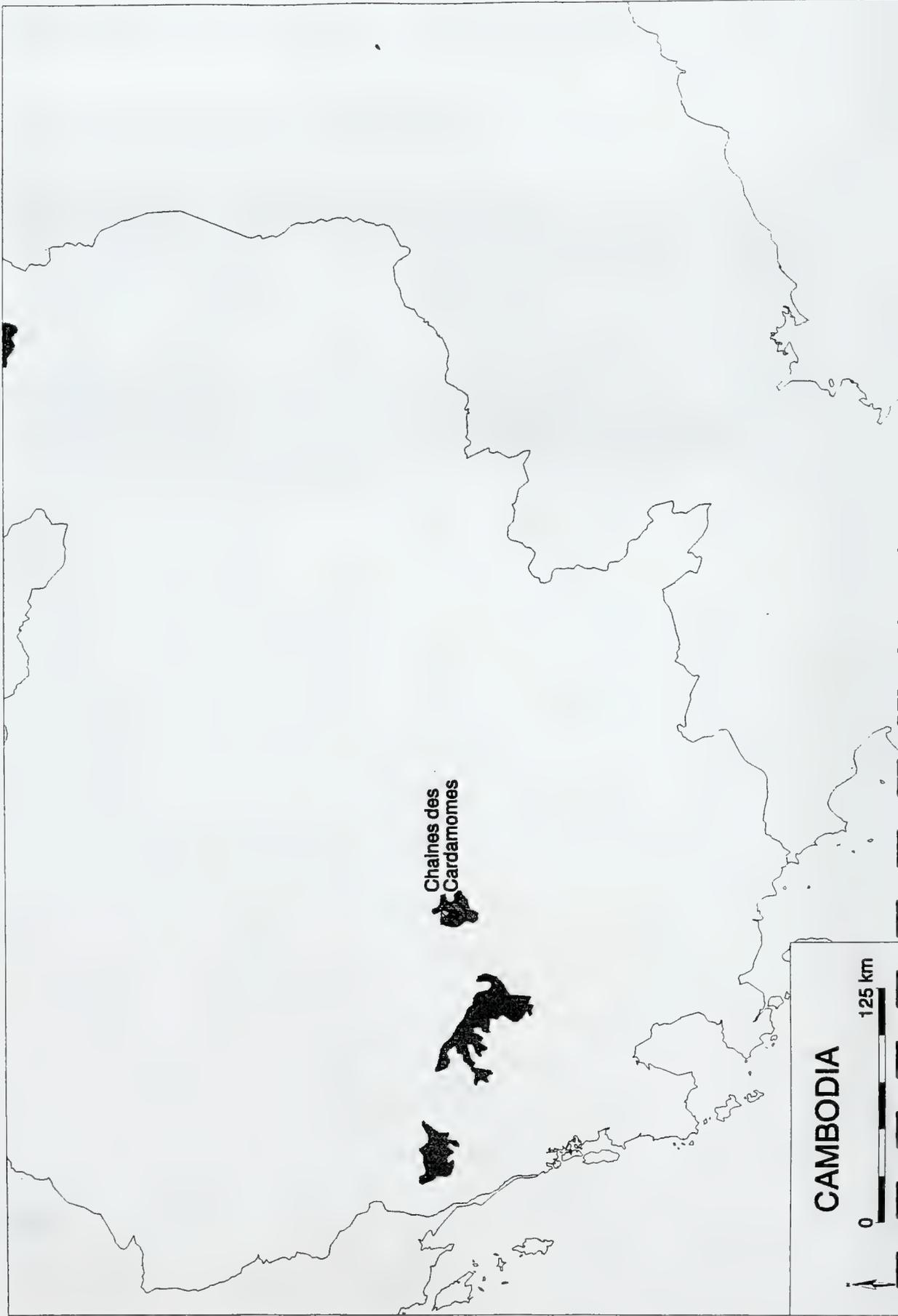
The only montane forest in Brunei is found in the Batu Apoi Forest Reserve. It develops at an altitude of between 700-900m, with upper montane forest generally developing between 1000m and 1200m. Montane forest may be found on the following five peaks: Gunung Pagon (1850m), Gunung Retak (1618m), Bukit Lesong (1192m), Bukit Tudal (1181m) and Bukit Belalong (915m). This forest is valued as a catchment area for three main rivers: the Temburong, Temawai and Belalong and is protected in the Ulu Temburong/Batu Apoi Primary Conservation Area. The montane forest is said to include plants of potential economic importance as ornamentals, which would need to be harvested with care. The Reserve is known to have a rich fauna with many of northern Borneo's larger mammals represented. Potential threats to the area include increased visitor pressure (Collins *et al.* (Eds.), 1991; Davis *et al.* (Eds.), 1995).

CAMBODIA

The plain of the Lower Mekong River, which comprises much of Cambodia, is densely populated and mostly under rice cultivation. Upland areas lies in the southwest of the country, namely in the Chaines des Cardamomes and Chaines de l'Elephant (Davis *et al.* (Eds.), 1995).

References

Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.



Chaine des
Cardamomes

CAMBODIA

125 km

0

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Chaines des Cardamomes	Phnom Aural	12°01'N/104°11'E	No
Total No. of CF Regions= 1	Total No. of CF Sites= 1	Total No. of CF Sites with an element of protection = 0	

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

Cloud Forest Region Summaries: Cambodia

Chaines des Cardamomes

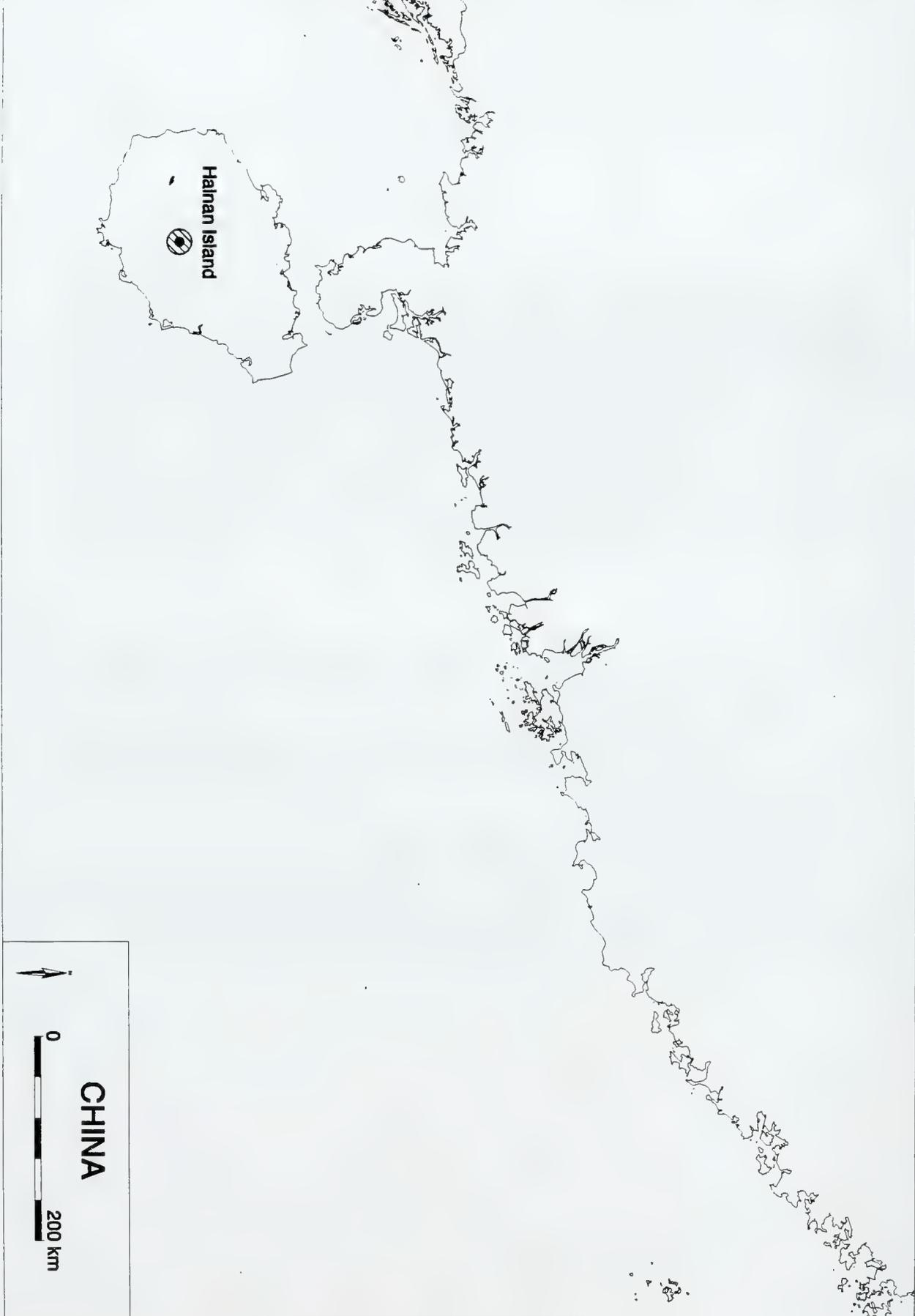
Phnom Aural (1813m) and Phnom Tumpor (1563m) are the two highest points in the Cardamom Mountains. This is, however, a poorly known area largely due to military conflicts, but it is thought that Phnom Aural, in particular, could be important for endemism and may contain a small area of cloud forest (Davis *et al.* (Eds.), 1995; WCMC unpubl. data).

CHINA

The tropical zone of China is located in the southwest of the Province Yunnan and in the islands of Hainan and Taiwan. The natural vegetation of this tropical zone includes montane evergreen forests and cloud forests on the highest peaks. The faunal affinities of this zone are largely Indo-Malayan. Much of the natural vegetation, however, has been destroyed or disturbed by man. The main threats to the remaining areas are deforestation, shifting cultivation, fire, population pressure, hunting, fuel collection and plantations. Tropical montane cloud forests, as such, are not thought to occur in Yunnan or Taiwan, although in Yunnan, between July and August, cloud level is high at above 2750m on the western slope of the Diancang Shan range (west of Dali) and between 2800-3500m on the eastern side of the range. The cloud level becomes still higher, above 3400m on the south slope of the Yulongxue Shan (near Lijiang) (Collins *et al.* (Eds.), 1991; Shimizu, 1991; Ohsawa, 1993; Davis *et al.* (Eds.), 1995; Mackinnon *et al.* 1996).

References

- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (Eds.). 1991. *The conservation atlas of tropical forests: Asia and the Pacific*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.
- Mackinnon, J., Meng Sha, Cheung, C., Carey, G., Zhu Xiang and Melville, D. 1996. *A biodiversity review of China*. WWF-International.
- Ohsawa, M. 1993. The montane cloud forest and its gradational changes in southeast Asia. In: *Tropical montane cloud forests: proceedings of an international symposium* (L.S. Hamilton, J.O. Juvik & F.N. Scatena, eds.). East-West Center, Hawai'i. pp.163-170.
- Shimizu, Y. 1991. Forest types and vegetation zones of Yunnan, China. *Journal of the Faculty of Science* (University of Tokyo), Section 3,15:1-71.



Halnan Island



0
200 km

CHINA

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Hainan Island	Wuzhi Mountain	18°57'N/109°42'E	Yes
Total No. of CF Regions= 1	Total No. of CF Sites= 1	Total No. of CF Sites with an element of protection = 1	

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

Cloud Forest Region Summaries: China

Hainan Island

In the middle and south of Hainan are mountains that are generally over 500m, with about 80 peaks higher than 1000m. Mount Wuzhi is the highest peak at 1867m. Wuzhi Mountain is included in the Wu Zhi Shan Nature Reserve. Elfin mossy forests are found above an altitude of 1600m. In these forests, the trees are about 5m high and there are abundant mosses and lichens (Mackinnon *et al.* 1996).

INDIA

One of the main area of tropical rain forest in the Indian Peninsula is found in the Western Ghats, which fringes the Arabian Sea coastline. This area contains montane forest (Collins *et al.* (Eds.), 1991).

References

- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (Eds.). 1991. *The conservation atlas of tropical forests: Asia and the Pacific*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- FAO. 1989. *Classification and mapping of vegetation types in tropical Asia*. FAO, Rome.

INDIA



0

500 km



Western Ghats

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Western Ghats	Anamalai Hills	10°08'N/ 77°12'E	Yes
	Nilgiri Hills	11°22'N/ 76°44'E	Yes
	Palni Hills	10°14'N/ 77°23'E	Yes
Total No. of CF Regions= 1	Total No. of CF Sites= 3	Total No. of CF Sites with an element of protection = 3	

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

Cloud Forest Region Summaries: India

Western Ghats

The Western Ghats contain evergreen and semi-evergreen high elevation (above 1400m) climax forests. One source estimates the area of montane forest in the Western Ghats to be greater than 4000sq.km. Some of the largest areas of montane forest are found in the Nilgiri, Palni and Anamalai Hills. Doda Betta (2636m), of the Nilgiri Hills, and Anai Mudi (2695m), of the Anamalai Hills, are the two highest mountains in the Western Ghats (Collins *et al.* (Eds.), 1991; FAO, 1989; WCMC unpubl. data).

INDONESIA

Indonesia has a total territory of about 780 million hectares. It comprises a 4500km long chain of islands stretching from Sumatra in the west to Irian Jaya in the east and is located between the continents of Asia and Australia and the Pacific and Indian Oceans. The total area of upper montane forest in Indonesia is estimated to be 29,029sq.km, i.e. 2.5% of Indonesia's natural forest. The majority of upper montane forest (77.2%) occurs in Irian Jaya. One of the values of these forests includes protection of watersheds and catchment areas and production of forest produce. Although Indonesia has high levels of species richness and endemism, it also has the world's longest list of species threatened with extinction. The main threats come from a large, growing and internally mobile human population, much of which is rural and engaged in agriculture (Veevers-Carter, 1978; FAO, 1979; Ministry of Forestry Republic of Indonesia, 1990; Collins *et al.* (Eds.), 1991; Soenartono Adisoemarto (Ed.), 1992).

References

- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (Eds.). 1991. *The conservation atlas of tropical forests: Asia and the Pacific*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.
- FAO. 1978. *Way Mual and Way Nua Nature Reserves, Central Seram, Maluku*. FO: INS/73/013 Project Field Report 8.
- FAO. 1979. *Nature conservation and wildlife management Indonesia terminal report*. FO:DP/INS/73/013.
- FAO. 1981. Proposed Manusela National Park management plan 1982-1987: *Field report of UNDP/FAO National Park development project INS/78/061*. FO/INS/78/061 Field report 15.
- Laumonier, Y., Gadrinab, A., Purnajaya and Blasco, F. 1983. *International map of the vegetation and environmental conditions: Southern Sumatra*. Institut de la Carte Internationale du Tapis Vegetal/Seameo-Biotrop.
- Laumonier, Y., Purnadjaya, Setiabudhi and Blasco, F. 1986. *Central Sumatra*. Institut de la Carte Internationale du Tapis Vegetal/Seameo-Biotrop.
- Laumonier, Y., Purnadjaya, Setiabudhi and Blasco, F. 1986. *International map of the vegetation and of environmental conditions: Northern Sumatra*. Institut de la Carte Internationale du Tapis Vegetal/Seameo-Biotrop.

A GLOBAL DIRECTORY OF TROPICAL MONTANE CLOUD FORESTS

- Long, A.J. 1993. Restricted-range and threatened bird species in tropical montane cloud forests. In: *Tropical montane cloud forests: proceedings of an international symposium* (eds. L.S. Hamilton, J.O. Juvik and F.N. Scatena). pp.47-65. East-West Center.
- MacKinnon, J., Smiet, F. and Artha, M.B. 1982. *National conservation plan for Indonesia, 3. Java and Bali*. UNDP/FAO Field Report 36, Bogor, FAO.
- Ministry of Forestry Republic of Indonesia. 1990. *The Indonesian tropical rain forest conservation areas*. Ministry of Forestry Republic of Indonesia.
- Nooteboom, H.P. 1987. Vegetation and flora. In: *Report of the 1982-1983 Bukit Raya Expedition* (ed. H.P. Nooteboom). pp.61-66. Rijksherbarium.
- Smiet, A.C. 1992. Forest ecology on Java: human impact and vegetation of montane forest. *J. of Trop. Ecol.* 8:129-152.
- Soenartono Adisoemarto (Ed.). 1992. *Indonesian country study on biological diversity*. Prepared for the United Nations Environment programme (UNEP) a study under the work programme for environment cooperation between the Republic of Indonesia and the Kingdom of Norway.
- Thiollay, J.M. and Meyburg, B.U. 1988. Forest fragmentation and the conservation of raptors: a survey on the island of Java. *Biol. Cons.* 44:229-250.
- UNDP/FAO. 1981. *Kerinci-Seblat Proposed National Park preliminary management plan 1982-1987*. Field report of UNDP/FAO National Park Development Project INS/78/061.
- Richards, P.W. 1996. *The tropical rain forest*. 2nd ed. Cambridge University Press.
- Whitten, A.J., Sengli Damanki, Jazanul Anwar and Nararuddin Hisyam. 1984. *The ecology of Sumatra*. Gadjah Mada University Press.
- Whitten, A.J., Muslimin Mustafa and Henderson, G.S. 1987. *The ecology of Sulawesi*. Gadjah Mada University Press.
- Werner, W.L. 1986. A comparison between two tropical montane ecosystems in Asia Pidurutalagala (Ceylon/Sri Lanka) and Pangrango-Gede (Java). *Mountain Research and Development*. 6:335-344.
- Whitmore, T.C. 1975. *Tropical rain forests of the far east*. Clarendon Press.
- Veevers-Carter, W. 1978. *Nature conservation in Indonesia*. PT Intermasa, Jakarta.

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?	
Barisan Mountain Range	Abong-Abong	04°20'N/096°45'E	No	
	Bandahara	03°46'N/097°47'E	Yes	
	Bepagut	04°20'S/103°29'E	No	
	Daun	03°22'S/102°19'E	No	
	Dempo	04°04'S/103°06'E	No	
	Gedang	2°44'S/101°53'E	Yes	
	Hulumasen	05°03'N/095°38'E	No	
	Hulunilo	/	Yes	
	Kapal	4°51'N/ 96°53'E	No	
	Kemiki	4°56'N/ 96°18'E	No	
	Kerinci	1°42'S/101°17'E	Yes	
	Lasung Tunkut	/	No	
	Lembu	04°05'N/ 97°29'E	No	
	Leuser	03°46'N/097°12'E	Yes	
	Malintang Sago	00°23'S/100°38'E	No	
	Marapi	00°20'S/100°26'E	No	
	Masurai	02°29'S/101°52'E	Yes	
	Patai	04°14'S/103°20'E	No	
	Seblat	02°52'S/102°08'E	Yes	
	Si Habu-Habu	/	No	
	Singgalang	00°23'S/100°19'E	No	
	Sopo Ucim	/	No	
	Sorik Merapi	00°38'N/099°33'E	No	
	Sumbing	03°25'S/101°47'E	Yes	
	Talamau	00°04'N/099°59'E	No	
	Talang	02°03'S/101°21'E	No	
	Tujuh	01°42'S/101°23'E	Yes	
	Gunung Palung Massif	Gunung Palung	01°12'S/110°09'E	Yes
		Gunung Panti	01°04'S/110°13'E	Yes
	Iban Range	Iban Range	03°11'N/115°15'E	Yes
	Merkele Ridge	Gunung Binaya	03°10'S/129°28'E	Yes
	Mountains of Buru	Gunung Kelapat Muda	03°18'S/126°13'E	Yes
	Mountains of Java and Bali	Gunung Agung	08°20'S/115°28'E	No
		Gunung Kawi	7°57'S/112°15'E	No
Gunung Semeru		08°05'S/112°43'E	Yes	
Gunung Tilu		/	Yes	
Haliman		06°42'S/106°26'E	Yes	
Pangrango		06°48'S/106°56'E	Yes	
Mountains of Lesser Sunda Islands		Gunung Rinjani	08°24'S/116°25'E	Yes
		Bukit Gandadiwata	02°45'S/119°25'E	No
Mountains of Sulawesi		Bukit Kambuno	02°20'S/120°05'E	No
		Gunung Dua Saudara	/	Yes
	Gunung Katopasa	01°15'S/121°25'E	No	
	Gunung Klabat	1°29'N/125°10'E	No	
	Gunung Lompobatang	05°22'S/119°58'E	Yes	
	Gunung Maling	00°45'N/120°46'E	No	
	Gunung Mekongga	03°39'S/121°15'E	No	
	Gunung Nokilalaki	01°21'S/120°12'E	Yes	
	Gunung Ogoamas	00°39'N/120°16'E	No	
	Gunung Rantemario	03°23'S/120°01'E	Yes	
	Gunung Roroka Timbu	01°16'S/120°19'E	Yes	
	Gunung Tambusisi	01°38'S/121°22'E	No	
	Gunung Tangkoko	/	Yes	
	Gunung Tokala	01°36'S/121°41'E	No	
	Gunung Waukana	/	No	
	New Guinea Cordillera/Pegunungan	Gunung Daam	04°23'S/138°25'E	No
Gunung Leonard Darwin		04°02'S/136°45'E	No	
Puncak Jaya/Mount Carstensz		4°05'S/137°09'E	Yes	
Puncak Mandala		04°43'S/140°16'E	No	
Puncak Tricora		04°17'S/138°39'E	No	

Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
	Puncak Wisnumurti	04°32'S/139°56'E	No
Schwaner Mountain Range and Muller	Bukit Baka	00°42'S/112°25'E	Yes
	Bukit Raya	00°38'S/112°43'E	Yes
Tamrau Mountains and Arfak	Gunung Lina	01°27'S/133°49'E	Yes
	Kwoka	00°40'S/132°24'E	No
Van Rees Mountains and Foja	Van Rees Mountains and Foja	2°32'S/138°46'E	No
Total No. of CF Regions= 12	Total No. of CF Sites= 66	Total No. of CF Sites with an element of protection = 29	

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

Cloud Forest Region Summaries: Indonesia

Barisan Mountain Range

The Barisan Mountain Range forms the backbone of the island of Sumatra and includes many active volcanoes. On the higher mountains a cloud zone forms at about 2000m and the average height of upper montane forest is 2100m to 3000m. These forests have a low even canopy, epiphytes are usually abundant and the trees are generally crooked. This forest is characterised by the order Coniferae, particularly *Dacrycarpus imbricatus* and the families Ericaceae and Myrtaceae, particularly *Leptospermum flavescens*. At least eleven species of mammals are more or less restricted to the Sumatran mountains. These include the grey fruit bat (*Aethalops alecto*), Sumatran rabbit (*Nesolagus netscherii*), volcano mouse (*Mus crociduroides*), giant Sumatran rat (*Sundamys infraluteus*), Edward's rat (*Leopoldamys edwardsi*), Hoogerwerf's rat (*Rattus hoogerwerfi*), Kerinci rat (*Maxomys hylomyoides*), Kerinci rat (*Maxomys inflatus*), Kinabalu rat (*Rattus baluensis*), mountain spiny rat (*Niviventer rapiti*) and the serow (*Capricornis sumatraensis*). The following sites are thought to contain cloud forest: Hulumasen (2315m); Kemiki (2800m); Kapal (2783m); Abong-Abong (2961m); Lembu (3043m); Leuser (3404m) and Bandahara (302m) both contained by Leuser National Park; Si Habu-Habu (2310m); Sopo Ucim (2199m); Sorik Merapi (2145m); Lasung Tunkut (2274m); Talamau (2912m); Singgalang (2877m); Marapi (2891m); Malintang Sago (2262m); Talang (2597m); Kerinci (3800m), Tujuh (2604m), Hulunilo (2469m), Sumbing (2507m), Masurai (2933m), Gedang (2446m) and Seblat (2383m) all contained by Kerinci-Seblat National Park; Daun (2492m); Dempo (3159m); Patah (2817m); and Bepagut (2732m). Many of these forests are valued for their rich flora and fauna but are threatened by encroachment (UNDP/FAO, 1981; Laumonier et al., 1983; Whitten, 1984; Laumonier et al. 1986; WCMC unpubl. data).

Gunung Palung Massif

This is an isolated massif in West Kalimantan in the island of Borneo. The two mountains, Gunung Palung (1160m) and Gunung panti, are protected by the Gunung Palung national Park. On the summits of these mountains a stunted bryophyte-encrusted upper montane rain forest is found. The dominant tree species are *Vaccinium* spp. (Ericaceae) and *Leptospermum* spp. (Myrtaceae). Pitcher plants (*Nepenthes* spp.), numerous species of orchids and ferns, and many species of mosses also occur (Davis et al. (Eds.), 1995).

Iban Range

Much of the Iban Mountain Range is included in the Sungai Kayan-Sungai Mentarang Nature Reserve. Upper montane forest is found above 1500m, with orchid-rich mossy forest occurring in river gorges. The area is valued as an area of supreme importance for conservation (Davies et al. (Eds.), 1995; WCMC unpubl. data).

Merkele Ridge

The Merkele Ridge is in the centre of the island of Seram, in the Moluccas in Indonesia. The highest mountain is Gunung Binaya (3027m) and it is included in the Manusela Wai Nua/Wai Mual National Park. Elfin/moss forest is found above 1500m on this ridge of mountains. The trees are small in this forest type and covered with moss and epiphytes. Orchids and ferns are common. The fauna on Seram is influenced by the Australian and Asian zoogeographical regions. Endemic species include two species of forest rat only found in high altitudes. Four bird species are confined to montane cloud forest in Seram (*Zoothera monticola*) and two bird species' main habitat is cloud forest (*Bradypterus castaneus* and *Gymnophaps mada*) (FAO, 1978; FAO, 1981; Long, 1993).

Mountains of Buru

Gunung Kelapat Muda, contained by the Gunung Kelapat Muda Game Reserve, is the highest mountain (2114m) in the island of Buru, in the Moluccas in Indonesia. One bird species is confined to tropical montane cloud forest in Buru (*Zoothera dumasi*) and two species' main habitat is cloud forest (*Gymnophaps mada* and *Bradypterus castaneus*) (Collins et al. (Eds.), 1991; Long, 1993).

Mountains of Java and Bali

Natural forests on Java, a densely populated island, have generally been cleared. Most of the forest remnants are confined to mountain areas, where montane vegetation is found from approximately 1500m to 2400m. The transition to mossy upper montane forest in west Java takes place above about 1650m. Mossy forest is best developed in west Java, as the climate becomes increasingly dry to the east. Fourteen bird species use cloud forest as their main habitat in the Javan and Balinese mountains. Mossy forest is found on Pangrango (Cibodas) National Park. This Park provides a refuge for a number of endangered and endemic taxa. It is also valued for research and tourism. Management constraints include agricultural encroachment and tourist pressure. Also in west Java is Gunung Halimun (1929m) contained by the Gunung Halimun National Park. South of Bandung there are 19 volcanoes of 1700m to

2800m covered by less than 100,000ha of montane forest in 13 to 15 separate patches, nearly all above 1400m. Some of this forest is included in the Cagar Alam Gunung Tilu (Mount Tilu Nature Reserve). In central Java few forest patches remain in spite of the presence of several high mountains. The highest peak in Java is Gunung Semeru (3676m), in east Java. This area is included in the Bromo-Tengger-Semeru National Park. Also thought to contain mossy forest in east Java is Gunung Kawi. In Bali, mossy forest is thought to occur on the north-west side of Gunung Agung (3142m) (Whitmore, 1975; MacKinnon et al., 1982; Werner, 1986; Thiollay & Meyburg, 1988; Smiet, 1992; Richards, 1996; WCMC unpubl. data).

Mountains of Lesser Sunda Islands

East of Java and Bali, the Lesser Sunda Islands are seasonally very dry, owing to a dry monsoon which blows off Australia during the middle months of the year. As a result, little if any mossy forest is found in these mountains, except perhaps on Gunung Rinjani (3726m - contained by Gunung Rinjani National Park) on the island of Lombok (Whitmore, 1975; WCMC unpubl. data).

Mountains of Sulawesi

In Sulawesi, a belt of cloud often forms around mountains at about 2000m. These high blocks of land are largely found in central and northern Sulawesi. Upper montane forest occurs in these areas between approximately 2400-3000m. Characteristic of the upper montane forest are members of the family Ericaceae such as *Rhododendron* (19 species are endemic to Sulawesi), *Vaccinium* (13 endemic species) and *Gaultheris* (two endemic species). The largest mammal of mountain forests is the mountain anoa *Bubalus quarlesi*, which is generally solitary. Other mountain mammal species include the shrew-rats (*Tateomys rhinogradoides*, *T. macrocercus* and *Melasmothrix naso*), which are known only from mountainous areas in Sulawesi and the Philippines where they live in mossy upper montane forest. Mountains with upper montane forest include: Gunung Lompobatang (2871m - contained by Gunung Lompobatang Protection Forests), where the upper montane forest is dominated by *Leptospermum*. Gunung Rantemario (3450m - contained by Pegunungan Latimojong Protection Forests) the highest mountain in Sulawesi, where upper montane forest can be found from about 2150, with proper upper montane forest occurring above 2650m. At 2650m *Rhododendron* bushes and some species of *Phyllocladus* predominate. Gunung Mekongga (2799m), Bukit Gandadiwata (3074m) in the Quarles mountains, Bukit Kambuno (2950m) and Gunung Tambusisi (2422m), where upper montane forest, with tall shrubs of mainly *Vaccinium*, is found above 1700m. Gunung Tokala (2630m), Gunung Katopasa (2835m) and Gunung Nokilalaki (2280m - contained by Lore Lindu National Park), where above 2000m, *Agathis* is absent and the most common trees are *Tristania*, *Lithocarpus* and *Castanopsis*. Gunung Roroka Timbu (2450m - contained by Lore Lindu National Park), Gunung Waukana

(3127m), Gunung Ogoamas (2565m), Gunung Maling (2443m), Gunung Klabat, and Gunung Tangkoko (1109m) and Gunung Dua Saudara (1351m) both contained in Dua Saudara Nature Reserve. Clearance for permanent and shifting cultivation is a threat to many of these areas (Whitten et al., 1987; WCMC unpubl. data).

New Guinea Cordillera/Pegunungan Maoke

This mountain range runs the length of New Guinea (see Papua New Guinea). Seven bird species (*Eurostopodus archboldi*, *Astrapia mayeri*, *Cnemophilus macgregorii*, *Epimachus meyeri*, *Ptiloprora guisei*, *Androphobus viridis* and *Eulacestoma nigropectus*) are confined to cloud forest in this mountain range and 13 other bird species use cloud forest on this range as their main habitat. Puncak Jaya (Mount Carstensz) at 4884m is the highest mountain not only in New Guinea, but also in the whole of Indonesia. It is contained by the Gunung Lorentz Nature Reserve. At the lower limits of montane forest on this mountain, *Castanopsis* is the dominant tree, replaced at higher elevations by moss-covered, monotypic stands of *Notofagus* and eventually by dense conifer forests comprising *Podocarpus*, *Dacrydium*, *Dacrycarpus* and *Papuacedrus*. The area is valued, in particular by tribal groups, for its rich biological resources. It is, however, threatened by mining, logging, petroleum exploration, road building, transmigration and tourism in that high-altitude vegetation is very vulnerable to trampling. Other high peaks in this range in Irian Jaya include Gunung Leonard Darwin (4234m), Gunung Daam (4922m), Puncak Tricora (4750m), Puncak Wisnumurti (4595m) and Puncak Mandala (4702m) (Long, 1993; Davis et al. (Eds.), 1995; WCMC unpubl. data).

Schwaner Mountain Range and Muller Mountain Range

These Mountain Ranges span the provincial borders between Central, West and East Kalimantan in the island of Borneo. Bukit Raya (2278m) and Bukit Baka (1617m) are two peaks in the Schwaner Mountain Range which are included in the Bukit Baka-Bukit Raya National Park. Montane forest in this area occurs above 1000m. From about 1600m upper montane forest is encountered, again with various Ericaceae, such as *Rhododendron* and *Vaccinium*, and Guttiferae, as well as *Phyllocladus hypophyllus* (Phyllocladaceae), *Elaeocarpus* (Elaeocarpaceae), *Embelia* (Embeliaceae), *Nepenthes* (Nepenthaceae) and tree ferns. The most serious threats to the forests are logging and road construction (Nooteboom, 1987; Davis et al. (Eds.), 1995; WCMC unpubl. data).

Tamrau Mountains and Arfak Mountains

These mountains are found in the Vogelkop or Bird's Head Peninsula, where there is a high incidence of endemic flora and fauna. In addition, three bird species use the cloud forest on these mountains as their main habitat (*Rallina rubra*, *Psittacella modesta* and *Ptiloprora perstriata*). Peaks include Kwoka (3000m) and Gunung Lina (3100m). On the Arfak Mountains there is persistent cloud cover around 1700m. *Nothofagus* forest occurs from 1500m to 2800m. Other common tree genera are *Castanopsis* and the conifers *Dacrycarpus*, *Dacrydium*, *Podocarpus*, *Libocedrus* and *Araucaria cunninghamii*. Ericaceae and orchids (such as *Dendrobium* spp. used by the Vogelkop bowerbird *Amblyornis inortatus* to decorate its bowers), treeferns, gingers, palms and selaginellas are also common. Above 2400m, the forest floor and tree trunks are covered in a thick layer of mosses, such as *Sphagnum* and *Dawsonia*. A Nature Reserve is sited in the mountains (Pegunungan Arfak Nature Reserve) (Long, 1993; Davis et al. (Eds.), 1995; WCMC unpubl. data).

Van Rees Mountains and Foja Mountains

These mountains are north of the Pegunungan Maoke in Irian Jaya. Botanically, much of this region is very poorly known and is difficult to access. It is, however, thought to contain some mossy forest. Threats to the area include petroleum exploration and logging. The area is home to nomadic hunter-gatherers and valued for its rich faunal diversity (Davis et al. (Eds.), 1995; WCMC unpubl.data).

LAO PEOPLE'S DEMOCRATIC REPUBLIC

Lao is a mountainous country with steep areas throughout the north of the country including Phou Bia (2829m) the highest mountain, the Chaine Annamitique forming the border with Viet Nam and the Bolovens Plateau in the south rising to over 1500m. Tropical montane cloud forests may be located in any of these three regions. The hills of northern Lao, above 1000m, are characterised by hill evergreen forest, usually a dense forest of Fagaceae and Lauraceae, or dipterocarps with palms. They also contain dry hill forest and secondary growth. The hills of central Lao and the Bolovens Plateau are similar, but include dense fagaceous forest and forest of broadleaf trees with *Podocarpus*, as well as dipterocarp forest and degraded areas. Above 2000m, the mountains are characterised by coniferous forest. The major causes of deforestation in Lao include shifting cultivation, poorly controlled logging and bomb damage (1960s and 1970s). The retention of forest cover on upland areas in order to protect watersheds and regulate water flow is considered to be fundamental to the maintenance of agricultural productivity in the lowlands (Gressitt, 1970; Anon, 1988; Collins *et al.* (Eds.) 1991; Davis *et al.* (Eds.) 1995).

References

- Anon. 1988. *Shifting cultivation in Laos: technical report prepared at the request of LAO PDR and SIDA (FOD/VF/JS/chr/dg 1088s)*. IUCN, Switzerland.
- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (Eds.). 1991. *The conservation atlas of tropical forests: Asia and the Pacific*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.
- Gressitt, J.L. 1970. Biogeography of Laos. *Pacific Insects Monograph* 24:573-626.

MALAYSIA

Montane forest occurs extensively on all the main mountains. Upper montane forest is mostly found above 1500m. However, on isolated peaks, in particular those close to the coast, upper montane forest abuts directly on to hill forest even below 800m. Endemism is very high. In addition, many endemics are confined to a single peak or adjacent peaks. The montane flora of Peninsular Malaysia is estimated to include at least 3000 vascular plant species, of which about 2125 species are confined to montane forest. Montane forests protect animals that are largely restricted to this vegetation type, for example, four species of mammals (*Hapalomys longicaudatus*, *Petaurista elegans*, *Chimarrogale himalayica* and *Talpa micrura*) and 75 species of birds in Peninsular Malaysia. The montane flora of Peninsular Malaysia is severely threatened by planned hill resort development, including bungalows, hotels, roads, golf courses, etc. Other substantial threats throughout Malaysia include logging, agricultural encroachment, tourist pressure on peaks and plant collecting (Whitmore, 1975; Davison, 1991; Ratnam, Nor Azman Hussein & Lim, 1991; Davis *et al.* (Eds.), 1995; Wyatt-Smith 1996).

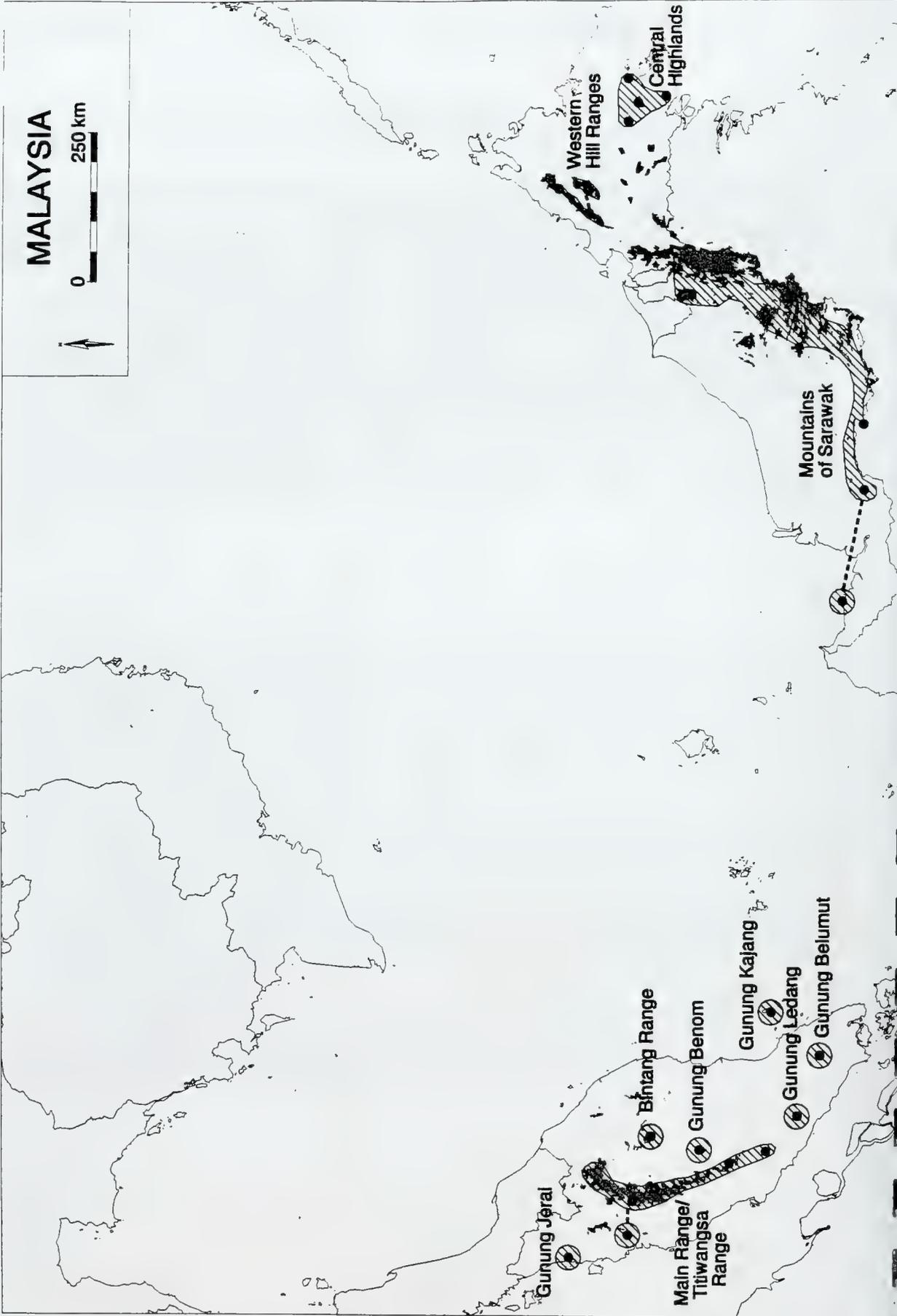
References

- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (Eds.). 1991. *The conservation atlas of tropical forests: Asia and the Pacific*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- Davison, G.W.H. 1991. Birds. In: *The State of Nature Conservation in Malaysia* (R. Kiew, ed.), Malaysian Nature Society. pp. 135-142.
- Davies, A.G. and Payne, J.B. 1982. *A Faunal Survey of Sabah*. World Wildlife Fund Malaysia, Kuala Lumpur.
- Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.
- Kitayama, K. 1993. Biophysical conditions of the montane cloud forests of Mount Kinabalu, Sabah, Malaysia. In: *Tropical montane cloud forests: proceedings of an international symposium* (L.S. Hamilton, J.O. Juvik & F.N. Scatena, eds.). East-West Center, Hawai'i. pp.115-125.
- Laidlaw, R.K. 1994. *The Virgin Jungle Reserves of Peninsular Malaysia: the ecology and dynamics of small protected areas in managed forest*. Unpubl. doctoral dissertation, University of Cambridge.
- Medway, Lord. 1969. *The wild mammals of Malaya*. Oxford University Press, Kuala Lumpur.

- Medway, Lord. 1972. The Gunong Benom expedition 1967. 6. The distribution and altitudinal zonation of birds and mammals on Gunong Benom. *Bull. Br. Mus. Nat. Hist. D.* 23:105-154.
- Payne, J., Francis, C.M. and Phillipps, K. 1985. *A field guide to the mammals of Borneo*. WWF Malaysia/The Sabah Society, Kuala Lumpur.
- Ratnam, L., Nor Azman Hussein and Lim, B.L. 1991. Small mammals in Peninsular Malaysia. In: *The State of Nature Conservation in Malaysia* (R. Kiew, ed.), pp. 150-172. Malayan Nature Society.
- Richards, P.W. 1996. *The tropical rain forest: an ecological study*. 2nd ed. Cambridge University Press.
- Whitmore, T.C. 1975. *Tropical rain forests of the Far East*. Clarendon Press, Oxford.
- Wyatt-Smith, J. 1996. Manual of Malaysian silviculture for inland forest. 2 Vols. 2nd Edition. *Malay. For.Rec.* 23.

MALAYSIA

0 250 km



Cloud Forest Region	Cloud Forest Site	Protected* Yes/No?	
Bintang Range	Gunung Tahan	4°34'N/102°17'E Yes	
Central Highlands	Gunung Lotong	4°58'N/117°31'E Yes	
	Gunung Silam	04°58'N/118°10'E No	
	Segama Highlands	4°49'N/117°48'E Yes	
	Tawau Highlands	4°24'N/117°54'E Yes	
	Gunung Lotong	4°58'N/117°31'E Yes	
Central Highlands - Kuamut	Tawau Highlands	4°24'N/117°54'E Yes	
Central Highlands - Tawau Highlands	Gunung Belumut	2°02'N/103°31'E No	
Gunung Belumut	Gunung Benom	3°50'N/102°05'E Yes	
Gunung Benom	Gunung Benom	3°50'N/102°05'E Yes	
Gunung Jerai	Kedah Peak	5°47'N/100°26'E Yes	
Gunung Kajang	Gunung Kajang	2°46'N/104°10'E Yes	
Gunung Ledang	Mount Ophir	2°22'N/102°36'E Yes	
Main Range/Titiwangsa Range	Bukit Larut/Maxwell Hill	4°54'N/100°47'E Yes	
	Cameron Highlands	4°30'N/101°30'E Yes	
	Gunung Bunga Buah	03°23'N/101°53'E No	
	Gunung Korbu	4°50'N/101°18'E No	
	Gunung Telapak Burok	2°50'N/102°04'E Yes	
	Gunung Yong Blar	/ No	
	Gunung Yong Yap	/ No	
	Mount. of Sarawak-Pegunungan Kapuas	Gunung Lawit	01°26'N/112°58'E Yes
		Tohenbatu	/ Yes
	Mountains of Sarawak	Bukit Batu Bora	02°35'N/114°52'E Yes
Bukit Batu Mabun		02°54'N/114°34'E Yes	
Bukit Kalulong		/ No	
Bukit Kenawang		02°55'N/114°39'E Yes	
Bukit Lanjak		01°25'N/112°00'E Yes	
Dulit Range		/ Yes	
Gunung Api		/ Yes	
Gunung Benarat		04°10'N/114°53'E Yes	
Gunung Lawit		01°26'N/112°58'E Yes	
Gunung Mulu		4°05'N/114°55'E Yes	
Gunung Santubong		01°44'N/110°20'E No	
Hose Mountains		/ Yes	
Linau Balui Plateau		/ Yes	
Penambo Range		/ Yes	
Tamabo Range		/ Yes	
Tohenbatu	/ Yes		
Mountains of Sarawak - Dulit Range	Dulit Range	/ Yes	
Mountains of Sarawak - Gunung	Gunung Benarat	04°10'N/114°53'E Yes	
Mountains of Sarawak - Hose	Hose Mountains	/ Yes	
Mountains of Sarawak - Linau Balui	Linau Balui Plateau	/ Yes	
Mountains of Sarawak - Pegunungan	Bukit Batu Bora	02°35'N/114°52'E Yes	
Mountains of Sarawak - Penambo	Penambo Range	/ Yes	
Mountains of Sarawak - Tamabo Range	Tamabo Range	/ Yes	
Mountains of Sarawak - Usun Apau	Bukit Batu Mabun	02°54'N/114°34'E Yes	
	Bukit Kenawang	02°55'N/114°39'E Yes	
Western Hill Ranges	Crocker Range	5°33'N/116°08'E Yes	
	Gunung Trus Madi	05°34'N/116°29'E Yes	
	Maligan Range	/ Yes	
	Mount Kinabalu	6°00'N/116°30'E Yes	
	Witti Range	/ Yes	
	Maligan Range	/ Yes	
Western Hill Ranges - Maligan Range	Gunung Trus Madi	05°34'N/116°29'E Yes	
Western Hill Ranges - Trus Madi	Witti Range	/ Yes	
Western Hill Ranges - Witti Range	Witti Range	/ Yes	
Total No. of CF Regions= 24	Total No. of CF Sites= 54	Total No. of CF Sites with an element of protection = 46	

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

Cloud Forest Region Summaries: Malaysia

Bintang Range

As with the Main Range, peaks in the Bintang Range mostly reach 1400m. Gunung Tahan is the highest mountain in both the range and in the Peninsula at 2190m. There are thought to be about 2000 vascular plant species on the mountain. Montane ericaceous forest starts at about 1200m where the most abundant species are *Leptospermum flavescens*, *Darydium beccarii*, *Rhododendron* spp., *Vaccinium* spp. and *Nepenthes* spp. The red-cheeked ground squirrel *Dremomys rufigenis*, a squirrel of mountain forest, is common on Gunung Tahan. Also there is a subspecies of the slender squirrel *Sundasciurus tenuis tahan* described from Gunung Tahan, which is found above approximately 1000m. Gunung Tahan is protected within Taman Negara, a National Park (Medway, 1969; Whitmore, 1975; Davis *et al.* (Eds.), 1996; WCMC unpubl. data).

Central Highlands

The Central Highlands include the Labuk, Kuamut, Segama and Tawau Highlands, which reach a height of about 1000m, with higher peaks such as Gunung Lotong (1900m and part of the Gunung Lotong Conservation Area in the Kuamut Highlands). Gunung Silam, known for its ultramafic flora, is a coastal mountain in Sabah where the transition to mossy upper montane forest takes place at c. 610-770m (due to the *Massenerhebung* effect). In the Tawau Highlands mossy forest occurs at about 1000m and is included in the Bukit Tawau Park. Mossy forest is also found in the Segama Highlands, part of which is included in the Danum Conservation Area. Forest in the Central Highlands is largely threatened by logging, and also mining (Collins *et al.* (Eds.), 1991; Davis *et al.* (Eds.), 1996; Richards, 1996; WCMC unpubl. data).

Central Highlands - Kuamut Highlands

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Central Highlands - Tawau Highlands

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Gunung Belumut

The summit of Gunung, which is an isolated peak of 1009m in the State of Johore, lies above the line of prevalent cloud with upper montane forest abutting onto lowland forest at about 810-840m. The forest has about 1500 vascular plant species. It may be under pressure from commercial timber extraction (Whitmore, 1975; Davis *et al.* (Eds.) 1996; Richards, 1996).

Gunung Benom

Gunung Benom is an isolated mountain (2075m) in the State of Pahang. It is protected by the Krau Wildlife Reserve. Pressures on the Reserve include logging and agricultural encroachment. Upper montane forest occurs from about 1500m. There are 48 species of birds found above 1200m, 39 species at 1500m and 31 species at 1800m (Medway; Whitmore, 1975; WCMC unpubl. data).

Gunung Jerai

Gunung Jerai is an isolated coastal mountain of 1200m in the State of Kedah, whose peak is often covered in cloud. The forest is valued as a water catchment area. The mountain is thought to have about 1000 vascular plant species. Although some of the forest on the mountain is protected by four Virgin Jungle Reserves, the area is threatened by visitor pressure associated with tourism. There is also a microwave station on the summit (Whitmore, 1975; Laidlaw, 1994; Davis *et al.* (Eds.), 1996).

Gunung Kajang

Gunung Kajang is on Pulau Tioman and on the crest of Gunung Kajang (1038m) above 1000m, there is mossy, upper montane forest. There are thought to be about 1000 vascular plant species on this mountain. Though the whole of Pulau Tioman is a Wildlife Reserve, plant collecting is a threat (Davis *et al.* (Eds.), 1996).

Gunung Ledang

An isolated mountain in the State of Johore, Gunung Ledang (1243m) is an important water catchment area and is thought to have about 1000 vascular plant species. Though the peak is partly protected by two Virgin Jungle Reserve, all summit vegetation has been destroyed by campers. There is also some disturbance from a microwave station and the area is threatened by a planned large-scale hill resort (Laidlaw, 1994; Davis *et al.* (Eds.), 1996).

Main Range/Titiwangsa Range

The majority of mountain peaks in Peninsular Malaysia lie on the Main Range. Peaks in the Main Range mostly reach 1400m. Montane sites include the Cameron Highlands (i.e. Gunung Brinchang, Gunung Jasar and Gunung Beremban), Bukit Larut/Maxwell Hill (1389m), Gunung Telapak Burok (1193m), Gunung Korbu (2179m), Gunung Yong Yap (2164m), Gunung Yong Blar (2178m) and Gunung Bunga Buah. Three of these sites, Cameron Highlands, Gunung Telapak Burok (in Berembun Forest Reserve) and Bukit Larut contain small protected areas of forest (Virgin Jungle Reserve). There is also a Wildlife Sanctuary in the Cameron Highlands. A major threat to the montane forests of the Main

Range is a mountain road planned to link hill resorts. The purpose of this road is to open up land for logging, residential housing and agriculture. The result is likely to be widespread damage to the upper montane forests, as well as landslips, soil erosion and siltation downstream (Whitmore, 1975; Collins *et al.* (Eds.), 1991; Laidlaw, 1994; Davis *et al.* (Eds.), 1995; WCMC unpubl. data).

Mount. of Sarawak-Pegunungan Kapuas Hulu

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Mountains of Sarawak

Including the upland areas of Gunung Mulu (2376m), Gunung Benarat (1515m) and Gunung Api (1750m), all part of the Gunung Mulu National Park; Tamabo Range; Penambo Range; Bukit Kalulong (1641m); Dulit Range and Gunung Dulit (1369m); Usun Apau Plateau and Bukit Batu Mabun (1270m) and Bukit Kenawang (1280m); Pegunungan Iban and Bukit Batu Bora (1465m); Linau Balui Plateau; Hose Mountains (highest peak 2012m); Pegunungan Kapuas Hulu and Tohenbatu (1527m) and Gunung Lawit (1767m); Boven Kapuas Mountains; Bukit Lanjak (1281m and included in the Lanjak-Entimau Wildlife Sanctuary); and Gunung Santubong (797m). Due to the *Massenerhebung* effect the limits of the altitudinal zones are much higher on inland mountains than on mountains near to the coast. For example, Gunung Santubong, an isolated mountain on the coast (797m) contains upper montane forest, whereas the inland Gunung Mulu and Gunung Dulit are covered with low cloud above an altitude of about 1000m for most of the year, with upper montane forest found above 1600m on Gunung Mulu. In the short facies of the Gunung Mulu upper montane forest, the most abundant tree species are *Lithocarpus hatuisimae*, *Dacrydium* and *Phyllocladus* and higher up, *Calophyllum garcinioides*, *Eugenia kinabaluensis*, *Dacrydium* and *Phyllocladus*. Smaller woody plants include many Ericaceae some of which are epiphytic. Scrambling *Nepenthes* (including small tree ferns as well as terrestrial orchids and other ground herbs. Above 1000m on Gunung Api a limestone variant of upper montane moss forest may be found. The composition of this

community is similar to that of the upper montane forest on Gunung Mulu. Logging is the predominant pressure on these forests (Whitmore, 1975; Collins *et al.* (Eds.), 1991; Davis *et al.* (Eds.), 1996; Richards, 1996; WCMC unpubl. data).

Mountains of Sarawak - Gunung Benarat

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Mountains of Sarawak - Hose Mountains

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Mountains of Sarawak - Linau Balui Plateau

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Mountains of Sarawak - Pegunungan Iban

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Mountains of Sarawak - Penambo Range

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Mountains of Sarawak - Tamabo Range

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Mountains of Sarawak - Usun Apau Plateau

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Western Hill Ranges

The Western Hill Ranges are mainly sedimentary formations up to about 1500m, with higher peaks such as Gunung Trus Madi (2649m) and Mount Kinabalu (the highest mountain in Malesia outside New Guinea at 4101m). The Western Hill Ranges includes the Crocker, Witti, Maligan and Trus Madi Ranges. The Crocker Range contains a Virgin Jungle Reserve and a National Park. Mount Kinabalu is perhaps the most famous site with upper montane forest in Sabah. It is also considered to be by far the most important botanical site in Borneo and is protected within the Kinabalu Park. Montane forest is the dominant vegetation type comprising 37% of the Park. With greater altitudes the montane habitats increasingly comprise species of Fagaceae, Ericaceae, Myrtaceae, Lauraceae, Magnoliaceae and Guttiferae along with conifers such as *Agathis*, *Dacrycarpus*, *Podocarpus*, *Phyllocladus* and *Dacrydium*. Members of the Nepenthaceae are also present in these habitats including the Kinabalu endemic *Nepenthes raja*. Montane mammal species include the Kinabalu squirrel *Callosciurus baluensis* and the summit rat *Rattus baluensis*. The mountain has long been regarded as a sacred mountain by the native Dusun people and given the wealth of species, the area is also of considerable scientific importance. In addition, it is valued for tourism (in 1991 the Park received 233,965 visitors) and the forest also acts as a very important catchment area. Pressures on the montane habitats include visitor pressure and illegal plant collecting (Davies & Payne, 1982; Kitayama, 1993; Payne *et al.*, 1985; Collins *et al.* (Eds.), 1991; Davies *et al.* (Eds.), 1996; Richards, 1996; WCMC unpubl. data).

Western Hill Ranges - Maligan Range

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Western Hill Ranges - Trus Madi Range

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

Western Hill Ranges - Witti Range

Presence of cloud forest, indicated but not confirmed. (WCMC 1997).

MYANMAR

The forests of Myanmar are under considerable pressure as a result of forest degradation, over hunting and deforestation. In addition, they are poorly documented largely due to political unrest in the country. The Myanmar Forestry Department, however, aims to include 5% of the total land area in the Myanmar protected area network. Upland areas in Myanmar include the Chin Hills in west-central Myanmar and the Shan Plateau in east-central Myanmar (Thein Lwin *et al.* 1990; Collins *et al.* (Eds.), 1991; Davis *et al.* (Eds.), 1995).

References

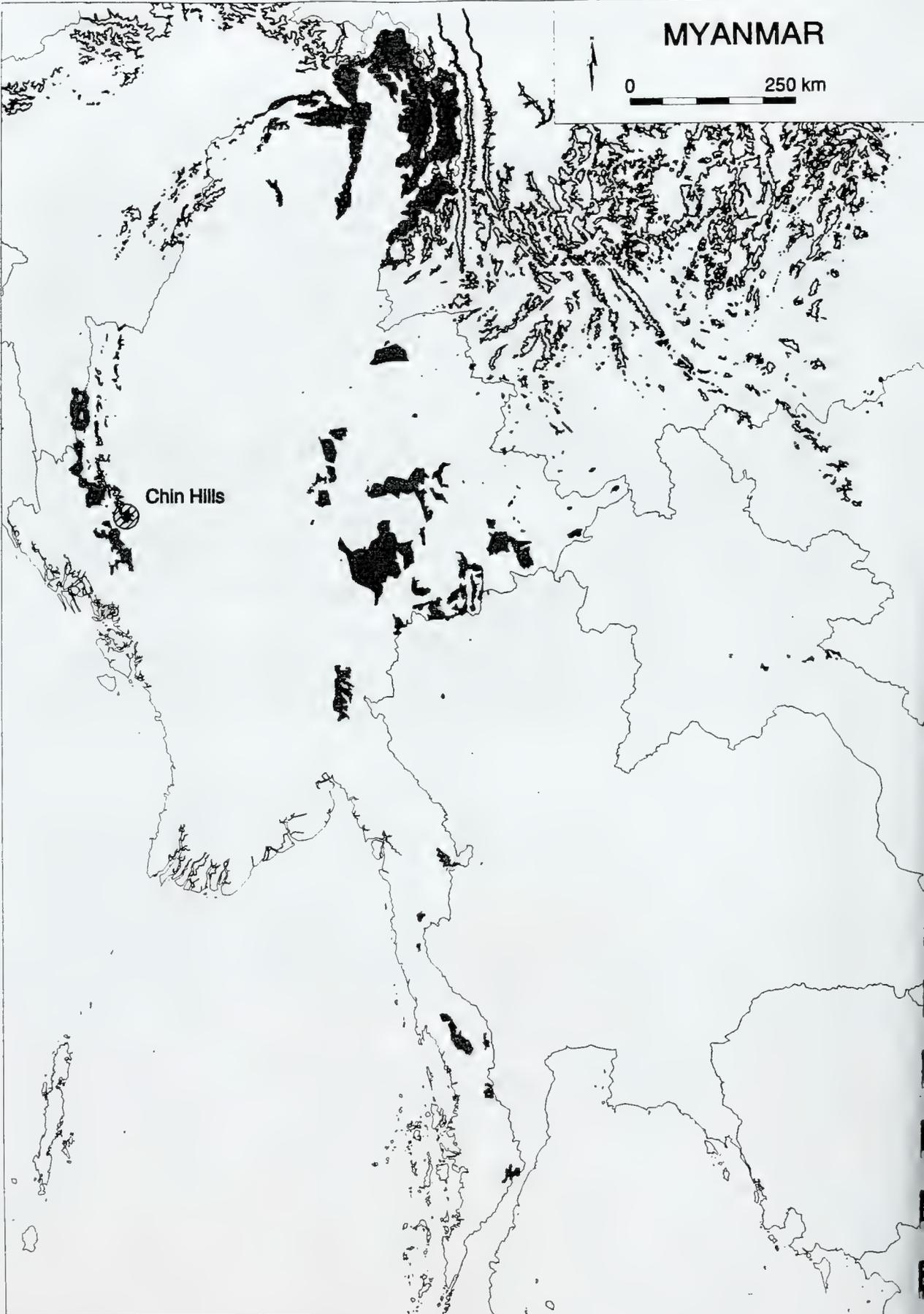
- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (Eds.). 1991. *The conservation atlas of tropical forests: Asia and the Pacific*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.
- FAO. 1983. *Nature conservation and National Parks, Burma: interim report (FO: DP/BUR/80/006)*. FAO, Rangoon.
- Forest Department Myanmar. 1991. *Forest Resources of Myanmar: conservation and management*. Forest Department Myanmar.
- Thein Lwin, Uga and Saw Tun Khaing. 1990. *Wildlife conservation in Myanmar*. Ministry of Agriculture and Forests, Myanmar.

MYANMAR

0

250 km

Chin Hills



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Chin Hills	Natma Taung/Mount Victoria	21°12'N/ 93°55'E	Yes
Total No. of CF Regions= 1	Total No. of CF Sites= 1	Total No. of CF Sites with an element of protection = 1	

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

Cloud Forest Region Summaries: Myanmar

Chin Hills

The Chin Hills are about 400km long and contain several peaks over 2500m. The highest peak in both the Chin Hills and in southern and central Myanmar is Natma Taung (Mount Victoria) at 3053m. Subtropical evergreen forest occurs at 1000-2130m and is below the mist-line, whereas temperate semi-evergreen forest occurs at 1830-3053m and is above the mist-line. This area is thought to contain a number of endemics, possibly including the white-browed nuthatch *Sitta victoria*, which is only known from Natma Taung. Natma Taung has been proposed as a National Park. It is valued by the local people who collect beewax, firewood, fruit and orchids from the forest. Threats to the area include habitat loss and hunting (FAO, 1983; Forest Department Myanmar, 1991; Collins *et al.* (Eds.), 1991; Davies *et al.* (Eds.), 1995; WCMC unpubl. data).

PAPUA NEW GUINEA

Papua New Guinea politically comprises not only the eastern half of New Guinea Island, but also a considerable number of islands, including New Britain, New Ireland, Bougainville Island, Goodenough Island and Fergusson Island. All of which are thought to contain at least some areas of cloud forest. The majority of cloud forests, however, are found on the New Guinea Cordillera, which is likely to be rich in endemics. Partly due to the complex system of land tenure, only two cloud forest sites (Mount Giluwe and Mount Wilhelm) are included in protected areas. Pressures on these forests include natural environmental factors (cyclones and landslides), agriculture and logging. The forests are valued for timber, food, medicines, textiles, fuel and ornaments (Davis *et al.* (Eds.), 1995; WCMC unpubl. data).

References

- Brass, L.J. 1956. Results of the Archbold expeditions. No.75. Summary of the fourth Archbold expedition to New Guinea (1953). *Bull. Am. Mus. Nat. Hist.* 111:80-152.
- Brass, L.S. 1959. Results of the Archbold expeditions. No.79. Summary of the fifth Archbold expedition to New Guinea (1956-57). *Bull. Am. Mus. Nat. Hist.* 118:1-70.
- Brass, L.S. 1964. Results of the Archbold expeditions. No.86. Summary of the sixth Archbold expedition to New Guinea (1959). *Bull. Am. Mus. Nat. Hist.* 127:145-215.
- Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.
- Paijchmans, K. 1975. Explanatory notes to the vegetation map of New Guinea. *Land Research Series No.35*. Commonwealth Scientific and Industrial Research Organisation. Australia.
- Richards, P.W. 1996. *The tropical rain forest: an ecological study*. 2nd ed. Cambridge University Press.
- Whitmore, T.C. 1975. *Tropical rain forests of the Far East*. Clarendon Press, Oxford.

PAPUA NEW GUINEA

250 km

0



New Ireland Island

New Britain Island

New Guinea
Cordillera

Goodenough Island

Fergusson Island



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
New Britain Island	New Britain	/	No
New Guinea Cordillera	Crater Mount	06°37'S/145°05'E	No
	Doma Peaks	05°54'S/143°43'E	No
	Mount Aiyang	/	No
	Mount Albert Edward	08°53'S/147°20'E	No
	Mount Amungwiwa	07°27'S/146°35'E	No
	Mount Bangeta	06°17'S/147°05'E	No
	Mount Dayman	09°50'S/149°15'E	No
	Mount Giluwe	06°06'S/143°54'E	Yes
	Mount Haagen	05°45'S/144°05'E	No
	Mount Herbert	05°54'S/144°59'E	No
	Mount Ialibu	06°16'S/144°02'E	No
	Mount Kerewa	06°00'S/143°45'E	No
	Mount Kubor	06°10'S/144°43'E	No
	Mount Lawson	07°43'S/146°35'E	No
	Mount Michael	06°25'S/145°20'E	No
	Mount Obree	09°30'S/148°04'E	No
	Mount Otto	05°59'S/145°28'E	No
	Mount Piora	06°45'S/146°00'E	No
	Mount Saint Mary	08°09'S/146°59'E	No
	Mount Simpson	10°05'S/149°36'E	No
	Mount Strong	07°58'S/147°57'E	No
	Mount Suckling	09°49'S/148°53'E	No
	Mount Victoria	08°52'S/147°32'E	No
Mount Wilhelm	05°46'S/144°59'E	Yes	
Mount Yelia	07°01'S/145°52'E	No	
The Sugarloaf	05°47'S/143°45'E	No	
New Ireland Island	New Ireland	/	No

Total No. of
CF Regions= 3

Total No. of
CF Sites= 28

Total No. of CF Sites with
an element of protection = 2

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

Cloud Forest Region Summaries: Papua New Guinea

New Britain Island

The vegetation of this island is little known and may contain cloud forest (Davis *et al.* (Eds.), 1995).

New Guinea Cordillera

This huge Cordillera runs the length of New Guinea, i.e. Papua New Guinea and Irian Jaya (see Indonesia) and has several peaks over 4000m. Other than Mount Kinabalu (4101m - see Malaysia), the mountains of New Guinea are the only mountains in the region that extend above the climatic tree line. The forest zones of Malesia attain their greatest height, variation with elevation and are the most extended on this mountain chain and it is thought that due to the huge mass of the Cordillera, it is the only mountain range in the tropical Far East likely to show a substantial *Massenerhebung* heating effect. The affinities of the New Guinea montane flora are mainly Malesian and Australian. There is, however, a high degree of endemism at specific level. Upper montane forest is found at about 3000m upwards and may be divided into two distinct floristic zones; cloud forest at 3000-3300/3350m and lower subalpine forest at 3300/3350-350/3600m. On the highest mountains, a third zone has been distinguished; upper subalpine forest. The upper montane flora is much poorer than that of the lower montane. Elaeocarpaceae and ground ferns are less abundant and Lauraceae distinctly rare, whereas ground-dwelling Ericaceae are fairly common. The canopy is generally less than 20m high. The abundance and luxuriance of bryophytes varies, but typically trees are covered with hepatics, mosses and other epiphytes. Cloud forest sites are thought to occur on the following peaks: Mount Aiyang (3993m), Doma Peaks (3962m), Mount Kerewa (3414m), The Sugarloaf (3962m), Mount Giluwe (4088m), Mount Ialibu (3353m) Mount Haagen (4000m), Mount Wilhelm (4508m - the highest point in Papua New Guinea), Mount Herbert (4267m), Mount Kubor (4359m), Mount Otto (3539m), Mount Michael (3810m), Crater Mount (3231m), Mount Piora (3719m), Mount Yelia (3810m), Mount Bangeta (4107m), Mount Amungwiwa (3277m), Mount Lawson (3216m), Mount Strong (3766m), Mount Saint Mary (3654m), Mount Albert Edward (3993m), Mount Victoria (4073m), Mount Obree (3129m), Mount Suckling (3676m), Mount Dayman and Mount Simpson (3039m) (Brass, 1956, 1959, 1964; Paijmans, 1975; Whitmore, 1975; FAO, 1989; Davis *et al.* (Eds.), 1995; Richards, 1996; WCMC unpubl. data).

New Ireland Island

This island may contain cloud forest (Davis *et al.* (Eds.), 1995).

PHILIPPINES

In the Philippines, tropical montane cloud forests, known locally as mossy forests, occur in rugged mountain regions above 900m elevation. They are best developed on mountains above 1200m. The upper limits vary depending on the locality and height of the mountain. Mossy forests cover about 8% of the land area and comprise the majority of remaining non-commercial native forest. There are estimated to be about 57 bryophyte, 91 fern, 18 gymnosperm and 377 angiosperm species in Philippine mossy forests. Typical trees in these forests are conifers of the genera *Dacrydium*, *Dacrycarpus* and *Podocarpus* as well as broadleaves of the genera *Lithocarpus*, *Symplocos*, *Engelhartia*, *Syzygium* and *Myrica*. Species of Ericaceae (*Rhododendron*, *Vaccinium*) and Melastomataceae (*Astonia*, *Medinilla*, *Melastoma*) are common as well as the tree fern genus *Cyathea*. In addition, there are an abundance of liverworts and mosses (66 species of mosses are endemic to the Philippines). These mossy forests are generally two-tiered with trees reaching an average height of 10m and having a diameter of less than 40cm. They are said to have little commercial value but are considered to have an important role to play in ensuring watershed stabilization (Tan, 1984; Cox, 1988; Fernando, 1988; Collins *et al.* (Eds.), 1991; Penafiel, 1993; Davis *et al.* (Eds.), 1995).

References

- Anon. 1988. *Development of an integrated protected areas system (IPAS) for the Philippines*. WWF-USA, DENR and Haribon Foundation unpubl. report.
- Anderson, G., Asane, D., Brooks, T., Dutson, G., Evans, T., Timmins, R. and Toledo, A. 1991. *Preliminary report of the Cambridge Philippines rainforest project 1991*. Unpubl.
- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (Eds.). 1991. *The conservation atlas of tropical forests: Asia and the Pacific*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- Cox, R. 1988. *The conservation status of biological resources in the Philippines: a report by the IUCN Conservation Monitoring Centre*. Draft prepared for IIED.
- Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.
- Enables, B.U. 1978. *Notes on Makiling Botanic Gardens and the Makiling Forest*. Unpubl.
- Fernando, E.S. 1988. Diversity of the flora in Philippines forest ecosystems. In: *Proceedings of the technical workshop on Philippine biological diversity*. Haribon Foundation and the International Institute for Environment and Development.

A GLOBAL DIRECTORY OF TROPICAL MONTANE CLOUD FORESTS

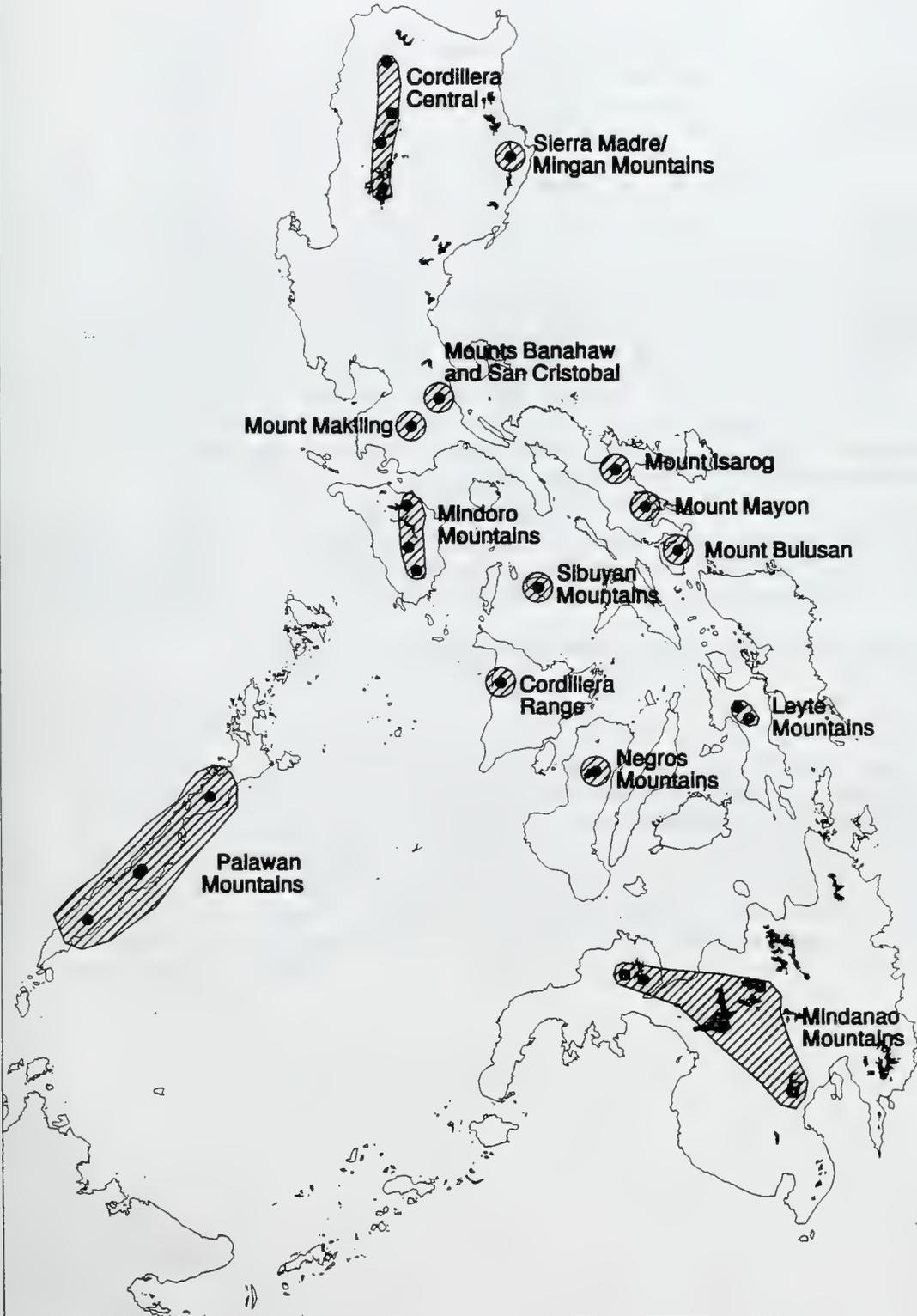
- Goodman, S.M. and Gonzales, P.C. 1990. The birds of Mt. Isarog National Park, Southern Luzon, Philippines, with particular reference to altitudinal distribution. *Fieldiana: Zoology New Series, No. 60*. Field Museum of Natural History.
- Penafiel, S.R. 1993. The biological and hydrological values of the mossy forests in the Central Cordillera Mountains, Philippines. In: *Tropical Montane Cloud Forests: Proceedings of an International Symposium* (eds. L.S. Hamilton, J.O. Juvik and F.N. Scatena). pp.171-175. East-West Center.
- Richards, P.W. 1996. *The tropical rain forest: an ecological study*. 2nd ed. Cambridge University Press.
- Whitmore, T.C. 1975. *Tropical rain forests of the Far East*. Clarendon Press, Oxford.
- Tan, B.C. 1982. Checklist of mosses of Mt Makiling (Luzon Island, Philippines). *Quart. Journ. Taiwan Museum* 35:135-148.
- Tan, B.C. 1984. A reconsideration of the affinity of the Philippine moss flora. *J.Hattori Bot.Lab.* 55:13-22.
- Tan, B.C. 1996. Biogeography of Palawan Mosses. *Australian Systematic Botany* 9:193-203.

PHILIPPINES



0

250 km



Cloud Forest Region	Cloud Forest Site	Protected*	
		Yes/No?	Yes/No?
Cordillera Central	Mount Dana	17°10'N/120°53'E	Yes
	Mount Pulog	16°36'N/120°53'E	Yes
	Mount Sapocoy	17°29'N/121°00'E	No
	Mount Tabayoo	16°41'N/120°54'E	No
	Sicapoo	18°02'N/120°57'E	No
Cordilleras Range	Mount Baloy	11°23'N/122°09'E	No
Leyte Mountains	Mount Lobi	11°00'N/124°48'E	Yes
	Mount Tinagan	11°07'N/124°41'E	Yes
Mindanao Mountains	Mount Apo	6°59'N/125°16'E	Yes
	Mount Dapiak	8°15'N/123°28'E	No
	Mount Kitanglad	08°07'N/124°55'E	Yes
	Mount Malindang	8°12'N/123°40'E	Yes
	Mount Ragang	7°41'N/124°30'E	No
Mindoro Mountains	Mount Baco	12°50'N/121°10'E	Yes
	Mount Halcon	13°17'N/121°09'E	No
	Mount Iglit/Mangibok	12°35'N/121°15'E	Yes
	Mount Malasimbo	/	Yes
	Mount Bulusan	Mount Bulusan	12°48'N/124°03'E
Mount Isarog	Mount Isarog	13°40'N/123°23'E	Yes
Mount Makiling	Mount Makiling	14°08'N/121°12'E	Yes
Mount Mayon	Mount Mayon	13°16'N/123°42'E	Yes
Mounts Banahaw and San Cristobal	Mounts Banahaw and San Cristobal	14°26'N/121°30'E	Yes
Negros Mountains	Mount Canlaon	10°26'N/123°10'E	No
Palawan Mountains	Cleopatra Needle	10°10'N/119°02'E	Yes
	Mount Beaufort	/	Yes
	Mount Mantalingajan	8°51'N/117°43'E	Yes
	The Teeth	9°21'N/118°16'E	No
	Victoria Peak	12°23'N/118°18'E	Yes
	Mount Guiting-Guiting	12°24'N/122°33'E	No
Sibuyan Mountains	Mount Cresta	/	No
Sierra Madre/Mingan Mountains	Mount Divilacan	/	No
	Mount Palanan	17°01'N/122°16'E	No
Total No. of CF Regions= 14	Total No. of CF Sites= 32	Total No. of CF Sites with an element of protection = 19	

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

Cloud Forest Region Summaries: Philippines

Cordillera Central

The Cordillera Central is located in the north-west of the island of Luzon. The dominant tree species in the canopy of the mossy forests of this mountain range are *Lithocarpus jordanae*, *L. scleriana*, *L. coopertus*, *Vicinium* spp., *Melastoma topingii*, *Eurya acuminata* and some gymnosperms represented by *Taxus sumatrana*, *Phyllocladus stugii* and *Darycarpus cumingii*. The subcanopy comprises *Clethrea canescens*, *Cyathea* spp., *Smilax* spp., *Decaspermum* spp., *Medenilla* spp., *Melastoma topingii* and *Duplocosia* spp. 5821 ha of mossy forest are contained within the Mount Pulog National Park, including Mount Pulog (2929m), the highest mountain in Luzon. The flora of this area has affinities with the montane floras of Sulawesi, New Guinea and Sabah, in particular Mount Kinabalu. Endemism is, however, quite high with approximately 23% of the total number of genera represented in the flora being endemic to Mount Pulog and its vicinities. The fauna includes the near-endemic bushy-tailed cloud rat *Crateromys schadenbergi*, nine species of bird endemic to Mount Pulog and eight species of bird, which are endangered. A second protected mossy forest site in this mountain range is Mount Data (-Bontoc) in the Mount Data National Park. Average annual rainfall in this site over a three-year period was recorded as 3770mm at an elevation of 2353m. The endemic forest rat *Batomys granti* is known only from Mount Data. Other peaks in this mountain range include Sicapoo (2234m), Mount Sapocoy (2456m) and Mount Tabayoo (2842m). The greatest threat to mossy forests in the Central Cordillera is the clearing of land in order to grow temperate and semi-temperate vegetable crops. Other threats include hunting and the extraction of certain tree species for house construction (Cox, 1988; Penafiel, 1993).

Cordilleras Range

The Cordilleras Range is located in the Island of Panay (one of the Visayas Islands). Mount Baloy (2049m), which is rich in gymnosperm and tree fern species, is located in western Panay and contains montane forest. The largest and possibly only viable population of the endemic Philippine spotted deer *Cervus alfredi*, which is in imminent danger of extinction, is found in the Mount Maja-as/Mount Baloy area. The endemic Visayan wild pig *Sus barbatus cebifrons* is also seriously threatened by habitat destruction and hunting. The area is threatened by illegal logging and shifting cultivation, but has no legal protection (Cox, 1988; Davis *et al.* (Eds.), 1995).

Leyte Mountains

The Leyte mountains are located on the Island of Leyte (one of the Visayas Islands) and contain mossy forest. This forest type is included in the Leyte Mountain National Park on the higher mountain ridges, for example, Mount Tinagan (1125m) and Mount Lobi (1310m). Deforestation threatens these forests (WCMC unpubl. data).

Mindanao Mountains

Mount Apo (2954m) is the highest peak in the Philippines. On this mountain, montane forest occurs above about 2000m. It includes species of *Lithocarpus*, *Cinnamomum*, *Melastoma*, *Caryota*, *Calamus*, *Ficus*, *Agathis* and many Lauraceae. Lichens, bryophytes, begonias, orchids, aroids, *Selaginella* and *Nephrolepis* ferns abound. Between 2400-2700m the vegetation is more open and stunted and is described as elfin. Upper montane endemics are *Cypholopus microphyllus* and *Nepenthes copelandii*. The fauna of Mount Apo includes several threatened animals, such as 24 highland restricted-range birds. Major pressures on the area include a geothermal power station, resettlement schemes, shifting cultivation and illegal logging. The mountain is included in Mount Apo National Park. Other peaks in Mindanao are Mount Kitanglad (2379m) contained by Mount Kitanglad Range National Park, Mount Dapiak (2560m), Mount Malindang (2425m) contained by Mount Malindang National Park and Mount Ragang (2815m) (Davis *et al.* (Eds.), 1995).

Mindoro Mountains

Some of the highest peaks on the island of Mindoro are Mount Halcon (2585m), Mount Malasimbo (1800m), Mount Iglit/Mangibok (1432m) and Mount Baco (2400m). Both Mount Iglit and Mount Baco are included in the Mount Iglit-Baco National Park, where management constraints include cattle ranching, farming, firewood gathering and settlements. Mossy forests are found in this area above 1000m. Mount Malasimbo is included in the Puerto Galera Biosphere Reserve (WCMC unpubl. data).

Mount Bulusan

The isolated volcano of Mount Bulusan (1560m) is thought to contain mossy forest. It is part of Bulusan Volcano National Park (WCMC unpubl. data).

Mount Isarog

This isolated mountain is located in southern Luzon and is included in the Mount Isarog National Park. Mossy forest is found at an elevation of 1500m to the summit at 1966m. A total of 135 bird species have been recorded on Mount Isarog: 116 residents and 19 migrants. The area is severely threatened by deforestation from illegal logging, poaching and squatters (Anon, 1988; Goodman & Gonzales, 1990).

Mount Makiling

Mount Makiling (Maquiling) is an isolated extinct volcano (1140m) situated in south Central Luzon. The flora of Mount Makiling has been studied in detail: The mossy forest zone occurs between 900-1140m and is similar to that on other Malesian mountains. There is a single tree storey of 6-10m high, with a covering of bryophytes, ferns and other epiphytes, up to 30cm thick (a total of 21 species of mosses have been reported from the mountain and macrophylls are absent. There is a fairly dense ground cover of herbaceous plants, including ferns. Climbing plants are plentiful, but not diverse in terms of species. The commonest trees are the tree fern *Cyathea caudata* and *Astonia lagunensis*. Threats to the area include illegal conversion to agriculture, illegal squatting and a geothermal plant. The Mount Makiling Faunal Reserve and the Mount Makiling Botanic Gardens are situated in this area (Enalbes, 1978; Tan, 1982; Davis *et al.* (Eds.), 1995; Richards, 1996).

Mount Mayon

This isolated volcano (2421m) in the south of Luzon is thought to contain mossy forest. It is part of Mayon Volcano National Park (WCMC unpubl. data).

Mounts Banahaw and San Cristobal

These mountains are situated in south Central Luzon to the east of Mount Makiling. Threats to the forests are similar to those pressurising the Mount Makiling forests. The mountains are included in the Mounts Banahaw-San Cristobal National Park (Davis *et al.* (Eds.), 1995).

Negros Mountains

These mountains on the island of Negros (one of the Visayas Islands) contains mossy forest. This forest type has legal protection in Mount Canlaon National park. The forest is, however, under severe threat from deforestation (Anderson *et al.*, 1991).

Palawan Mountains

The island of Palawan has the highest percentage of forest cover in the Philippines archipelago. Montane forests occur between 800m and 1500m on some of the highest peaks, for example, Mount Mantalingajan (2054m) the highest mountain in Palawan. The Teeth (1798m) and Cleopatra Needle (1593), Mount Beaufort and Victoria Peak. Common species of upper montane forest are *Agathis philippinensis*, *Dacrydium pectinatum*, *Podocarpus polystachyus*, *Gnetum latifolium*, *Cycas wadei*, *Cinnamomum rupestre*, *Nepenthes philippinensis* and *Angiopteris* spp. The moss flora of Palawan consists of 192 species in 88 genera. The most serious threats to the forests are logging and shifting cultivation. The whole of the island of Palawan has been declared a Biosphere Reserve (Davis *et al.* (Eds.), 1995; Tan, 1996).

Sibuyan Mountains

Sibuyan Island is composed of several volcanic mountain masses, the highest point being Mount Guiting-Guiting (2052m). The montane forest on this island includes small to medium-sized trees, such as *Dacrydium elatum*, *Vaccinium gitingensis*, *Agathis* spp. and *Podocarpus* spp. Several plant species are known to be endemic to this mountain. Fifty-four species are endemic to Sibuyan Island (Cox, 1988; Davis *et al.* (Eds.), 1995).

Sierra Madre/Mingan Mountains

This mountainous area is located along the north east coast of the island of Luzon. It is largely bounded on the west by the Cagayan Valley and on the east by the Philippine Sea. Some of the highest peaks in the area include Mount Cresta (1672m), Mount Divilacan (1311m) and Mount Palanan (1184m). Numerous endemics and rare species are restricted to this area, with many species being restricted to particular vegetation types such as the mossy forests. The forests are threatened by the expansion of towns, illegal squatters, over-exploitation for forest products and by selective logging by local people. Part of the area was included in the Palanan Wilderness Area in 1979 (Davies *et al.* (Eds.), 1995).

SRI LANKA

The upper montane rain forests of Sri Lanka occur above 1500m in the Central Highlands and Knuckles Mountains. The original area is thought to have been about 600sq. km., but now only fragments survive. Much of the land has been cleared for tea plantations, vegetable gardens, terraced rice fields, housing and large plantations of *Eucalyptus* and *Pinus caribbea* and rubber at lower elevations. At present, however, over 26,682 ha of montane forests are legally protected. The upper montane forests are characterised by Lauraceae (*Cinnamomum*, *Litsea*, *Actinodaphne*) and Myrtaceae (*Syzygium*, *Eugenia*, *Rhodomyrtus*), followed by Clusiaceae (*Calophyllum*, *Garcinia*), Theaceae (*Gordonia*, *Ternstroemia*), Elaeocarpaceae and Symplocaceae. Gymnosperms and Fagaceae, which are prominent in the mountains of Asia and other regions of the world are lacking in South India and Sri Lanka, as, unusually, in Sri Lanka the montane species are thought to derive from the rain forest flora of the lowlands. The montane forests are known to be rich in endemic herbs. In addition, they are valued for their contribution of additional moisture through interception of fog. Unique animal species which inhabit swamps in and around the cloud forests include two endemic and monotypic shrews, *Feroculus feroculus* and *Solisorex pearsonii* (Sumithraarachchi, 1989; Collins *et al.* (Eds.), 1991; IIED, 1992; Werner & Balasubramaniam, 1992; Dent & Goonewardene, 1993; Green & Gunawardena, 1993; Werner, 1993)

References

- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (Eds.). 1991. *The conservation atlas of tropical forests: Asia and the Pacific*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- Dent, D.L. & Goonewardene, L.K.P.A. 1993. *Resource Assessment and Land Use Planning in Sri Lanka: a case study*. Environmental Planning Issues No.4.
- Forest Department. ? *The Knuckles Range (Dumbara Hills)*. Education & Extension Division Forest Department Sri Lanka.
- Green, M.J.B. & Gunawardena, E.R.N. 1993. *Conservation evaluation of some natural forests in Sri Lanka*. Unpubl. report.
- IUCN & Sri Lankan Forest Department. 1994. *Management plan for the conservation of the Knuckles Forest*. Unpubl. report.
- Sumithraarachchi, D.B. 1989. Sri Lankan forests: diversity and genetic resources. In: *Tropical Forests: botanical dynamics, speciation and diversity* (L.B. Holm-Nielsen, I.C. Nielsen & H. Balslev, eds.). Academic Press. pp.253-258.
- Werner, W.L. & Balasubramaniam, S. 1992. Structure and dynamics of the upper montane rain forests of Sri Lanka. In: *Tropical forests in transition: ecology of natural and anthropogenic disturbance processes* (J.G. Goldammer, ed.). Birkhauser Verlag Basel/Switzerland. pp.165-172.

A GLOBAL DIRECTORY OF TROPICAL MONTANE CLOUD FORESTS

- Werner, W.L. 1986. A comparison between two tropical montane ecosystems in Asia
Pidurutalagala (Ceylon/Sri Lanka) and Pangrango-Gede (Java). *Mountain Research
and Development* 6:335-344.
- Werner, W.L. 1993. Biogeography and ecology of the upper montane rain forest of Sri
Lanka (Ceylon). In: *Tropical montane cloud forests: proceedings of an international
symposium* (L.S. Hamilton, J.O. Juvik & F.N. Scatena, eds.). East-West Center,
Hawai'i. pp.224-230.
- WCMC. 1990. *IUCN directory of south Asian protected areas*. IUCN - the World
Conservation Union.

SRI LANKA



0

75 km



**Knuckles
Mountains/
Dumbara**



**Central
Highlands**

Cloud Forest Region	Cloud Forest Site	Protected* Yes/No?	
Central Highlands	Agra Bopats	/ No	
	Bogawantalawa	/ No	
	Conical Hill	06°55'N/080°45'E No	
	Hakagala	/ Yes	
	Hakgala Peak	6°56'N/ 80°48'E Yes	
	Harasbedda	/ No	
	Horton Plains	/ Yes	
	Kandapola Sita Eliya	/ Yes	
	Kikilimana	06°59'N/080°43'E No	
	Kirigalpota	06°48'N/080°45'E Yes	
	Mahakudugala	07°02'N/080°48'E No	
	Namunukula	06°56'N/081°07'E No	
	Nanuoya	06°56'N/080°40'E No	
	Ohiya	/ No	
	Pattipola	/ No	
	Pattipola Ambewela	/ No	
	Peak Wilderness	/ Yes	
	Pedro	/ No	
	Pidurutalagala	07°01'N/080°45'E No	
	Ragala	07°01'N/080°51'E No	
	Sri Pada/Adam's Peak	06°47'N/080°31'E Yes	
	Thangamalai	/ No	
	Welegama	/ No	
	Knuckles Mountains/Dumbara	Dotulugala	/ No
		Dumbanagala	07°23'N/080°52'E No
		Galtuna	/ No
		Gombaniya	07°28'N/080°44'E No
Kalupahana		07°28'N/080°47'E No	
Knuckles		7°22'N/ 80°50'E No	
Koboneelagala		/ No	
Labulessapatana		/ No	
Lakegala		/ No	
Wamarapugala		/ No	
Total No. of CF Regions= 2	Total No. of CF Sites= 33	Total No. of CF Sites with an element of protection = 7	

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

Cloud Forest Region Summaries: Sri Lanka

Central Highlands

Areas of montane cloud forest in the Central Highlands that are protected are contained in Hakgala Strict Nature Reserve (SNR), Horton Plains National Park (NP) and Peak Wilderness Sanctuary. Hakgala SNR ranges from about 1650m to 2178m with Hakgala Peak being the highest point. This area is noted for its endemic Monimiaceae *Hortonia floribunda* and also for a number of mammal endemics such as the purple-faced langur *Presbytis senex* and the toque macaque *Macaca sinica*. Horton Plains NP ranges from 1800m to 2389m and Kirigalpota is the highest point. The forest is dominated by the endemic *Calophyllum walkeri* in association with varieties of Myrtaceae and Lauraceae. A number of wild relatives of cultivated plants, such as pepper, guava, tobacco and cardamon are also found in the cloud forests of this area, along with the endemic long-clawed shrew *Feroculus feroculus* occurs in the area. The highest point in the Peak Wilderness is Sri Pada/Adam's Peak (2238m). Montane cloud forest occurs above 1700m in this Sanctuary and is confined to a narrow strip along the ridge line and slopes of Adams Peak. It is characterised by *Calophyllum walkeri* and *C. trapezifolium*. The continuous areas of Peak Wilderness Sanctuary and Horton Plains NP contain all 21 species of bird endemic to the country. Pidurutalagala, which is not protected, is the highest point in Sri Lanka and in the Central Highlands (2524m). Mossy forest covers the slopes from above 1500m. Other areas of forest in the Central Highlands that are thought to intercept fog include: Agra Bopats Proposed Reserve (PR), Bogawantalawa PR, Conical Hill PR, Harasbedda PR, Kandapola Sita Eliya Forest Reserve (FR), Kikilimana PR, Mahakudugala PR, Namunukula FR, Nanu Oya PR, Ohiya PR, Pattipola Ambewela PR, Pattipola PR, Pedro PR, Ragala PR, Thangamalai and Welegama PR (Werner, 1986; WCMC, 1990; WCMC unpubl. data).

Knuckles Mountains/Dumbara Hills/Batadandu Kanda

The upper montane rain forest in the Dumbara Hills, also locally referred to as cloud forest or moss forest (Dumbara means "covered in mist"), is rich in epiphytic orchids, ferns, mosses and leafy liverworts. The forest is characterised by a single storied canopy and an undergrowth of *Strobilanthes* spp., bamboos, *Impatiens* spp., *Hedyotis* spp. and *Gaertnera* spp. In addition, of the twenty-one endemic bird species of Sri Lanka, fourteen have been observed in the Knuckles region. The highest peaks in the Knuckles Range include Dotulugala (1564m), Koboneelagala (1544m), Knuckles (1852m), Gombaniya (1893m), Kalupahana (1618m), Wamarapugala (1560m), Lakegala (1310m), Labulessapatana (1485m), Dumbanagala (1631m) and Galtuna (1164m). The main ridge has an elevation of about 1515m. The area is threatened by cardamom cultivation in particular. The Knuckles Ranges is, however, valued as an important water catchment area (IUCN & Forest Dept., 1994).

THAILAND

Montane forests are said to be difficult to define and to map in Thailand, because distribution is apparently dependent upon locally complex climatic and topographic variations. Montane forests contain substantial numbers of temperate species which become more abundant to the north of the country. Typical genera include *Castanopsis*, *Lithocarpus* and *Quercus* and to the north the families Aceraceae, Lauraceae, Magnoliaceae and Rosaceae. Tropical montane cloud forest may occur in the north of the country (other than on Doi Inthanon) for example, in Doi Chiang Dao Wildlife Sanctuary and in Thung Yai Naresuan-Huai Kha Khaeng World Heritage Site; in Khao Soi Dao Wildlife Sanctuary, which is part of the Cardamom Mountains (see Cambodia); and also on Luang Mountain (1,786m) on the Isthmus of Kra (Collins *et al.* (Eds.), 1991; Davis *et al.* (Eds.), 1995; WCMC unpubl. data).

References

- Collins, N.M., Sayer, J.A. and Whitmore, T.C. (Eds.). 1991. *The conservation atlas of tropical forests: Asia and the Pacific*. IUCN, Gland & WCMC, Cambridge. Simon & Schuster, New York. pp.335.
- Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.
- Ewins, P.J. & Bazely, D.R. 1989. *A report on wildlife conservation problems in Thailand's National Parks*. Unpubl.

THAILAND



0

250 km



Doi Inthanon



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Doi Inthanon	Doi Inthanon	18°35'N/ 98°29'E	Yes
Total No. of CF Regions= 1	Total No. of CF Sites= 1		Total No. of CF Sites with an element of protection = 1

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

Cloud Forest Region Summaries: Thailand

Doi Inthanon

At 2595m, Doi Inthanon is the highest mountain in Thailand and is included in the Doi Inthanon National Park. The highest peaks above 1850m are frequently cloud covered and contain upper montane forest with small gnarled trees, which are thickly covered with bryophytes. The fauna in this area has been severely depleted by hunting and shifting cultivation has converted forest on the lower slopes into fire climax grasslands (Davies *et al.* (Eds.), 1995; WCMC unpubl. data).

VIET NAM

Three quarters of Viet Nam consists of hills and mountains reaching up to over 3000m. Cloud forest sites may be contained within the two main mountain ranges in the country, the Chaine Annamitique and the Hoang Lien Son mountain range. The latter range includes the highest peak in the country, Phan Si Pan (3143m), which contains deciduous tropical montane forest and subtropical montane forest. The highest mountains in the country, some of which are also included in nature reserves, are in the Hoang Lien Son to the north, the Ngoc Linh in the centre and the Da Lat (Lam Vien/Langbian) Plateau to the south. These areas are said to be the main refuges of local endemic forms of plants and animals. Upper montane forests tend to be dominated by conifers, with an understorey of bamboo. Political unrest and warfare have resulted in extensive deforestation throughout Viet Nam. Currently, 40% of the country is classified as bare land (Vo Quy, 1985; WCMC, 1994; Davis *et al.* (Eds.), 1995; WCMC unpubl. data).

References

- Davis, S.D., Heywood, V.H. and Hamilton, A.C. (Eds.). 1995. *Centres of plant diversity: a guide and strategy for their conservation*. Vol.2 Asia, Australasia and the Pacific. WWF and IUCN. pp.578.
- WCMC. 1994. *The Socialist Republic of Viet Nam: an environmental profile*. Unpubl.
- Vo Quy. 1985. Rare species and protection measures proposed for Viet Nam. In: *Conserving Asia's natural heritage: the planning and management of protected areas in the Indomalayan realm* (J.W. Thorsell, eds.) pp.98-102. Proceedings of the 25th Working Session of IUCN's Commission on National Parks and Protected Areas.

VIET NAM



0

250 km



**Da Lat/Lam Vien/
Lang Bian Plateau**



Cloud Forest Region	Cloud Forest Site		Protected* Yes/No?
Da Lat/Lam Vien/Lang Bian Plateau	Mount Lang Bian	11°56'N/108°25'E	No
Total No. of CF Regions= 1	Total No. of CF Sites= 1	Total No. of CF Sites with an element of protection = 0	

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

Cloud Forest Region Summaries: Viet Nam

Da Lat/Lam Vien/Lang Bian Plateau

The highest points on the Plateau are Bidoup (2289m) and Mount Lang Bian (2140m). However, most of the land on the Plateau is below 1500m. Tropical montane evergreen forest and subtropical montane forest occur above 1700m. Mount Lang Bian contains various montane forests: the principal forest types being conifer secondary forest, comprising mainly *Pinus kesiya*; forest dominated by *Lithocarpus* spp. and oak *Quercus lanata*; and elfin woodland comprising Ericaceae, Podocarpaceae and *Rhododendron*. Distinct faunal species and subspecies have developed on the Plateau. The montane evergreen forest above 900m supports seven restricted-range bird species, of which three are endemic; the grey-crowned crocias *Crocias langbianis*, the black-hooded laughing-thrush *Garrulax milleti* and the collared laughing-thrush *Garrulax yersini*. The forests are valued for water catchment, but are threatened by commercial logging and slash and burn cultivation (Davies *et al.* (Eds.), 1995; WCMC unpubl. data).

TROPICAL MONTANE CLOUD FORESTS: SITE SHEET FORMAT - GUIDE

1) SUMMARY INFORMATION

CLOUD FOREST SITE NAME : name of particular TMCF site
 (if none then protected area or region)

COUNTRY :

REGION : state, province, region and approx location in
 country e.g NE, SW Argentina

SIZE : Area (ha)

LATITUDE : centre point co-ordinates

LONGITUDE : (boundary information if available)

LOW ALTITUDE : Lower altitudinal limit (m above sea level)

HIGH ALTITUDE : Upper altitudinal limit (m above sea level)

RAINFALL : mean annual(mm)
 maximum monthly average
 minimum monthly average

TEMPERATURE : mean annual (°C)
 maximum monthly average
 minimum monthly average

SPECIES INFORMATION FLORA : Species information exists? *Please circle.* Y/N

- Preliminary*
- Extensive
- Comprehensive

Please tick most appropriate

~~X~~ FAUNA : Species information exists? Y/N

- Preliminary*
- Extensive
- Comprehensive

* Preliminary - based on limited field observations
 Extensive - partial surveys of the area
 Comprehensive - systematic surveys

✓ THREATS : Main Threats - *Please tick those with major relevance and add any others:*

- agricultural encroachment
- grazing pressure
- commercial logging
- mining
- hunting
- fire/burning
- non-wood forest products
- tourism
- exploitation of non-wood forest products
- roads
- **others?**

✓ VALUES : Important Values - *Again tick one or more from list below:*

- watershed protection
- soil conservation
- endemism
- socio-cultural
- socio-economic
- medicinal
- biodiversity (endangered species)
- tourism / recreation
- **other?**

→ PROTECTED AREA NAME : Protected Area Name (if relevant)

SPATIAL RELATIONSHIP : Spatial relationship with PA eg. CF is included, includes, same, adjacent. Overlap (ha)?

TROPICAL MONTANE CLOUD FORESTS: SITE SHEET FORMAT - BLANK

Please refer to enclosed guide version for help where needed.

1) SUMMARY INFORMATION

CLOUD FOREST SITE NAME : _____

COUNTRY : _____

REGION : _____

SIZE : _____ ha

LATITUDE : _____

LONGITUDE : _____

LOW ALTITUDE : _____ m asl

HIGH ALTITUDE : _____ m asl

RAINFALL : _____ mm

TEMPERATURE : _____ °C

SPECIES INFORMATION FLORA : Species information exists? *Please circle.* Y/N

Preliminary*

Extensive

Comprehensive

Please tick most appropriate

FAUNA : Species information exists? Y/N

Preliminary*

Extensive

Comprehensive

* Preliminary - based on limited field observations

Extensive - partial surveys of the area

Comprehensive - systematic surveys

THREATS : Main Threats - *Please tick those with major relevance and add any others:*

- agricultural encroachment
- grazing pressure
- commercial logging
- mining
- hunting
- fire/burning
- tourism
- exploitation of non-wood forest products
- roads
- _____
- _____
- _____
- _____

VALUES : Important Values - *Again tick one or more from list below:*

- watershed protection
- soil conservation
- endemism
- socio-cultural
- socio-economic
- medicinal
- biodiversity (endangered species)
- tourism / recreation
- _____
- _____
- _____
- _____

PROTECTED AREA NAME : _____

SPATIAL RELATIONSHIP : _____

2) MORE DETAILED INFORMATION (TEXT BASED) - GUIDE

• SITE DESCRIPTION

Geographical Location

Area

Altitudinal limits

Hydrology - *e.g. catchment extent*

Physical features

Climate - *details of seasonality, max and min rainfall and temperature ranges, temporal distribution, special cloud water characteristics*

• VEGETATION AND FAUNA

Vegetation: - description of forest structure
- details of rare, threatened and endemic spp
- existence of species inventory/records? if so date, and where held?
- more detail on different plant groups
- total species numbers for each group

Fauna: as above, detail on birds, mammals etc.

Ecological value - summary comments

• LEGAL STATUS AND MANAGEMENT

History of Legal Protection

Management responsibility

Land Tenure details

• SOCIO-ECONOMICS

Local Human populations: forest/adjacent communities (including approximate numbers)

Goods and services - socio-cultural, economic, including local uses

• THREATS TO SUSTAINABLE MANAGEMENT

Particular detail on any threats

- **CONSERVATION AND SUSTAINABLE MANAGEMENT INITIATIVES**

Details of active and pending initiatives:

eg. local NGOs, national/international NGOs, bilateral development projects

- **RESEARCH STUDIES**

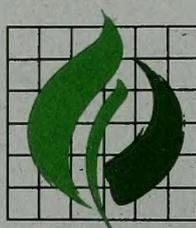
Details of relevant studies, current or completed

Name of institution, list of citations

- **LOCAL ADDRESSES**

- **REFERENCES**

To sources of information



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Cambridge CB3 0DL
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IUCN
The World Conservation Union



The World Conservation Monitoring Centre is a joint-venture between the three partners who developed 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.