Albertine Rift
Technical Reports
Series Number 3

THE BIODIVERSITY OF THE ALBERTINE RIFT

WILDLIFE CONSERVATION SOCIETY

A.J. PLUMPTRE, M.BEHANGANA, T.R.B.DAVENPORT, C.KAHINDO, R.KITYO, E.NDOMBA, D.NKUUTU, I.OWIUNJI, P.SSEGAWA, G.EILU

WCS's Albertine Rift Programme

The WCS Albertine Rift Programme is working to conserve some of Africa's most biodiverse sites for the future generations of Africans and the global community. The Albertine rift stretches from the northern end of lake Albert down to the southern end of lake Tanganyika and encompasses the forests, savannahs, wetlands and mountains to be found in the rift and on the adjacent escarpment in Uganda, Rwanda, Burundi, Tanzania and Democratic Republic of Congo (DRC). This area of Africa contains 52% of all bird species and 39% of all mammal species on the African continent. Many species are endemic to this part of the world and it has been identified as being of global conservation importance by several global priority-setting exercises (it is an endemic bird area, ecoregion and a hotspot). The Albertine Rift Programme focuses on three main goals:

1. The provision of science-based information to enable protected area managers to better manage conservation sites within the region. Current research includes biological surveys of Albertine Rift sites, monitoring of mammal and bird populations in Bwindi Impenetrable National Park, Virunga Volcanoes, Nyungwe National Park and Kahuzi Biega National Park, and more detailed studies of threatened species such as Grauer's rush warbler, golden monkey and chimpanzee. We have recently completed the first census of chimpanzees in Uganda, building on a history of monitoring ape populations through support to the mountain gorilla surveys since 1960. WCS recognises the importance of good science-based information to make sound management decisions.
2. Building capacity of African nationals to be able to use a scientific method in their approach to protected area management, particularly focussing on staff of protected area authorities in the region (UWA, ORTPN, TANAPA and ICCN). WCS is supporting a programme of training wardens of the Uganda Wildlife Authority and in Tanzania's National Parks (TANAPA) to develop sensible monitoring and research programmes in all of Uganda's protected areas. WCS has also been supporting the development of ORTPN and ICCN staff where it works in Rwanda and DRC respectively.
3. Supporting management authorities to manage certain sites within the Albertine Rift through financial support for the basic operating costs, planning, training, monitoring and research programmes. WCS is committed to site conservation over long periods of time because it recognises the need for long term support. We are currently supporting some of the management costs of Nyungwe National Park, Virunga National Park, Bwindi Impenetrable National Park and Kahuzi Biega National Park.

To learn more about the programme visit: www.albertinerift.org

COVER PHOTOS

PHOTO OF VIRUNGA VOLCANOES WITH L'HOEST'S GUENON, BLUE-HEADED SUNBIRD, MOUNTAIN GORILLA, GIANT *LOBELIAS* AND RWENZORI DOUBLE-COLLARED SUNBIRD AS INSETS (CLOCKWISE FROM TOP LEFT). PHOTOS BY A.J. PLUMPTRE.

SUGGESTED CITATION:

PLUMPTRE, A.J., BEHANGANA, M., NDOMBA, E., DAVENPORT, T., KAHINDO, C., KITYO, R. SSEGAWA, P., EILU, G., NKUUTU, D. AND OWIUNJI, I. (2003) THE BIODIVERSITY OF THE ALBERTINE RIFT. *ALBERTINE RIFT TECHNICAL REPORTS* NO. 3

ISSN: 1543-4109

Albertine Rift Technical Reports
Number 3

THE BIODIVERSITY OF THE ALBERTINE RIFT

A.J. PLUMPTRE, M.BEHANGANA, T.R.B.DAVENPORT, C.KAHINDO, R.KITYO, E.NDOMBA, D.NKUUTU, I.OWIUNJI, P.SSEGAWA, G.EILU

Albertine Rift Technical Reports
No. 3

THE BIODIVERSITY OF THE ALBERTINE RIFT

A.J.Plumptre, M. Behangana, T. Davenport,
C.Kahindo, R.Kityo, E.Ndomba, D. Nkuutu,
I. Owiunji, P. Ssegawa, and G. Eilu

Published by Wildlife Conservation Society
2003

Supported by:

The John D. and Catherine T. MacArthur Foundation

USFWS Great Ape Conservation Fund

Dan K. Thorne Foundation

Wildlife Conservation Society

Institutions that provided information

Chicago Field Museum

Conservation International

Makerere University
(MUIENR, Forestry and Nature
Conservation and Zoology)

Missouri Botanical Gardens

Nature Uganda

Royal Botanic Gardens, Kew

Royal Museum of Central Africa, Tervuren

Royal Society for the Protection of Birds

Uganda Forest Department

University of Copenhagen

University of Florida

University of Maryland/Woods Hole Research Center

University of Stuttgart

Wildlife Conservation Society

World Wide Fund for Nature

THE MACARTHUR PROCESS

The John D. and Catherine T. MacArthur Foundation is a private, independent grant making institution dedicated to helping groups and institutions foster lasting improvement in the human condition. As such it supports many different projects around the world. As part of their support to biodiversity conservation they have selected two areas within the African continent where they will focus their activities for the moment; the Cameroon-Nigeria mountains and the Albertine Rift. In February 2001 the Foundation held a meeting in Cyangugu, Rwanda which brought together protected area authorities from all countries in the Albertine Rift (Uganda, Rwanda, Burundi, Democratic republic of Congo and Tanzania), and international and national NGOs to share information about their activities in the rift, and to identify gaps in activities. At the meeting it was agreed that a process would begin to develop a strategic plan for the Albertine Rift, which would include regional planning and monitoring. Many of the protected areas in the Albertine Rift are connected across international borders and it made sense to develop regional as well as national plans to protect these contiguous landscapes. A 'core group' was elected to continue the process comprising Albertine Rift Conservation Society, Dian Fossey Gorilla Fund International, Institute for Tropical Forest Conservation, International Gorilla Conservation Programme, Makerere University Institute for the Environment and Natural Resources, The Wildlife Conservation Society, and World Wildlife Fund. These institutions were selected because they already had programmes with a regional focus in the Albertine Rift.

The core group began a series of meetings to develop a process for regional planning, which has become known informally as the MacArthur Process. As part of the process the group decided to compile what is known of the biodiversity of the Albertine Rift to identify priority sites for conservation in the rift. The Wildlife Conservation Society offered to lead this initiative and during 2002 worked with many scientists to pull together information for protected areas within the Albertine Rift. A meeting organised by the core group in June 2002 also brought experts together to comment on and add to provisional lists. Data were compiled for six taxa; mammals, birds, reptiles, amphibians, butterflies and plants. The data for sites for these taxa are still incomplete as current surveys continue to find new species but we believe we have most of the existing information for each site. Other taxa were poorly known and not collected from many sites and were not considered as a result. This report summarises the results of the data compilation to date and provides a summary of the biological importance of the Albertine Rift.

LE PROCESSUS MACARTHUR

La Fondation John D. et Catherine T. MacArthur est une institution privée, indépendante de financement consacrée à aider les groupes et institutions dans l'amélioration durable des conditions humaines. Ainsi, elle appuie plusieurs projets partout dans le monde. Comme partie de leur appui à la conservation de la biodiversité ; ils ont sélectionné deux zones dans le continent africain où ils concentrent leurs activités pour le moment; les Monts du Cameroun-Nigeria et le Rift Albertin. En février 2001, la Fondation a tenu une réunion à Cyangugu au Rwanda qui a regroupé les autorités de toutes les aires protégées de tous les pays faisant partie du Rift Albertin (Ouganda, Rwanda, Burundi, République Démocratique du Congo et Tanzanie), et les Organisations non gouvernementales Nationales et Internationales pour partager les informations au sujet de leurs activités dans le Rift et d'identifier les lacunes de leurs interventions. Dans la réunion, il a été conclu que le processus devrait développer un plan stratégique pour le Rift Albertin qui devrait inclure la planification et le suivi régionaux. Plusieurs aires protégées du Rift Albertin sont connectées à travers les frontières internationales et il convient de ce fait de développer des plans tant régionaux que nationaux pour protéger ces paysages contigus. Un "groupe noyau"(core group) a été élu pour continuer avec le processus comprenant le Albertine Rift Conservation Society, le Dian Fossey Gorilla Fund International, l'Institute for Tropical Forest Conservation, le Programme International de Conservation des Gorilles, Makerere University Institute for environment and Natural Resources, le Wildlife Conservation Society et le World Wildlife Fund. Ces institutions ont été sélectionnées parce qu'elles avaient déjà des programmes à caractère régional dans le Rift Albertin.

Le groupe noyau a commencé des séries de réunions pour développer le processus de planification régionale, qui a commencé à être reconnu d'une manière informelle comme le processus MacArthur. Comme partie du processus, le groupe avait décidé de compiler les richesses de la biodiversité du Rift Albertin pour identifier les sites prioritaires pour la conservation dans le rift. Le Wildlife Conservation Society a accepté de guider l'initiative et durant l'année 2002, il a travaillé avec plusieurs scientifiques pour rassembler les informations concernant les aires protégées du Rift Albertin. La réunioin organisée par le "groupe noyau" en juin 2002 a aussi réuni les experts pour discuter et amender les listes provisoires. Les données ont été rédigées pour six taxa: les mammifères, les oiseaux, les reptiles, les amphibies, les papillons et les plantes. Les données de ces taxa pour lesdits sites demeurent incomplètes comme les inventaires en cours continuent à découvrir de nouvelles espèces, mais nous croyons avoir la plupart d'informations existentes pour chaque site. Les autres taxa étaient mal connus et non collectionnés pour plusieurs sites et n'étaient pas considérés comme résultat. Ce rapport résume les résultats de la compilation des données et fournit le résumé de l'importance biologique du Rift Albertin.

ACKNOWLEDGEMENTS

Many people contributed to the compilation of the data used in this report. Those who contributed records are named as authors on the respective chapter. Particular people deserve special mention, however, as they contributed a great deal of time in checking lists and revising names of species. In particular we would like to thank John Pilgrim of Conservation International (CI) for comments he made on the mammal and bird lists, Marc Languy from World Wildlife Fund (WWF) for detailed comments on the bird list, Danny Meirte from the Royal Museum of Central Africa, Tervuren, for time he spent updating names for amphibians and reptiles, and Henk Beentje from the Royal Botanic Gardens at Kew for identifying botanical experts to comment on the plant lists. We would also like to thank those people who donated their own unpublished data, in particular Robert Kityo (Makerere University) for unpublished mammal records, Malcolm Wilson (consultant), Marc Languy (WWF), Tom Butynski (CI), Charles Kahindo (Makerere University), Marc Herremans (Tervuren Museum) and Isaiah Owiunji (WCS) for their unpublished bird records, David Nkuutu (WCS), Roy Gereau (Missouri Botanical Gardens), David Hafashimana (Uganda Forest Department), Toshisada Nishida (University of Tokyo), and Gerald Eilu (Makerere University) for plant records, and Danny Meirte (Tervuren Museum) and Harald Hinkel for reptile and amphibian records. Steve Collins (ABRI, Nairobi) provided considerable information on the butterflies, and Colin Congdon (Tanzania) and Alan Gardiner (Zambia) commented on the butterfly endemic species list. Alan Rodgers (UNDP/GEF East Africa) contributed to the development of the map of the Albertine Rift.

Scovia Kobusingye dedicated a lot of time to entering data and updating plant names. We are also grateful to Alison Strugnell at the Department of Plant Sciences, Oxford University for help with floras and where to check species that were potential plant endemics.

SUMMARY

The Albertine Rift stretches from the northern tip of Lake Albert to the southern tip of Lake Tanganyika and encompasses the natural habitat within about 100 km of the border of the Democratic Republic of Congo (DRC). This region is the most species rich region in Africa for vertebrates and contains many endemic and threatened species. It is therefore an area of particular conservation concern. This report compiles the biological information that exists for 40 sites (protected areas and sites that are relatively undisturbed but not gazetted) and assesses their relative importance for conservation. Many of these sites remain poorly surveyed and hence this report is part of a work in progress. However, we believe that the patterns we show in the individual taxa chapters (chapters 2-8) reflect the reality of the situation even though there may be minor changes in the numbers presented for each site.

Seven taxa are reviewed in this report: mammals, birds, reptiles, amphibians, butterflies, plants and fish. The data for the terrestrial vertebrates and the plants are used to rank sites for conservation priority. It is predicted that these taxa will act as surrogates of total biodiversity given that it is impossible to survey all possible taxa as most are poorly collected. A test is made which shows that for endemic species each of these taxa is a good predictor of the others and for the most part this holds for total species richness.

The Albertine Rift is an area of high endemism and threatened species (Critical, Endangered and Vulnerable). Over 50% of birds, 39% of mammals, 19% of amphibians and 14% of reptiles and plants of mainland Africa occur in this region The table below summarises the numbers of species for each taxa studied.

Summary Table. The total number of species, number of endemic species, and threatened species for the five taxa in the Albertine Rift. We did not compile the data to allow such an analysis for fish and butterflies because of the available time. We compiled data on fish species for each of the large lakes in the Rift and a list of butterfly endemics. This provides a minimum estimate of the number of endemic species for these two taxa.

	Species richness	Endemic species	Threatened species
Mammals	402	34	35
Birds	1,061	41	25
Reptiles	175	16	2
Amphibians	118	34	16
Butterflies		117	
Fish		366 +	
Plants	5,793	567	40

The threats that affect this rich biodiversity are described in chapter nine. Threats are mostly human caused and are particularly intense in DRC at present. However, analysis of satellite images shows that more forest has been converted to agriculture in Uganda than in similar sized areas in DRC. Since the mid 1980s 1,560 km^2 of

forest has been converted to other land uses in the region of the Albertine Rift between the northern end of Lake Albert to the northern end of Lake Tanganyika.

Sites are ranked in terms of their species richness and their number of endemic and threatened species. Eight sites rank highly on both accounts: Virunga, Semliki, Kibale, Bwindi Impenetrable, and Kahuzi Biega national Parks and Nyungwe Forest and Lake Tanganyika. Other sites that are important for endemic and threatened species include Rwenzori Mountains and Kibira National Parks, Kasyoha-Kitomi Forest Reserve and Lakes Edward and George. The Itombwe Massif is an important site for conservation and yet has still to be gazetted. This should be a priority site for future conservation activities.

Many protected areas are contiguous with others in the Albertine Rift and several are contiguous with protected areas across international boundaries. As such they form larger 'landscapes' of natural habitat. Managing individual protected areas alone may lead to the loss of some of the important processes that could be maintained if these contiguous areas were managed as one unit. The 'Virunga landscape', which is comprised of the Virunga National Park and its contiguous protected areas in Rwanda and Uganda, is one of the most species rich regions on earth. There is a need to develop formal transboundary management mechanisms to ensure such important areas as this survive in the long-term. Falling on the divide between funding zones for East and Central Africa means that supporting cross-border activities in this region is made more difficult and donors need to be made aware of the importance of collaboration between countries in this region.

SOMMAIRE

Le Rift Albertin s'étend de la pointe septentrionale du Lac Albert à la pointe méridionale du Lac Tanganyika et renferme l'habitat naturel d'environ 100 km le long de la frontière de la République Démocratique de Congo (DRC). Cette région est la région riche en espèces en Afrique pour les vertébrés et contient beaucoup plus d'espèces endémiques et menacées. Il est donc une région sensible pour la conservation. Ce rapport compile l'information biologique qui existe pour 40 sites (les aires protégées et les sites qui ne sont pas relativement perturbés mais non publiés) et évalue leur importance relative pour la conservation. La plupart de ces sites restent mal connus et par conséquent ce rapport fait la partie d'un travail en progression. Cependant, nous croyons que les types que nous montrons dans les chapitres de taxa individuels (les chapitres 2-8) reflètent la réalité de la situation bien qu'il peut y avoir des changements mineurs dans les chiffres présentés pour chaque site.

Sept taxa sont réexaminés dans ce rapport: les mammifères, les oiseaux, les reptiles, les amphibiens, les papillons, les plantes et les poissons. Les données pour les vertébrés terrestres et les plantes sont utilisées pour classer des sites par priorité de conservation. Il est prédit que ces taxa serviront de de substitution de la biodiversité totale donnée qu'il est impossible d'inventorier tous les taxa possible comme la plupart d'entre elles est mal collectée. Un test est appliqué qui montre que pour les espèces endémiques de chacun de ces taxa est un bon signe de prediction des autres et pour la plupart ceci tient pour richesse totale d'espèces.

Le Rift Abertin est une région d'endemisme le plus élevé et d'espèces menacées (Critique, Extinction et Vulnérable). Plus de 50% d'oiseaux, 39% de mammifères, 19% d'amphibies et 14% de reptiles et des plantes du continent africain se retrouvent dans cette région. Le tableau ci-dessous résume les nombres d'espèces pour chaque taxa étudié.

Tableau synthèse. *Le nombres total d'espèce, le nombre d'espèce endemiques, et d'espèces menacées pour les cinq taxa du Rift Albertin. Nous n'avons pas compilé les données pouvant permettre une analyse pour les poissons et les papillons à cause du temps disponible. Nous avons compilé les données sur les espèces de poissons pour chacun des grands lacs du Rift et la liste des papillons endémiques. Ceci fournit une estimation minimum du nombre d'espèces endemiques pour ces deux taxa.*

	Richesse en espèces	Espèces endémiques	Espèces ménacées
Mammifères	402	34	35
Oiseaux	1,061	41	25
Reptiles	175	16	2
Amphibiens	118	34	16
Papillons		117	
Poissons		366 +	
Plantes	5,793	567	40

Les menaces qui affectent cette riche biodiversité sont décrites dans le chapitre neuf. Les menaces sont surtout humaines et sont particulièrement intenses en RDC en ce moment. Cependant, l'analyse des images satellitaires montrent que la grande partie de la forêt a été convertie à l'agriculture plus en Ouganda qu'en DRC pour les surfaces similaires. Depuis la moitié des années 1980, 1,560 km2 de forêt ont été convertis pour d'autres utilisation des terres dans la région du Rift Albertin entre la partie septentrionale extrême du Lac Albert jusqu'à la partie septentrionale extrême du Lac Tanganyika. Ceci est plus large que tous les aires protégées qui se retrouvent dans le Rift.

Les sites sont classés suivant leur richesse en espèces et leur nombre d'espèces endémiques et menacées. Huit sites se trouvent plus en tête suivant les deux critères: Les Parcs Nationaux de Virunga, Semuliki, Kibale, Bwindi Impenetrable, Kahuzi Biega, la Forêt de Nyungwe et le Lac Tanganyika. Les autres sites qui sont importants pour les espèces endémiques et menacées incluent les Parcs Nationaux des Monts Ruwenzori et Kibira, la Réserve Forestière Kasyoha-Kitomi et les Lacs Edward et George. Le Massif d'Itombwe est un site important pour la conservation et pourtant calme doit être reconnu officiellement. Ceci devrait être un site de priorité pour les activités de conservation dans le futur.

Plusieurs aires protégées sont contiguës aux autres du Rift Albertin et plusieurs sont contiguës à d'autres aires protégées le long des frontières internationales. Ainsi ils forment le plus grand 'landscape' d'habitat naturel. Gérer une seule aire protégée à part peut mener à la perte d'une partie des procédés importants qui pourrait être maintenu si ces aires contiguës étaient gérées comme une unité. Le 'landscape' des Virunga qui comprend le Parc National des Virunga et ses aires protégées contiguës au Rwanda et en Ouganda sont l'un des régions les plus riches en espèces sur la terre. Il y a un besoin de développer les mécanismes de gestion transfrontalière formels pour assurer la survie des aires protégées à long terme. L'échec de la subdivision des zones de financement pour l'Afrique de l'Est et Centrale signifie qu'appuyer les activités transfrontalières dans cette région sont faites difficile et les bailleurs doivent être conscientés de l'importance de la collaboration entre les pays de cette région.

TABLE OF CONTENTS

THE MACARTHUR PROCESS 6

LE PROCESSUS MACARTHUR 7

ACKNOWLEDGEMENTS 8

SUMMARY 9

SOMMAIRE 11

TABLE OF CONTENTS 13

THE ALBERTINE RIFT
1.1 Summary 16
1.2 Introduction 16
1.3 Analyses of the biodiversity of the Albertine Rift 17
1.3.1 Prior studies 17
1.3.2 Surrogacy and scale 19
1.4 Data compilation and analyses 20
1.4.1 Compiling species lists 20
1.4.2 Analyses 22

MAMMALS
2.1 Summary 23
2.2 Introduction 24
2.3 Information sources 24
2.4 Results 25
2.4.1 Species richness 25
2.4.2 Endemism 26
2.4.3 Threatened species 29
2.4.4 Complementarity analyses 29
2.4.5 Cluster analyses 29
2.5 Discussion 31

BIRDS
3.1 Summary 34
3.2 Introduction 35
3.3 Information sources 35
3.4 Results 36
3.4.1 Species richness 36
3.4.2 Endemism 36
3.4.3 Threatened species 39
3.4.4 Complementarity analysis 39
3.4.5 Cluster analyses 40
3.5 Discussion 41

REPTILES
4.1 Summary 43
4.2 Introduction....44
4.3 Information sources....44
4.4 Results....45
4.4.1 Species richness....45
4.4.2 Endemism....46
4.4.3 Threatened species....46
4.4.4 Complementarity analysis....47
4.4.5 Cluster analyses 47
4.5 Discussion....48

AMPHIBIANS
5.1 Summary 51
5.2 Introduction....52
5.3 Information sources....52
5.4 Results....53
5.4.1 Species richness....53
5.4.2 Endemism....55
5.4.3 Threatened species....55
5.4.4 Complementarity analysis....55
5.4.5 Cluster analyses 56
5.5 Discussion....56

BUTTERFLIES
6.1 Summary 59
6.2 Introduction....59
6.3 Information sources and acknowledgements....60
6.3.1 Taxonomy 60
6.4 Information provided 60
6.4.1 Why butterflies?....61
6.5 number of endemic species....61
6.6 Discussion....62
6.7. The checklist 63
6.7.1 Key 66

PLANTS
7.1 Summary 68
7.2 Introduction....69
7.3 Information sources....69
7.4 Results....70
7.4.1 Species richness....70
7.4.2 Endemism....71
7.4.3 Threatened species....72
7.4.4 Complementarity analysis....72
7.4.5 Cluster analyses 72
7.4.6 Ordination of sites 75
7.5 Discussion....76

THE LAKES
8.1 Summary 78
8.2 Introduction....79
8.3 Taxonomy of fishes and the radiation of cichlid fishes....79
8.4 Biodiversity of the lakes in the albertine rift 79
8.5 Economic importance of the lakes 80
8.6 Discussion....81

THREATS TO SITES
9.1 Summary 82
9.2 introduction....83
9.3 Habitat loss 83
9.4 Hunting wildlife....85
9.5 Harvesting plant products 86
9.5.1 Timber 86
9.5.2 Non-timber forest products 86
9.6 Mining....86
9.7 Fire 87
9.8 Other threats 87
9.9 Sites most affected 87

PRIORITISING SITES FOR CONSERVATION
10.1 Summary 89
10.2 Introduction....90
10.3 Ranking using species data 90
10.3.1 Species richness....90
10.3.2 Endemic species....91
10.3.3 IUCN threatened species....92
10.3.4 IUCN threatened species and endemic species 93
10.4 Testing surrogacy 95
10.5 Important sites in the Albertine rift....96
10.6 Landscape Conservation 98
10.6.1 Contiguous sites 98
10.6.2 Landscape Processes....100
10.7 Funding conservation in the albertine rift....101
10.8 Conclusions 102

REFERENCES.... 104

THE ALBERTINE RIFT TECHNICAL REPORTS 112

SECTION 1: THE ALBERTINE RIFT

Mount Mikeno in Virunga Park, DRC., A.J. Plumptre, WCS

A.J. PLUMPTRE

1.1 Summary

The Albertine Rift has been identified as a region of great importance for conservation by several priority-setting studies. It is an 'ecoregion', 'biodiversity hotspot' and an 'endemic bird area'. Species lists were compiled for as many sites in the Albertine Rift as we could obtain data for six different taxa: mammals, birds, reptiles, amphibians, butterflies and plants. In addition the species richness of fish in the lakes in the rift were compiled from existing publications. Each of the following chapters summarises the results for each of these taxa.

Le Rift Albertin a été identifié comme une région de grande importance pour la conservation par diverses études de prioritisation. C'est une "écorégion", "biodiversity hotspot" et une "région endémique d'oiseaux". Les listes des espèces ont été dressées pour les sites dans le Rift Albertin pour autant que les données pouvaient être obtenues pour les six taxa: les mammifères, les oiseaux, les amphibiens, les reptiles, les papillons et les plantes. En complément, la richesse en espèces icthiologiques (poissons) dans les lacs du rift ont été compilées sur base de la documentation existente. Chacun des chapitres ci-après résume les résultats pour chacun de ces taxa.

1.2 Introduction

The Albertine rift extends from the northern tip of Lake Albert down to the southern tip of Lake Tanganyika and encompasses the rift valley, the lakes in the rift and the natural vegetation on the escarpment above the rift (Fig. 1.1). This region has been independently identified as an 'Endemic Bird Area' by Birdlife International (Thirgood and Heath, 1994; Stattersfield et al, 1998), an 'Ecoregion' by the World Wildlife Fund (Olson and Dinerstein, 1998), and recently it has been made a 'Biodiversity Hotspot' by conservation International (T. Butynski pers. comm.; Myers et al, 2000). As such it is recognised as an area of global importance for conservation. Each of the three definitions of the Albertine rift differ somewhat with some concentrating primarily on the montane forests while others focus on a broader definition. For the purposes of this study we adopted a definition that would be as inclusive as possible of all natural vegetation within the region of the rift valley and includes the freshwater lakes. As

such we defined the rift as including all natural vegetation within about 100 km of the border between the Democratic Republic of Congo (DRC) and the neighbouring countries. In DRC where natural vegetation is relatively continuous the 900-metre altitude boundary was selected as the limit while in the other countries where human density is higher we included all the protected areas within about 100 km of the international border. As such this definition is as inclusive as possible and further work can select subsets of the data from different vegetation types.

1.3 Analyses of the biodiversity of the Albertine Rift

1.3.1 Prior studies

Several studies have highlighted the importance and unique characteristics of African mountains. Frank White (1983) highlighted that the African mountain forests contained a unique flora that made them distinct from the surrounding vegetation and Jonathan Kingdon (1989) showed this applied to both the fauna as well as the flora.

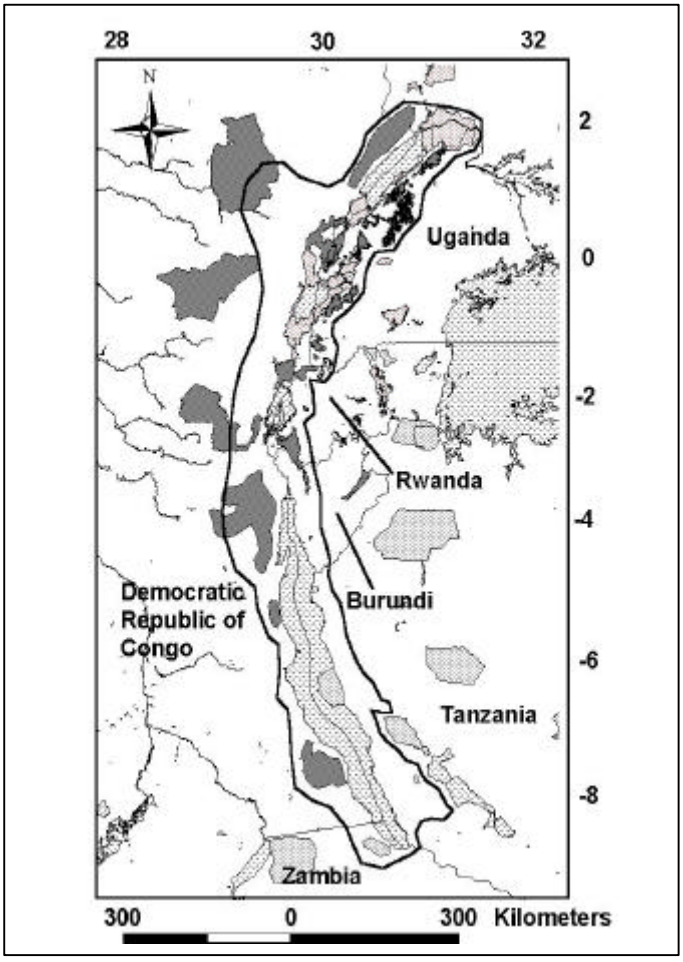


Figure 1.1 Map of the Albertine Rift showing existing protected areas or regions referred to in this study and the approximate boundary of the Albertine Rift (dark line). The Latitude and longitude around the map are labeled in degrees.

An analysis of centres of plant diversity highlighted several montane sites within the Albertine Rift as being regional centres of endemism (Davis et al., 1994). Birdlife International provided one of the first global analyses of endemism in a taxa with their definitions of endemic bird areas of the world (Stattersfield et al., 1998), although this built upon previous work on the distributions of birds in Africa (Diamond, 1985; Prigogine, 1985).

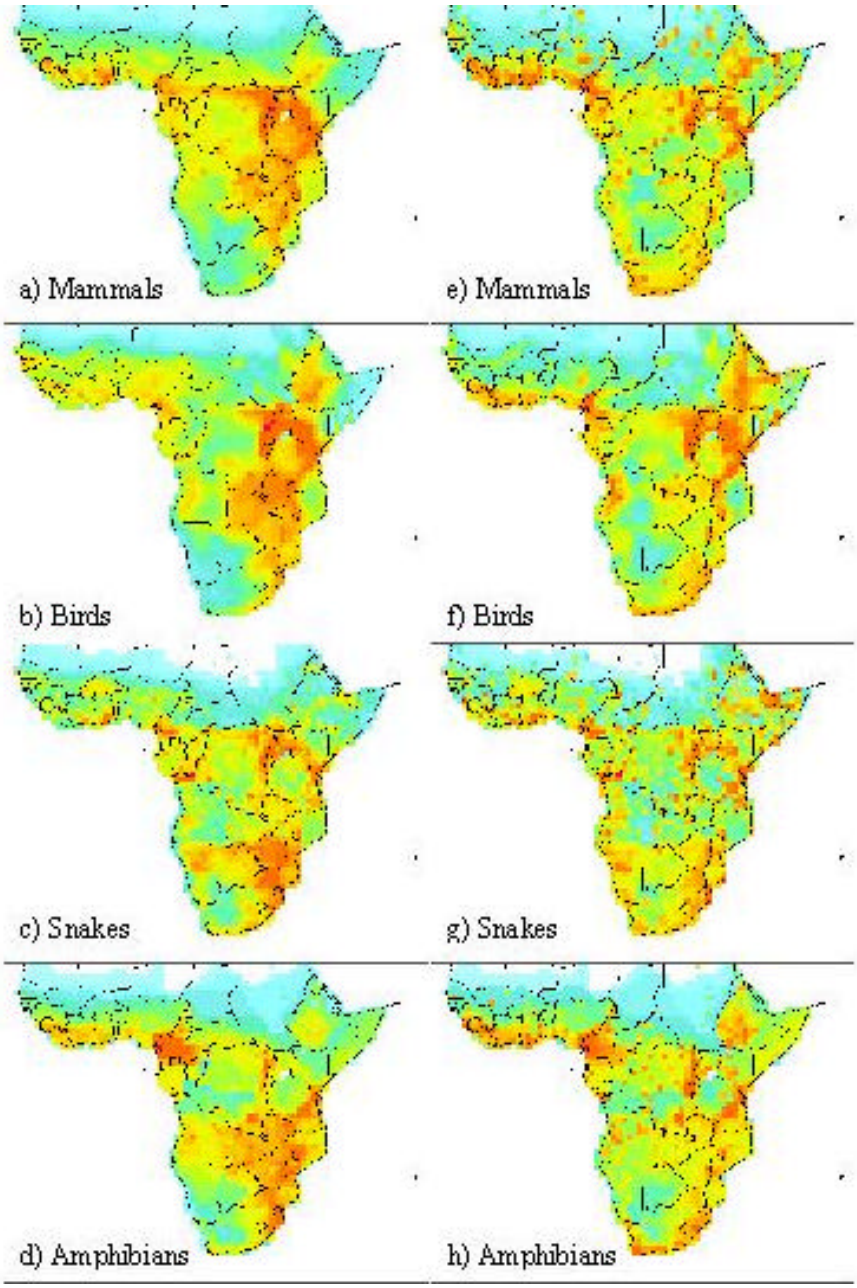


Figure 1.2 The species richness (left maps: a-d) and number of endemic species (right maps: e-f) for mammals, birds, snakes and amphibians. Colours run from red (high numbers) to blue (low numbers). From Brooks et al. (2001)

These analyses showed that the Albertine rift was particularly rich in total numbers of bird species and numbers of endemic bird species, with 36 endemic birds and an additional six in the contiguous eastern Zairian lowlands endemic bird area. Given that these two areas are contiguous and are simply a separation by altitude we decided to include both endemic areas within the analyses presented here.

More recently still analyses of the diversity of vertebrates across Africa show that the Albertine Rift is very rich in total numbers and numbers of endemic species for

mammals, birds, snakes and amphibians (Figure 1.2). Both mammals and birds have highest species richness in the region around the Rwenzori mountains. The data used to analyse these distributions was compiled by the Zoological Museum of the University of Copenhagen and are located spatially at a scale of 1-degree latitude/longitude grid cells (Brooks et al., 2001).
This is appropriate when analysing cross continent patterns of species distributions but of less value when focusing on a smaller areas. This report pulls together similar information at a finer scale to allow comparisons to be made between protected areas within the rift.

1.3.2 Surrogacy and scale

It is costly and time consuming to measure the diversity of all species at any one site let alone at many different sites. The only surveys of the Albertine Rift that even approach the level of intensity required were the surveys made in the 1930s and 1940s of the Virunga National Park in eastern DRC. These surveys not only collected vertebrates but also all plant species, many orders of insect species, other invertebrates and even microorganisms (Mollaret, 1961). We therefore have resorted to analysing the distribution of a subset of the possible taxa that could have been assessed. The taxa we selected are those that have good keys and hence tend to be readily identified and which are of interest to many people and hence which have better distribution records than obscure taxa. The taxa selected were mammals, birds, reptiles, amphibians, butterflies and plants. These taxa we hope will act as surrogates for other biodiversity that have been poorly studied in this part of the world. At large scales across continents this is generally true where it has been studied (ICBP, 1992; Balmford and Long, 1994) and on the whole at medium scales of protected areas (Howard et al. 1998) but generally does not hold at smaller scales such as habitats (Pomeroy, 2000). This is in part due to the affects of the species-area relationship, which predicts more species in larger areas (Rosenzweig, 1995).

In terms of conservation in the Albertine Rift we are constrained by the fact that human density is very high in this region. In fact there is a correlation between biodiversity richness and human population density across Africa (Balmford et al., 2001). For the most part the existing protected areas with proposed protected areas are likely to be all that we can protect in the future. Only a few sites in DRC and Tanzania have the potential to be included as new or expanded protected areas. Consequently the analysis here is less interested in comparing the effects of scale because for the most part the boundaries of the protected areas analysed are already fixed and most conservation action focuses on protected areas. As conservationists we are primarily interested in which protected areas have the most species, the most endemic or restricted-range species and the most threatened species as identified by IUCN (Hilton Taylor, 2000).

In this study we collated presence/absence information for species at the scale of protected area apart from two sites, which were subdivided due to their large size. These two were Kahuzi Biega National Park and Virunga National Park in eastern DRC. Kahuzi Biega was divided into the highland and lowland sectors of the park because the species composition varies greatly with altitude. Virunga National Park was subdivided into the Virunga volcanoes, southern, central, Rwenzori and northern sectors because of its long shape and large size. Where scale is more appropriately taken into consideration is where protected areas are contiguous across international borders. In the last section of the report we analyse the diversity of contiguous units of protected areas to highlight the diversity of these landscapes.

1.4 DATA COMPILATION AND ANALYSES

1.4.1 Compiling species lists

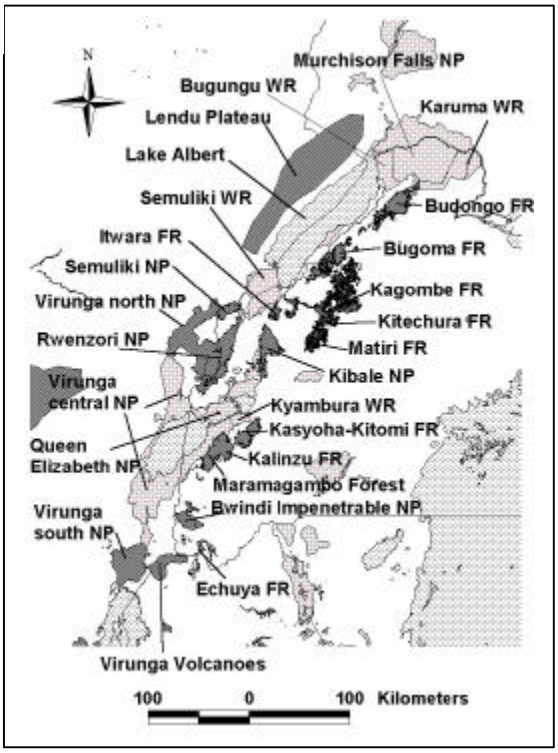
The data summarised in this report were compiled by collecting published species lists for each of the various protected areas and taxa of interest. We were particular that for the most part we did not use generalised distribution maps to compile species lists but only used data from surveys that had taken place. For certain sites such as the newly created Tayna Community Reserve in DRC there is a likelihood of a high number of species given the numbers found in the neighbouring Kahuzi Biega National Park, however surveys have not been made for many taxa here and we therefore have not included it as a site we have looked at. The only generalised distribution data we used were those from amphibian and reptile studies in eastern DRC and western Tanzania and for mammals in northern Zambia where the resolution was sufficiently fine to be able to state that the species came from a particular site. Surprisingly there are quite extensive lists of species for sites in the Albertine Rift, particularly for birds. Where possible we collated the data from the original publications rather than relying on references. This involved extensive checking of names, particularly for DRC where many of the publications data from over 50 years ago. We also attempted to contact many of the experts working on the various taxa to add records and also check the lists we were producing. Many of them gave considerable time to commenting on the lists for which we are extremely grateful.

The protected areas and ungazetted regions where data were available for at least one taxa are mapped in figure 1.3. It is clear that the northern end of the rift has many more small protected areas as compared with the southern end. The southern end is poorly explored with few records from the southern highlands in Tanzania, the Marungu Massif, Mt Kabobo and Itombwe Massif in DRC and Sumbu National Park in Zambia. The taxon with most complete data for this region is birds, although it is likely that more species would be discovered if these areas are surveyed further. The northern end of the Rift has had more intensive surveys with the detailed surveys by Belgian scientists in Virunga park in DRC in the 1930s and 40s, and the Forest Department (Howard and Davenport, 1996) and National Park species lists (Wilson, 1995) in Uganda which come from the compilation of records provided by many people. Each of the taxa chapters that follow details the sources of the records. As there was great variability in the intensity of the surveys in different areas both between taxa and within taxa we scored the survey effort as follows:

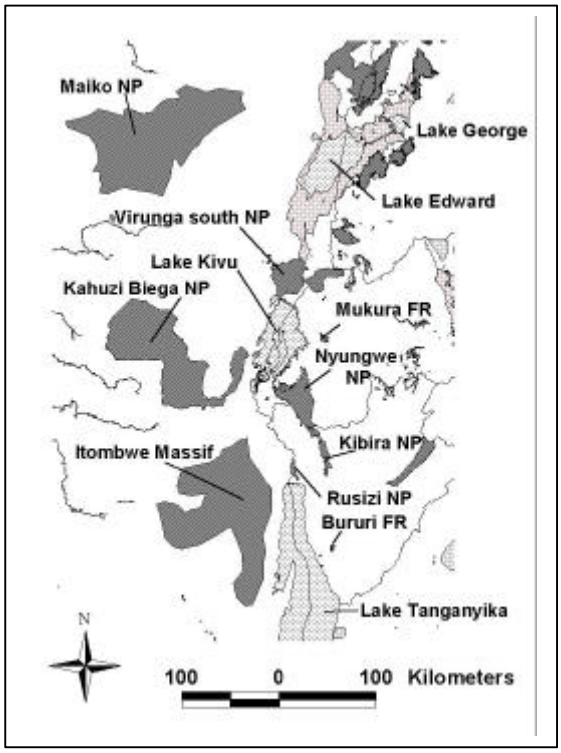
1. When was survey made: 1990-present = 3; 1975-1990=2; before 1975=1.
2. Sampling time: brief visits< 1 month=1; long visits (same observer)=2; repeated visits by several people=3.
3. Area surveyed: 1-25%=1, 25-50%=2; 50+%=3

These scores were summed for each site to give a ranking of the survey effort. This was made separately for each taxa surveyed. This scoring is important when comparing sites because the more time that is spent at a site the more species that are likely to be encountered. This is particularly true for wide-ranging species such as birds of prey and migratory species. For this report we have not separated species that remain at a site and species that probably pass through. Ideally we would probably only include those species that breed or reproduce at a site rather than all species seen but there has not been time to list these separately. However it is primarily the bird taxa where this issue is a common problem. Most analyses were based on sites where the combined effort score was 6 or greater.

a



b



c

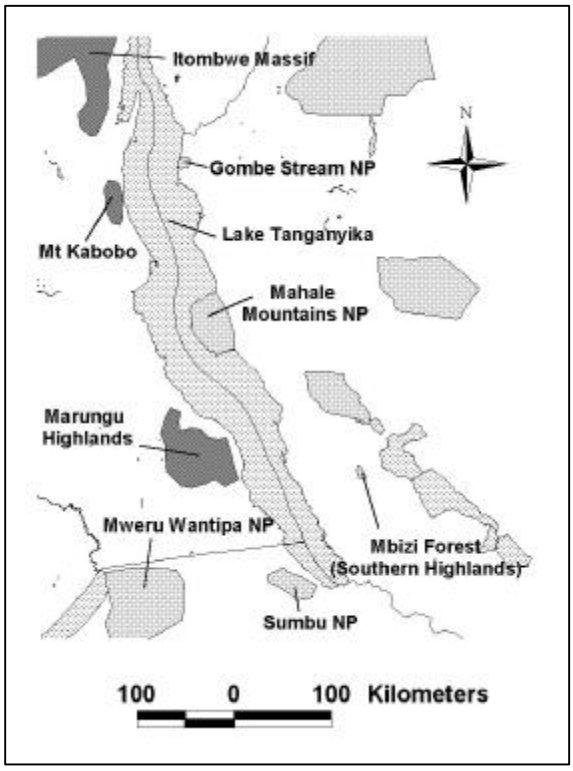


Figure 1.3 The northern (a), central (b) and southern (c) portions of the Albertine Rift showing the locations of the various protected areas (NP=national park; FR=forest reserve; WR=wildlife reserve) or ungazetted areas with species data (no NP/FR/WR). Darker shaded areas are forested and lighter areas are savanna grassland or woodland.

Any list will become out of date as soon as it is published because new species are constantly being added. We believe however that we have managed to compile reasonably complete lists for these protected areas where surveys have taken place at several dates and by different people. This report is considered by the authors to be part of an ongoing process to provide more complete lists of these sites and provides a good 'first cut' of the biodiversity of the Albertine Rift and the priority sites for conservation.

1.4.2 Analyses

For each species list for each taxon a list of endemic species was made using existing literature or in the case of reptiles, amphibians, butterflies and plants through examining species distributions and creating new lists. Tom Brookes at Conservation International kindly provided a draft list for several taxa which helped at the start of the project. Danny Meirte at the Royal Museum of Central Africa in Tervuren (Institut Royal des Sciences Naturelles de Belgique) helped create reptile and amphibian endemic lists from their database on species collecting localities. Tim Davenport created a list of butterfly endemics from his collection of literature and in collaboration with Steve Collins, Colin Congdon and Alan Gardiner. The plant list was developed as a collaborative effort within the Wildlife Conservation Society by Ewango Ndomba, Paul Ssegawa, Gerald Eilu and Andrew Plumptre with help with checking of lists by botanists from the Royal Botanic Gardens at Kew.

Similarly lists of threatened species for each taxon were compiled using the IUCN red list (Hilton-Taylor, 2000) for most taxa but using Birdlife International's analysis for birds (Birdlife International, 2000) and a draft updated list for amphibians kindly provided by Simon Stuart at Conservation international. For each site the number of threatened species ('critical', 'endangered' or 'vulnerable' under IUCN criteria) and the total number of IUCN-listed species (adding 'lower risk' and 'data deficient' species to the threatened list) were calculated.

A cluster analysis (Ward's method) was performed for each taxa for the sites where the score of survey effort was equal to or greater than 6. This analysis highlights the similarities and differences between sites and can identify whether there are clusters of communities for each taxa.

A complementarity analysis was also performed for each taxon. This analysis identifies the minimum number of sites needed to protect all species in the taxa. It starts by selecting the site with the highest number of species and then selects the site with the highest number of new species and continues this process until all species are accounted for. For the analyses presented here we weighted this analysis by the number of threatened and endemic species such that the sites selected first contained the most number of threatened and endemic species until these are all accounted for and then additional sites are added based on the largest number of species they add.

SECTION 2: MAMMALS

Mountain Gorilla, an endemic subspecies. A.J. Plumptre, WCS

R. Kityo[1], A.J. Plumptre[2], J. Kerbis Peterhans[3], J. Pilgrim[4] and D. Moyer[2]

2.1 Summary

A total of 402 species of mammal (excluding humans) have been recorded in the 35 sites of the Albertine Rift for which we could obtain records. This is about 39% of all mammals found on mainland Africa. There are 34 species thought to be endemic to the Albertine Rift and 12 near-endemic species whose distribution extends into the Ituri forest in eastern DRC. Three endemic subspecies were included in the analyses because of the way in which they are managed as distinct populations: mountain gorilla (*Gorilla beringei beringei*) and Grauer's gorilla (*Gorilla beringei graueri*) and the golden monkey (*Cercopithecus mitis kandtii*). The Virunga National Park in DRC has a recorded list of 196 species of which 79 are large mammals and in both cases is the richest of the protected areas in the Albertine rift. Kahuzi Biega and Bwindi Impenetrable National Parks with 136 and 135 mammals recorded respectively are the next most species rich of the sites. Virunga National Park and Bwindi Impenetrable National Park contain 21 and 20 Albertine Rift endemic species respectively with Rwenzori Mountains National Park third with 18 endemic species. Kahuzi Biega National Park has 14 threatened species (CR, EN or VU) with Virunga National Park (13) and Rwenzori Mountains National Park and Itombwe Massif (10) as the next most abundant sites. If all IUCN red listed species are counted then Virunga National park contains the highest number (42), Kahuzi Biega National Park comes second (39) and the Itombwe Massif ranks third (24). Of the 18 sites with relatively complete lists of mammals, 8 are required to protect over 90% of all mammals at these sites. Nine sites are required to protect all the endemic and threatened mammals at these sites. Larger mammals have been more completely surveyed and reasonable lists existed for 24 sites. Only four sites are required to protect over 90% of large mammals with 98% of endemic and threatened species

[1] Makerere University Zoology Department and Museum
[2] Wildlife Conservation Society
[3] Chicago Field museum
[4] CABS - Conservation International

protected by these four sites. Only five sites are required to protect all 46 endemic and threatened large mammals.

Au total, 402 espèces de mammifères (les humains exclus) ont été enregistrées dans les 35 sites du Rift Albertin pour lesquelles nous avons pu obtenir des données. C'est environ 39% de tous les mammifères du continent Africain. On compte 34 espèces supposées endémiques au Rift Albertin et 12 espèces proche de l'endémisme qui s'étendent jusqu'à la forêt d'Ituri à l'Est de la RDC. Trois sous espèces endemiques ont été inclues dans les analyses à cause de la manière dont elles sont gérées comme populations distinctes: les gorilles de montagne (Gorilla beringei beringei), le Gorille de Graueri (Gorilla beringei graueri) et le Singe doré (Cercopithecus mitis kandtii). Le Parc National des Virunga en RDC a enregistré une liste de 196 espèces parmi lesquelles 79 sont de grands mammifères et dans les deux cas, il est le plus riche de toutes les aires protégées du Rift Albertin. Le Parc National de Kahuzi-Biega et le Bwindi Impenetrable National Park respectivement avec 136 et 135 mammifères enregistrés sont les suivants. Le Parc National des Virunga et le Bwindi Impenetrable National Park respectivement ont 21 et 20 espèces endémiques du Rift Albertin avec le Parc National de Rwenzori, troisième avec 18 espèces endémiques. Le parc National de Kahuzi Biega a 14 espèces menacées (CR, EN ou VU) avec le Parc National des Virunga(13), le Rwenzori Mountains National Park et le Massif d'Itombwe(10) comme autres sites abondants. S'il faut considérer tous les critères de la liste rouge des espèces de l'UICN, le Parc National des Virunga contient le nombre le plus élevé (42), le Parc National de Kahuzi-Biega est le deuxième (39) et le Massif d'Itombwe, le troisième (24). De tous les 18 sites avec des listes des mammifères relativement complètes, 8 nécessitent la protection de plus de 90% de tous les mammifères de ces sites. Neuf sites sont importants pour protéger tous les mammifères endémiques et menacés. Les grands mammifères ont été complètement inventoriés et les listes acceptables existaient pour 24 sites. Quatre sites seulement nécessitent la protection de plus de 90% de grands mammifères avec 98% d'espèces menacées et endémiques protégées (par ces quatre sites). Cinq sites seulement sont nécessaires protéger tous les 46 grands mammifères endémiques et menacés.

2.2 Introduction

Mammals are often the first taxa to be listed for a site and consequently reasonable lists exist for many of the sites in the Albertine Rift. At least this is true for the larger mammals down to the size of primates. However lists of nocturnal species (genets, civets, mongooses) and small mammals (shrews, bats and rodents) are rare and often incomplete. One of the problems with the lists that exist is that a fair number are based on information from the first half of last century. Mammals are hunted by man for bushmeat and their skins and, as a result, are usually the first taxa to decline where man is having a significant impact on a protected area. Since the first half of last century most of the countries in the Albertine Rift have experienced war and civil turmoil and many large mammals have been hunted to very low populations or to local extinction. An attempt was made to remove species that are known to be extinct from sites to reflect the current reality rather than historical data.

2.3 Information sources

A variety of sources were used to compile mammal lists for the 31 sites where surveys had taken place. These are listed below by country. The authors of this chapter have also contributed many records.

Uganda

The main source for Uganda was the checklist of mammals of the national parks (Wilson, 1995) and the small mammal surveys undertaken by the Uganda Forest

Department (Howard and Davenport, 1996). Additional data for large mammals came from Kingdon (1971-1983) and for small mammals from Kerbis Peterhans *et al.* (1996), Kerbis Peterhans and Austin (1996), Kerbis Peterhans (1997) and van der Straeten and Kerbis Peterhans (1999).

Rwanda
Dowsett (1990) produced a list of mammals for the Nyungwe Forest Reserve and this was combined with unpublished sightings from the Wildlife Conservation Society project in this forest and Hutterer *et al.* (1987). A list for the Virunga Volcanoes was produced using de Witte (1938), Wilson (1995) and Hutterer *et al.* (1987)

DR Congo
De Witte (1938) reported on extensive surveys by Belgian scientists in the Virunga National Park. Muhlenberg, Slowik and Steinhauer (undated) provided a list for Kahuzi Biega National Park and Omari *et al*. (1999) provided a list for Itombwe Massif.

Burundi
A list was obtained for Kibira National Park (Peace Corps and INECN undated).

Tanzania
Lists were obtained for Gombe from the Gombe National Park website, for Mahale from Anonymous (1985) and for Mbizi from David Moyer.

Zambia
Lists for Sumbu and Mweru-Wantipa National Parks were generated from the distribution records given by Ansell (1978).

Endemic species lists were based upon those drafted by Conservation International (T. Brooks *et al*. unpublished) and revised with contributions from various specialists, particularly Julian Kerbis Peterhans.

2.4 Results

2.4.1 Species richness

A total of 402 species of mammal were identified as occurring in the 35 sites for which data were compiled. This is 39.3% of the total number of mammals found on the mainland of Africa (totals from WWF database). Virunga National Park has the highest number of mammals with 196 species or 48.8% of the total number of mammals from these sites in the Albertine Rift. Kahuzi Biega National Park with 136 species, and Bwindi Impenetrable National Park with 135 species, rank second and third (Table 2.1). Several sites have few mammal species listed and have not been well surveyed, particularly for small mammals (rats, bats and shrews). Larger mammals (primates, felids, canids, mongooses, genets, ungulates, large rats, hyraxes and squirrels) tend to be identified and listed at more sites than small mammals and hence these poorly surveyed sites were analysed separately. A total of 24 sites were considered sufficiently surveyed for large mammals and only 18 sites sufficiently surveyed for all mammals (Table 2.1).

2.4.2 Endemism

A total of 34 endemic mammals were identified with 12 near endemic species (Table 2.2). The near endemic species range into the Ituri forest from the Albertine Rift but for the most part of their range they are confined to the Albertine Rift. Three subspecies were also considered; 2 endemic and one near-endemic. Both Virunga National Park (21) and Bwindi Impenetrable National Park (20) had the highest numbers of Albertine Rift endemic species followed by Rwenzori Mountains National Park (18). If near-endemic species are included, Virunga National Park ranks highest (28) with Bwindi Impenetrable National Park (26) and Rwenzori Mountains National Park rank (22) second and third (Table 2.1).

Table 2.1 The total number of species compiled, number of large mammals (excluding rats, bats, shrews and nocturnal primates), number of Albertine Rift (AR) endemic species, number of near-endemic species, number of threatened species and total number of IUCN listed species. Virunga Park is divided into five sectors due to its size and numbers are given separately for each sector as well as the total. *= reasonably surveyed for all mammals;

Site	SPP no.	No. Large mammals	AR endemic species	Near endemic species	Threatened CR,EN, VU	IUCN listed species
Murchison Falls NP *	109	54	0	1	5	21
Bugungu WR	9	7	0	0	1	1
Karuma WR	57	27	0	0	4	7
Budongo FR *	95	27	0	3	5	10
Bugoma FR	38	15	0	0	4	7
Kagombe FR	14	6	0	0	3	5
Kitechura FR	17	3	0	1	1	2
Ibambaro FR	2	2	0	0	0	0
Matiri FR	12	2	1	2	0	0
Itwara FR	18	4	0	1	0	2
Semliki WR	69	35	0	1	4	12
Semliki NP *	86	27	1	2	5	16
Rwenzori Mountains NP *	102	26	18	4	10	20
Kibale NP *	115	59	5	3	7	21
Kasyoha-Kitomi FR *	47	15	2	5	3	7
Kalinzu-Maramagambo FR *	58	18	1	3	3	7
Kyambura WR	37	24	0	0	3	8
Queen Elizabeth NP *	97	62	0	2	6	21
Bwindi Impenetrable NP *	135	43	20	6	7	18
Mafuga FR	20	2	3	1	1	4
Echuya FR *	24	3	7	2	1	5
Virunga Volcanoes	86	34	18	3	6	16
Virunga south	26	19	4	0	5	6
Virunga central	66	39	1	1	5	15
Virunga north	46	24	1	1	4	13
Virunga Rwenzori	44	16	7	0	3	11
PNVi total *	196	79	21	7	13	42
West of Lake Edward	8	6	0	0	1	1
Nyungwe NP *	86	42	14	4	3	16
Kahuzi Biega NP *	136	67	15	6	14	39
Kibira NP *	71	34	8	3	7	16
Bururi FR	9	8	1	0	1	1
Itombwe Massif *	72	54	4	3	10	24
Gombe NP	19	18	1	0	4	7
Mahale Mountains NP *	52	49	1	0	6	14
Mbizi FR	21	6	1	0	2	7
Sumbu NP *	61	43	0	0	6	13
Mweru-Wantipa NP *	50	35	0	0	7	15

Table 2.2 The endemic and near-endemic species of mammal that occur in the Albertine Rift with their IUCN threatened status. Three subspecies are included (see text). IUCN threats: CR=Critically Endangered; EN=endangered; VU=vulnerable; DD=data deficient; LR/nt=near threatened. AR=Albertine Rift endemic; NE=near-endemic species.

Family	Species	Common name	IUCN	AR endemic
Bovidae	*Cephalophus rubidus*	Rwenzori Duiker		AR
Cercopithecidae	*Cercopithecus hamlyni*	Owl-faced monkey	LR/nt	NE
Cercopithecidae	*Cercopithecus lhoesti*	L'hoest's monkey	LR/nt	NE
Cercopithecidae	*Cercopithecus mitis kandti*	Golden monkey	EN	AR
Cercopithecidae	*Piliocolobus oustaleti*	Red colobus	EN	AR
Cricetidae	*Delanymys brooksi*	Delany's Mouse		AR
Cricetidae	*Dendromus kahuziensis*	Kahuzi Climbing Mouse	LR/nt	AR
Cricetidae	*Dendromus kivu*	Rwenzori climbing mouse		AR
Galagonidae	*Galago matschiei*	Spectacled Galago	LR/nt	NE
Hominidae	*Gorilla beringei beringei*	Mountain gorilla	CR	AR
Hominidae	*Gorilla beringei graueri*	Grauer's Gorilla	EN	NE
Muridae	*Dasymys montanus*	Montane Marsh Rat	VU	AR
Muridae	*Grammomys dryas*	Montane Thicket Rat		AR
Muridae	*Hybomys lunaris*	Rwenzori striped mouse		NE
Muridae	*Lophuromys cinereus*	Brush-furred Rat	DD	AR
Muridae	*Lophuromys medicaudatus*	Brush-furred Rat	LR/nt	AR
Muridae	*Lophuromys rahmi*	Brush-furred Rat	LR/nt	AR
Muridae	*Lophuromys woosnami*	Woosnam's Brush-furred rat		AR
Muridae	*Mus bufo*	Western Rift Pygmy Mouse		AR
Muridae	*Pelomys hopkinsi*	Papyrus Rat	VU	NE
Muridae	*Praomys degraafi*			AR
Muridae	*Praomys montis*			AR
Muridae	*Thamnomys kempi*	Kemps' Forest Rat		AR
Muridae	*Thamnomys venustus*	Kemp's Forest Rat		AR
Rhinolophidae	*Rhinolophus hilli*			AR
Rhinolophidae	*Rhinolophus ruwenzorii*			AR
Rhizomyidae	*Tachyoryctes ankoliae*	Mole rat/Desmol	VU	NE
Rhizomyidae	*Tachyoryctes ruandae*	Mole rat/Desmol		AR
Sciuridae	*Funisciurus carruthersi*	Carruther's Mountain Tree Squirrel	VU	AR
Sciuridae	*Heliosciurus ruwenzorii*	Montane Sun Squirrel		AR
Soricidae	*Crocidura kivuana*	Musk Shrew	VU	AR
Soricidae	*Crocidura lanosa*	Musk Shrew		AR
Soricidae	*Crocidura maurisica*	Northern Swamp Musk Shrew		NE
Soricidae	*Crocidura montis*			NE
Soricidae	*Crocidura niobe*	Rwenzori Musk Shrew		AR
Soricidae	*Crocidura stenocephala*	Musk Shrew	VU	AR
Soricidae	*Myosorex babaulti*	Mouse Shrew		AR
Soricidae	*Myosorex blarina*	Rwenzori Mouse Shrew	VU	AR
Soricidae	*Myosorex schalleri*	Schaller's Mouse Shrew	CR	AR
Soricidae	*Paracrocidura graueri*	Grauer's Montane Shrew	CR	AR
Soricidae	*Paracrocidura maxima*	East African Montane Shrew		AR
Soricidae	*Rwenzorisorex suncoides*	Osgood's Montane Shrew	VU	AR
Soricidae	*Scutisorex somereni*	Hero shrew		NE
Soricidae	*Sylvisorex granti*	Least long-tailed Forest Shrew		NE
Soricidae	*Sylvisorex lunaris*			AR
Soricidae	*Sylvisorex vulcanorum*			AR
Tenrecidae	*Micropotamogale ruwenzorii*	Rwenzori Otter Shrew	EN	AR
Viverridae	*Genetta victoriae*	Giant Forest Genet		NE
Viverridae	*Osbornicitis piscivora*	Aquatic Genet	DD	NE

2.4.3 Threatened species

Two categories of threatened species were analysed: 1. threatened (including critically threatened, endangered and vulnerable) and 2. all IUCN listed species (CR, EN, VU and lower risk and data deficient species). A total of 36 mammals are threatened and 89 are IUCN-listed in the rift. Kahuzi Biega National Park has the highest number of threatened species (14) followed by Virunga National Park (13) but the positions are reversed (39 vs 42 respectively) if all IUCN-listed species are analysed (Table 2.1).

2.4.4 Complementarity analyses

A complementarity analysis was made of both the large mammal data set (24 sites) and the total mammal data set (18 sites). The analysis selected those sites with the highest number of endemic (including near-endemic) and IUCN-listed species initially, until all of these species had been selected, and then selected those sites that contributed the most number of additional species.

Virunga National Park was selected first followed by Kahuzi Biega National Park and Murchison Falls National Park for both data sets. These three sites accounted for 82.7% of all large mammals and 67.4% of all mammals with 93.5% and 75.2% of endemic and threatened species respectively. Five sites were necessary to protect all endemic and threatened large mammals in at least one site and eleven sites were required to capture all large mammal species. Of the 18 sites that had been surveyed for small mammals, nine were needed to protect all the endemic and threatened mammals at these sites. These nine did not include 11 species that are found at other sites that have been poorly surveyed for small mammals. Of the 18 sites, 15 were required to capture all mammals at these 18 sites (Table 2.3).

Not surprisingly the complementarity analyses select sites at both ends of the Albertine Rift (Murchison Falls NP in the north and Mweru-Wantipa and Sumbu parks in the south). What is interesting, however, is that both Virunga and Kahuzi Biega parks are the two most important sites for all mammals and large mammals (of the sites analysed) and yet these two parks are relatively close to each other within the Rift. Virunga park captures many of the mammals found in savanna and woodland habitat while Kahuzi Biega park probably captures the species that occur at lower elevations in lowland forest that are not found in the northern sector of the Virunga park.

2.4.5 Cluster analyses

A cluster analysis was performed on both the large mammal data set and also the total mammal data set. As the Virunga Park is large and extends over several habitat types it was subdivided into 5 sectors (volcanoes, south, central, Rwenzori and northern sectors) and these separate areas were included in the cluster analyses.

The clusters for the large mammal data set group into five main groups (Fig. 2.1). These are: 1. the southern end of Lake Tanganyika (Mahale, Sumbu and Mweru-Wantipa); 2. the sites of high species richness and biomass (Murchison Falls, Queen Elizabeth, Virunga park and Kibale park); 3. most of the high altitude forests (Bwindi - Itombwe), 4. central savannas and low altitude forest (Karuma – Gombe) and 5. high and medium altitude forests (Bugoma – Rwenzori mountains).

Table 2.3 Results of the complementarity analysis indicating the minimum number of sites that together would maximise the number of mammals (all species and large mammals alone) protected. *=point at which all endemic and threatened species are captured in at least one site.

All mammal species (18 sites)			Large mammal species (24 sites)		
Sites	Species added	ARE/IUCN added	Sites	Species added	ARE/IUCN added
Virunga NP	196	61	Virunga NP	79	31
Kahuzi Biega NP	49	20	Kahuzi Biega NP	17	8
Murchison Falls NP	26	7	Murchison Falls NP	9	4
Rwenzori NP	15	6	Mweru-Wantipa NP	10	2
Semliki NP	11	3	Kibale NP*	3*	1
Mweru-Wantipa	15	2	Sumbu NP	5	
Nyungwe	6	2	Rwenzori NP	1	
Itombwe	3	2	Mahale Mts NP	1	
Kibale NP*	3*	1	Karuma WR	1	
Bwindi	12		West of L. Edward	1	
Sumbu NP	9		Nyungwe FR	1	
Budongo FR	5				
Kalinzu-Maramagambo FR	2				
Mahale Mt NP	1				
Kibira NP	1				

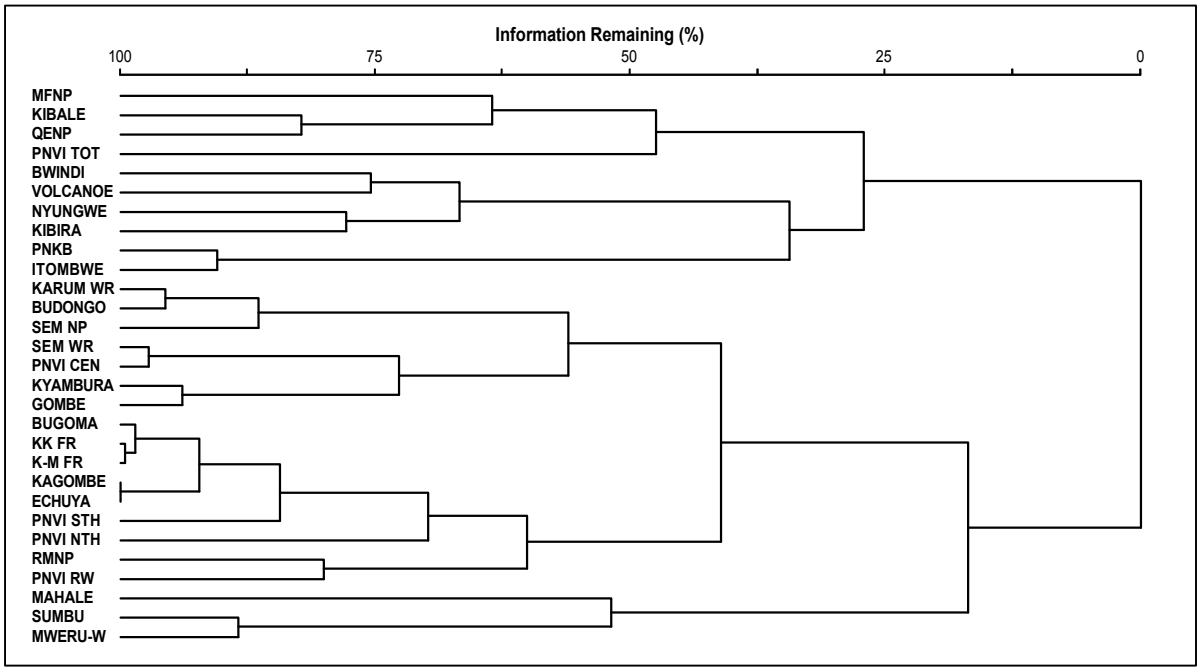


Figure 2.1 A cluster dendrogram for the large mammal data set. The Virunga Park (PNVi) is separated into five subsectors (Volcanoes, south – PNVi sth, central – PNVI cen, north – PNVI nth and Rwenzori – PNVI RW). MFNP=Murchison Falls park, QENP=Queen Elizabeth park, PNKB=Kahuzi Biega park, SEM=Semliki, KK=Kasyoha-Kitomi Forest Reserve, K-M=Kalinzu–Maramagambo forests, RMNP=Rwenzori mountains park.

The cluster analysis for the total mammal list for the 18 sites (and 5 sectors of Virunga park) shows a similar classification although not quite the same (Fig. 2.2). Mahale, Mweru-Wantipa and Sumbu are now clustered with the central Virunga park; Queen Elizabeth, Murchison Falls, Kibale and Virunga park (total) now cluster with Itombwe and Kahuzi Biega; at the bottom half of the dendrogram are high altitude forests apart from Virunga northern sector; and the lower altitude forests (Budongo-Kalinzu-Maramagambo) form a cluster.

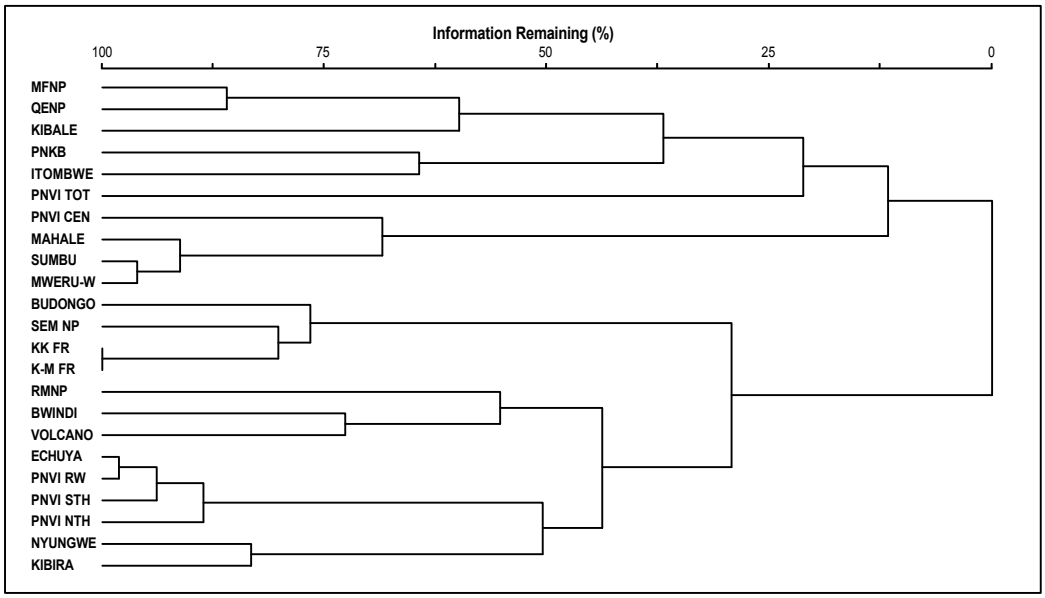


Figure 2.2 Cluster dendrogram for the sites with reasonable lists of all mammal species. For codes see legend to Fig. 2.1.

2.5 Discussion

These results show that the Albertine Rift is particularly rich in mammal species. A total of 402 species occur in this part of Africa of which 8.9% are endemic and 22.1% are listed under IUCN criteria (8.7% threatened). The data compilation also highlights that there are many sites where information on the nocturnal and smaller mammals is lacking and there is a consequent need for surveys. Of the 36 terrestrial sites mapped in figure 1.3, only 18 were considered to have reasonable total lists of mammals and of these only 24 also had reasonable lists of large mammals. It is likely that lists could be compiled for some of these sites from museum records given significant input of time, since most specimen localities have been entered into georeferenced databases. However, it may be more feasible, and even cheaper, to actually undertake new surveys in these sites if the security and access are good. Particular areas that need further work include: Gombe Stream National Park (Tanzania), Marungu Massif (DRC), Mt Kabobo (DRC), Itombwe Massif (DRC), Karuma and Bugungu Wildlife Reserves (Uganda), and Semliki and Kyambura Wildlife Reserves (Uganda).

The cluster analyses show that Mahale and the two sites in Zambia have distinct mammal faunas (particularly of large mammals) and does question whether these sites should be included in the Albertine Rift. However their small mammal fauna does link them to the central Virunga Park and represents communities of dry savanna and woodland.

Virunga and Kahuzi Biega National Parks rank most highly in mammal diversity and in numbers of threatened and endemic species. Although Virunga Park was reasonably well surveyed in the 1930s it would probably be possible to increase the species list considerably. For example the Rwenzori Mountains Park, which is contiguous with Virunga, has many more species of mammal listed than the Rwenzori section of the Virunga Park. Similarly Kahuzi Biega has not been surveyed very intensively for rodents, shrews and bats so the list could probably be easily increased with more effort. Ultimately what this shows is that there is still a real need for basic mammal surveys at many of the sites in the Rift, particularly focusing on the small and nocturnal species.

Figure 2.3 (a-d) summarises the results in a geographical information system (GIS). Total and large mammal species richness is generally evenly spread along the Rift with no clustering occurring in any clear pattern. Endemic species tend to be clustered in the central portion of the Rift between Bwindi Impenetrable National Park and Itombwe Massif. Threatened species are most abundant in two clusters; one around Rwenzori Mountains-Semliki-Kibale National Parks in Uganda and the other around Kahuzi Biega National Park and Itombwe Massif.

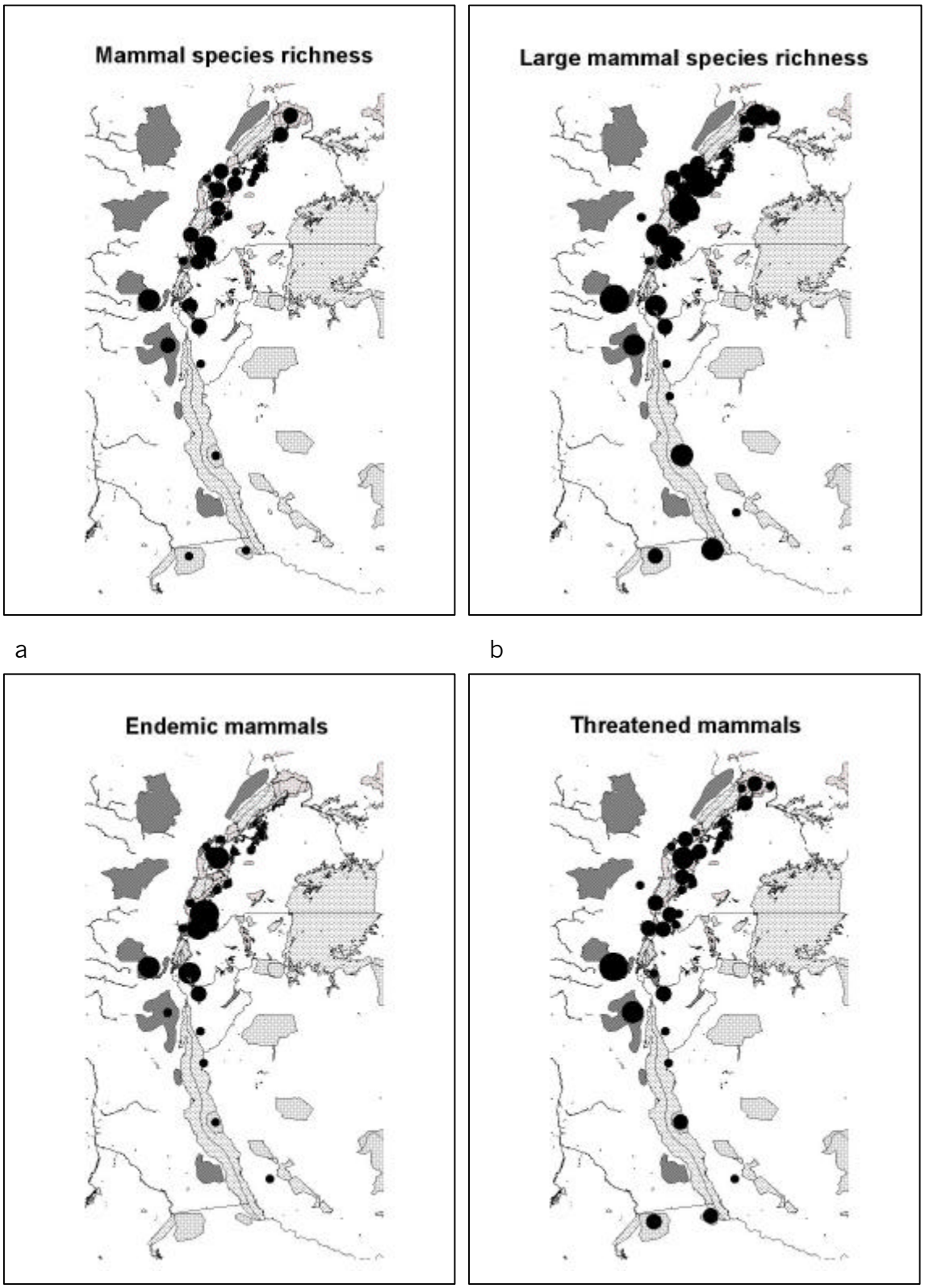


Figure 2.3 A summary of the results for the mammal data represented geographically. Each site that has non-zero data is represented by a circle of varying size depending on the number of species. a) Total mammal species richness; b) Large mammal species richness; c) endemic mammals; d) threatened mammals (CR, EN and VU).

SECTION 3: BIRDS

Blue-headed sunbird, an endemic species. A.J.Plumptre, WCS

C. Kahindo Ngabo[1], A. Plumptre[2], N. E. Baker[3], I.Owiunji[2], M. Wilson[4], C. T. Williams[5], A. Byaruhanga[6], M. Languy[7], M. Herremans[8], T. Butynski[9] and D.Moyer[2]

3.1 Summary

A total of 1061 species of bird have been recorded in the 33 sites of the Albertine Rift for which we could obtain reasonable records. This is about 52% of all birds found on mainland Africa. There are 41 species endemic to the Albertine Rift and associated Eastern Zairian Lowland forests. The Virunga National Park in DRC has a recorded list of 706 species and is the richest of the protected areas in the Albertine Rift. Queen Elizabeth National Park in Uganda ranks second with 594 species and Itombwe Massif with 583 ranks third. The Itombwe Massif, with 34 species, has more species endemic to the Albertine Rift than any other site followed by Kahuzi Biega National Park (30) and Virunga National Park (27). The Itombwe Massif has more highly threatened species (CR, EN or VU) than any other site (15) with Virunga National Park, Kahuzi Biega National Park and the highlands west of Lake Edward each ranking second (11). If all IUCN red list criteria species are included then the Itombwe Massif contains the highest number (30), and Virunga National Park ranks second (23) and Kahuzi Biega National Park ranks third (19). Six sites can protect more than 90% of species in the rift and over 95% of all endemic and threatened species. Nine sites are required to protect all endemic species in at least one site.

Au total 1061 espèces d'oiseaux ont été inventoriées dans les 33 sites du Rift Albertin pour lesquels nous avons pu obtenir des données fiables. Cela représente environ 52% de tous

[1] Makerere University Institute for Environment and Natural resources (MUIENR)
[2] Wildlife Conservation Society
[3] Tanzania Bird Atlas
[4] Consultant ornithologist
[5] Royal Society for the Protection of Birds/MUIENR/Conservation Biology Group, Cambridge University
[6] Nature uganda
[7] World Wide Fund for Nature
[8] Museum of Central Africa, Tervuren
[9] Conservation International, Nairobi

les oiseaux du continent Africain. On compte 41 espèces supposées endémiques au Rift Albertin. Le Parc National des Virunga en RDC avec un record de 706 espèces d'oiseaux est a ce point le plus riche des aires protégées du Rift Albertin. Le parc national Queen Elizabeth en Ouganda est le deuxième avec 594 espèces, suivi du Massif d'Itombwe, avec ses 583 espèces. Ce dernier, avec 34 espèces, a plus d'espèces endémiques au Rift Albertin que tout autre site, suivi du Parc National de Kahuzi-Biega (30) et du parc National des Virunga (27). Le Massif d'Itombwe detient plus d'espèces menacées (CR, EN ou VU) que toute autre site (15) suivi en seconde position par les Parcs Nationaux des Virunga, Kahuzi-Biega et les Hauts plateaux du Lac Edouard (11). Si tous les critères de la liste rouge des espèces de L'UICN étaient inclus, alors le Massif d'Itombwe contiendrait le nombre le plus élevé (30), suivi des Parcs Nationaux des Virunga (23) et Kahuzi-Biega (19). Six sites pourraient protéger plus de 90% d'espèces dans le rift et plus de 95 % de toutes les espèces endémiques et menacées. Neuf sites sont nécessaires pour protéger toutes les espèces endémiques dans au moins un site.

3.2 Introduction

The bird list that was compiled is probably the most complete of any of the lists available. This is due to the work of many ornithologists over the years that have contributed to the cataloguing and study of birds in this region. Ornithology is a hobby for many people who are not professional biologists and there are several magazines and small journals that allow species lists to be published unlike the other taxa in this report. This is probably why the bird list is more complete than the other taxa presented in this report.

3.3 Information sources

A variety of sources were used to compile the bird list for the 33 sites where surveys have taken place. These sources are listed below by country. The authors of this chapter have also contributed many records.

Uganda

The main source for Uganda was the checklist of birds of the national parks (Wilson, 1995) and the biological surveys undertaken by the Uganda Forest Department (Howard and Davenport, 1996 – which also compiled data from many previously published sources). Additional data came from the Enhancement of Research Capacity (ENRECA) project managed by Makerere University Institute of Environment and Natural Resources, surveys undertaken by the Wildlife Conservation Society, and records compiled by Malcolm Wilson. Additional published records that were incorporated after checking with experts who knew the sites include: Evans and Balmford (1992), Gnoske and Marks (1997), Kalina and Butynski (1996), Friedman and Williams (1970), Dehn and Christiansen (2001), Stubblefield (1993), and Allan (1994).

Rwanda

Kunkel and Kunkel (1969), Dowsett, Dowsett-Lemaire and Van de Weghe (undated), Dowsett (1990) and Plumptre et al. (2002) produced lists of birds for the Nyungwe Forest Reserve. These data were combined with unpublished sightings from the Wildlife Conservation Society project in this forest. A list for the Virunga Volcanoes was produced using Schouteden (1938), Wilson (1982), and Wilson (1995).

DR Congo

Schouteden (1938) reported on extensive surveys by Belgian scientists in the Virunga National Park and Verheyen (1947) added species to the northern part of the park. M.

Languy provided additional observations. Muhlenberg, Slowik and Steinhauer (undated) and Wilson and Catsis (1990) provided a preliminary list for Kahuzi Biega National Park and this was augmented using the database of bird specimens at the Royal Museum of central Africa in Tervuren (M. Herremans pers. contributions.). Schouteden (1949) surveyed Katanga district from which a list for Marungu Massif was derived, Prigogine (1960) provided a list for Mt Kabobo, Prigogine (1971-1984), Wilson and Catsis (1990) and Omari et al. (1999) provided lists for Itombwe Massif and Prigogine also provided lists for Idjwi island (Prigogine, 1967) and for the area west of Lake Edward (Prigogine 1953). Many new records in eastern DRC have been published by Demey et al (2000). Tom Butynski contributed records for Mt Tsiaberimu.

Burundi
Schouteden (1966) published a list of birds of Burundi with locations where they had been sighted – this publication was used to compile a list for Ruzizi National Park. Gaugris, Prigogine and van de Weghe (1981) added species to this list and INECN produced a list for Kibira National Park in the mid 1980s (INECN, undated). Van de Weghe and Loiselle (1987) also produced a list for Bururi forest reserve.

Tanzania
Neil Baker provided lists for Gombe Stream and Mahale Mountains National Parks from the database he has of Tanzania's birds. These were used to correct and add to lists compiled by Stanford and Msuya (1995), Ulfstrand and Lamprey (1960), and Moreau (1943). D. Moyer provided lists for Mbizi forest and Ufipa plateau.

All species names in the old lists were carefully updated to the recent names to ensure that species were not duplicated in the database. Endemic species were based upon lists that were drafted by Birdlife International Stattersfield et al. (1998) and revised using recent knowledge of bird distributions and taxonomy (M. Herremans and M. Languy pers. comm.).

3.4 Results

3.4.1 Species richness

A total of 1061 species of bird were identified as occurring in the 33 sites for which data were compiled. This is 52.3% of the total number of birds recorded for the mainland of Africa (total from WWF database). Virunga National Park has the highest number of birds with 706 species or 66.5% of the total number of birds from these sites in the Albertine Rift. Queen Elizabeth National Park with 596 species, and Itombwe Massif with 583 species, rank second and third (Table 3.1). Virunga National Park is thus the richest protected area for birds on the whole continent. Further research will separate these species into different categories such as migrants vs residents and various categories of habitat dependent species such that the lists reflect species that reproduce at the site rather than all birds seen.

3.4.2 Endemism

A total of 35 Albertine Rift endemic birds were identified with 6 eastern Zairian lowland endemic species (Table 3.2). These two endemic bird groups are contiguous when mapped (Stattersfield et al. 1998) and for this study we decided to combine both of them because some Albertine Rift endemic species also range into the medium altitude forests in the Ituri (M. Herremans – Tervuren database). The number of Albertine rift endemic species are two less than in Stattersfield et al. (1998) because *Muscicapa lendu* is present in Kakamega Forest in Kenya and *Sylvietta chapini*

is now considered to be a subspecies of *S. leucophrys*. Itombwe Massif has the highest number of endemic species (34) followed by Kahuzi Biega National Park (30) and Virunga National Park (27). Mbizi and Ufipa plateau have two endemic species from the Tanzania-Malawi Mountains Endemic Bird Area (*Cisticola nigricolis* and *Phyllastrephus alfredi*), however these two species were not incorporated in the analyses because they belong to another endemic bird region.

Table 3.1 The total number of species compiled, number of Albertine Rift (AR) endemic species, number of eastern Zairian lowland endemic species, number of threatened species and total number of IUCN listed species. Virunga Park is divided into five sectors due to its size and habitat types and numbers are given separately for each sector as well as the total.

Site	SPP no.	AR endemic species	E. Zairian lowland endemic species	Threatened CR,EN, VU	IUCN listed species
Murchison Falls NP	476	0	0	7	10
Budongo FR	362	0	0	1	2
Bugoma FR	221	0	0	1	2
Kagombe FR	121	0	0	0	0
Kitechura FR	90	0	0	0	0
Matiri FR	119	0	0	0	1
Itwara FR	183	0	0	0	0
Lendu plateau	317	6	0	4	6
Semliki WR	435	0	0	3	4
Semliki NP	441	2	5	9	11
Rwenzori Mountains NP	241	21	0	4	6
Kibale NP	327	3	0	3	3
Kasyoha-Kitomi FR	308	2	0	1	1
Kalinzu-Maramagambo FR	393	4	0	1	1
Kyambura WR	450	0	0	6	10
Queen Elizabeth	594	0	0	7	15
Bwindi Impenetrable NP	381	23	1	6	9
Mafuga FR	130	10	0	0	0
Echuya FR	136	14	0	2	2
Virunga Volcanoes	258	20	0	4	7
Virunga south	370	16	0	4	9
Virunga central	420	0	1	4	7
Virunga Rwenzori	103	13	0	0	1
Virunga north	515	9	1	3	8
Virunga Total	706	25	2	11	23
West of Lake Edward	420	25	0	11	17
Nyungwe NP	280	26	0	7	11
Kahuzi Biega NP	335	29	3	11	19
Idjwi	150	2	0	1	2
Kibira NP	211	21	0	7	9
Bururi FR	155	13	0	3	3
Lac Ruzizi	182	1	0	3	4
Itombwe Massif	583	30	4	15	30
Gombe NP	267	0	0	2	2
Mahale Mountains NP	250	2	0	1	2
Mt Kabobo	231	18	0	3	5
Mbizi/Ufipa	154	0	0	0	1
Marungu	282	1	0	0	3

Table 3.2 The endemic species of bird that occur in the Albertine Rift with their IUCN threatened species status (2000). IUCN threats: CR=Critically Endangered; EN=endangered; VU=vulnerable; DD=data deficient; NT=near threatened. AR=Albertine Rift endemic; EZL=Eastern Zaire Lowland endemic species.

Family	Species	Common name	IUCN	AR endemic
Phasianidae	*Francolinus nobilis*	Handsome Francolin		AR
Musophagidae	*Tauraco johnstoni*	Rwenzori Turaco		AR
Strigidae	*Glaucidium albertinum*	Albertine Owlet	VU	AR
Tytonidae	*Phodilus prigoginei*	Congo Bay Owl	EN	AR
Caprimulgidae	*Caprimulgus prigoginei*	Itombwe Nightjar	EN	AR
Caprimulgidae	*Caprimulgus ruwenzorii*	Rwenzori Nightjar		AR
Indicatoridae	*Indicator pumilio*	Dwarf Honeyguide	NT	AR
Eurylaimidae	*Pseudocalyptomena graueri*	African Green Broadbill	VU	AR
Paridae	*Parus fasciiventer*	Stripe-breasted Tit		AR
Timaliidae	*Kupeornis rufocinctus*	Red-collared Mountain Babbler	NT	AR
Timaliidae	*Kupeornis chapini*	Chapin's Mountain Babbler	NT	AR
Campephagidae	*Coracina graueri*	Grauer's Cuckoo Shrike	NT	AR
Pycnonotidae	*Chlorocichla prigoginei*	Prigogine's greenbul	EN	AR
Turdidae	*Alethe poliophrys*	Red-throated Alethe		AR
Turdidae	*Cossypha archeri*	Archer's Ground Robin		AR
Turdidae	*Zoothera tanganjicae*	Kivu Ground Thrush	NT	AR
Sylviidae	*Apalis argentea*	Kungwe Apalis	EN	AR
Sylviidae	*Apalis kaboboensis*	Kabobo Apalis	DD	AR
Sylviidae	*Apalis personata*	Montane Masked Apalis		AR
Sylviidae	*Apalis ruwenzori*	Collared Apalis		AR
Sylviidae	*Bradypterus graueri*	Grauer's Rush Warbler	EN	AR
Sylviidae	*Graueria vittata*	Grauer's Warbler		AR
Sylviidae	*Hemitesia neumanni*	Short-tailed/Neumann's Warbler		AR
Sylviidae	*Phylloscopus laetus*	Red-faced Woodland Warbler		AR
Muscicapidae	*Melaenornis ardesiacus*	Yellow-eyed Black Flycatcher		AR
Platysteiridae	*Batis diops*	Rwenzori Batis		AR
Prionopidae	*Prionops alberti*	Yellow-crested Helmet Shrike	VU	AR
Nectariniidae	*Cyanomitra alinae*	Blue-headed Sunbird		AR
Nectariniidae	*Nectarinia purpureiventris*	Purple-breasted Sunbird		AR
Nectariniidae	*Cinnyris regia*	Regal Sunbird		AR
Nectariniidae	*Cinnyris rockefelleri*	Rockefeller's Sunbird	VU	AR
Nectariniidae	*Cinnyris stuhlmanni*	Rwenzori Double-collared Sunbird		AR
Ploceidae	*Ploceus alienus*	Strange Weaver		AR
Estrildidae	*Cryptospiza jacksoni*	Dusky Crimson-wing		AR
Estrildidae	*Cryptospiza shelleyi*	Shelley's Crimson-wing	VU	AR
Apodidae	*Schoutedenapus schoutedeni*	Schouteden's swift	VU	EZL
Pycnonotidae	*Phyllastrephus lorenzi*	Sassi's Olive Greenbul	NT	EZL
Turdidae	*Zoothera oberlaenderi*	Oberlander's/Forest Ground Thrush	NT	EZL
Monarchidae	*Terpsiphone bedfordi*	Bedford's Flycatcher	NT	EZL
Ploceidae	*Ploceus aureonucha*	Golden-naped weaver	EN	EZL
Ploceidae	*Ploceus flavipes*	Yellow-legged weaver	VU	EZL

3.4.3 Threatened species

Two categories of IUCN-listed species were analysed: 1. threatened (including critically threatened, endangered and vulnerable) and 2. all IUCN-listed species (CR, EN, VU and lower risk and data deficient species. A total of 25 birds are threatened and 48 are IUCN-listed in the rift. Itombwe Massif has the highest number of threatened species (15) followed by three sites with 11 species: Virunga National Park, Kahuzi Biega National Park and the mountains west of Lake Edward. Itombwe Massif also has the largest number of IUCN-listed species (30) followed by Virunga Park (23) and Kahuzi Biega Park with 19 (Table 3.1).

3.4.4 Complementarity analysis

A complementarity analysis was made of the bird data set (33 sites). The analysis selected those sites with the highest number of endemic (Albertine Rift and Eastern Zaire Lowland) and IUCN-listed species initially, until all of these species had been selected, and then selected those sites that contributed the most number of additional species.

Itombwe Massif was selected first followed by Virunga National Park and Queen Elizabeth National Park. These three sites accounted for 82.8% of all bird species and 91.0% of endemic and threatened species respectively. Nine sites were necessary to protect all endemic and threatened large mammals in at least one site and 19 sites were required to capture all bird species (Table 3.3).

Not surprisingly the complementarity analyses select sites at both ends of the Albertine Rift (Lendu Plateau (north) and Mahale Mountains and Marungu (south)). What is interesting, however, is that both Virunga and Queen Elizabeth National Parks are selected before these other sites and yet these two national parks are contiguous. It is probable that with more surveys Virunga National Park will be found to contain many of the additional species that were added by Queen Elizabeth Park, which has been very intensively surveyed over the years.

Table 3.3 Results of the complementarity analysis indicating the minimum number of sites that together would maximise the number of birds protected. The three columns on the left show the order in which sites are selected until all endemic and IUCN-listed species are 'captured' by at least one site and the columns on the right show the additional sites needed to 'capture' all bird species.

Sites which added endemic/threatened birds			**Sites adding additional birds**		
Sites	Species added	ARE/IUCN added	Sites	Species added	ARE/IUCN added
Itombwe Massif	583	48	Murchison falls park	32	0
Virunga Park	220	11	Gombe park	13	0
Queen Elizabeth park	75	2	Kyambura WR	11	0
Marungu Massif	47	1	Mbizi/Ufipa	10	0
Lendu plateau	26	1	Budongo FR	4	0
Mahale mountains park	19	1	Rwenzori park	3	0
Semliki park	4	1	Lac Ruzizi	3	0
Mt Kabobo	3	1	W. Lake Edward	3	0
Idjwi	2	1	Semliki WR	2	0
			Nyungwe Forest	1	0

3.4.5 Cluster analyses

A cluster analysis was performed on the bird data set. As the Virunga Park is large and extends over several habitat types it was subdivided into 5 sectors (volcanoes, south, central, Rwenzori and northern sectors) and these five sectors were included in the cluster analyses.

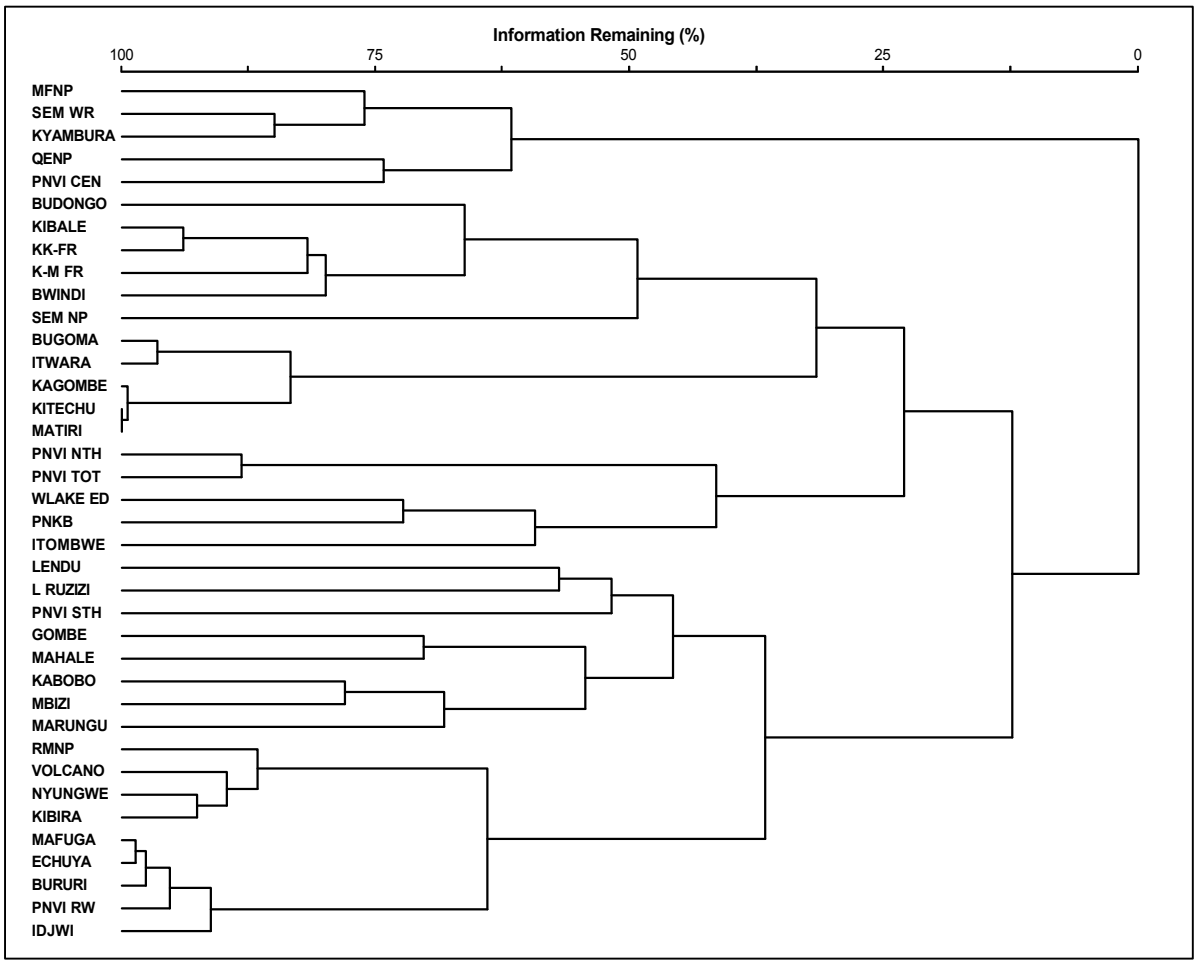


Figure 3.1 A cluster dendrogram for the bird data set. The Virunga Park (PNVi) is separated into five subsectors (Volcanoes, south – PNVi sth, central – PNVI cen, north – PNVI nth and Rwenzori – PNVI RW). MFNP=Murchison Falls park, QENP=Queen Elizabeth park, PNKB=Kahuzi Biega park, SEM=Semliki, KK=Kasyoha-Kitomi Forest Reserve, K-M=Kalinzu–Maramagambo forests, RMNP=Rwenzori mountains park.

The clusters group into six main groups (Fig. 3.1). These are: 1. the savanna areas in the centre and north of the rift (Murchison falls, Queen Elizabeth, Semliki and Kyambura Wildlife Reserves and central Virunga park); 2. Lower altitude forests in Uganda (Budongo, Kibale, Kasyoha-Kitomi, Kalinzu-Maramagambo, Semliki park and a bit of an outlier, Bwindi park); 3. Lower altitude forests that have been less intensively surveyed (Bugoma, Itwara, Kagombe, Kitechura, Matiri) – these would probably cluster more closely with group 2 with better data; 4. Forests in DRC in the central part of the rift (Virunga north, all Virunga park, Kahuzi Biega park and Itombwe Massif); 5. The drier savanna/woodland areas in DRC and Tanzania (Lendu plateau, Lac Ruzizi, Southern Virunga park, Gombe and Mahale parks, Mt Kabobo, Mbizi/Ufipa and Marungu Massif) and 6. The mountain forests (Rwenzori park,

Virunga volcanoes, Nyungwe forest, Kabira park, Mafuga, Echuya, Bururi and Idjwi forests with the Rwenzori sector of Virunga park.

3.5 Discussion

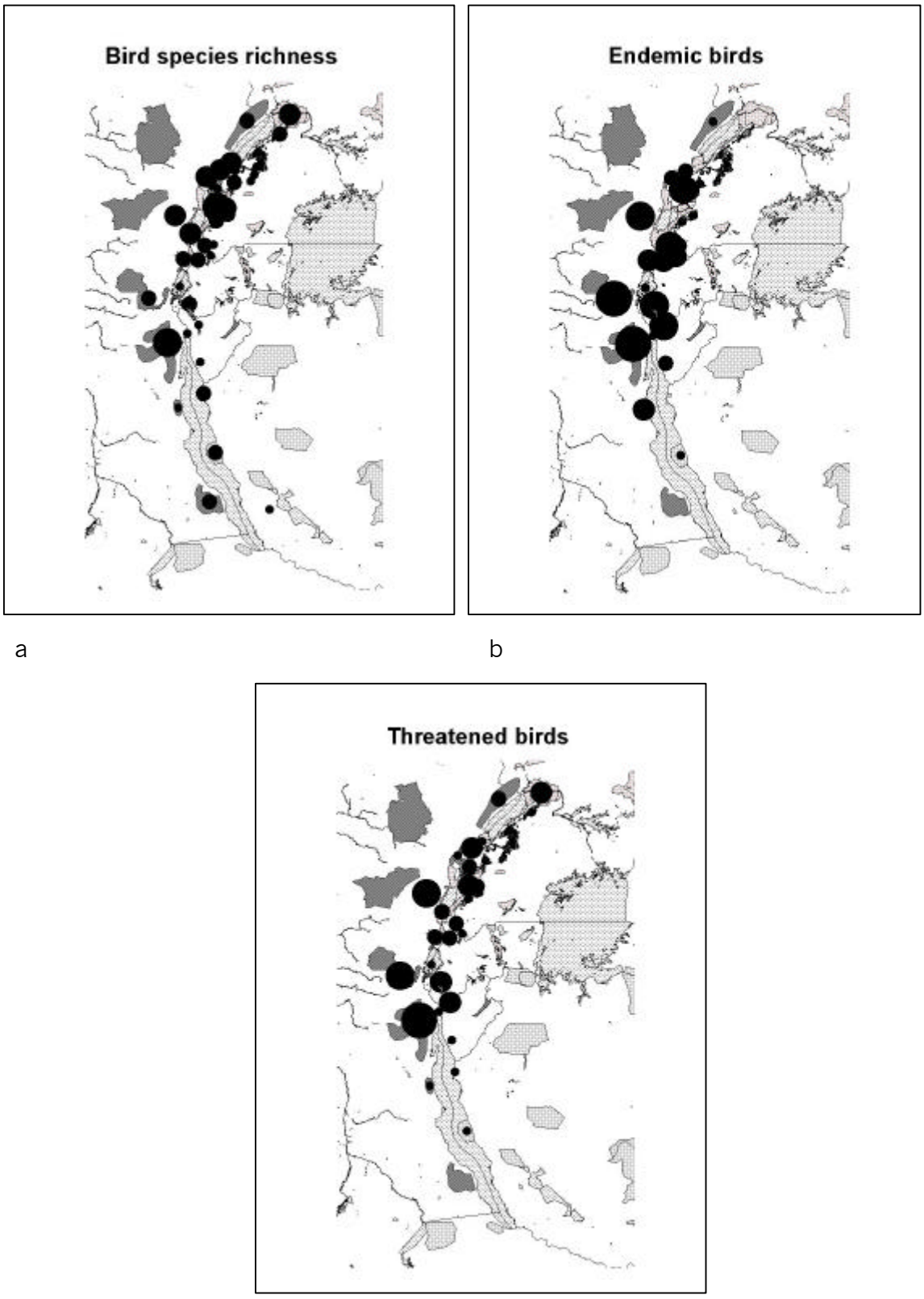
These results show that the Albertine Rift is incredibly rich in bird species. A total of 1061 species occur in this part of Africa of which 3.8% are endemic and 4.5% are IUCN-listed species (2.4% threatened). The data set for birds is a lot better than that for the mammals and we can be far more confident that the patterns shown here reflect the situation in reality. However, despite fairly intensive surveys in many of these sites in the rift it is clear that further effort would add more species to the list. For example, Queen Elizabeth National Park is selected immediately after Virunga Park in the complementarity analysis yet these two parks are connected and probably share most of their species. Queen Elizabeth has had much more attention from ornithologists, however, and therefore probably has a more complete list.

The cluster analyses show that Mahale, Gombe, Mt Kabobo, Mbizi/Ufipa and Marungu form a cluster of sites at the southern end of the rift. Apart from Mt Kabobo, these sites have few Albertine Rift endemic species because most endemic species are forest birds. The presence of these few species though has kept these sites as part of the Albertine Rift.

Itombwe Massif is the richest site for endemic species and threatened species and yet remains poorly surveyed and has no protected status. Prior to the recent fighting in DRC the Governor of south Kivu was interested in gazetting part of Itombwe under some form of protection and it is hoped this will be possible once peace is restored to the country. Virunga and Queen Elizabeth National Parks are very rich in bird diversity and are important migratory stopping points for birds coming from Europe. The diversity of habitats in these two parks is what contributes to the high bird species richness. Sites that need more survey work include Itombwe Massif, Mt Kabobo and Marungu Massif, the Lendu plateau (primarily to see what is left there) and some of the lower altitude forests in Uganda such as Bugoma and Itwara. The Mbizi forest/Ufipa plateau, Gombe and Mahale parks would probably be found to contain many more species if these were surveyed further also.

The endemic species are primarily found in the central part of the Albertine Rift (as outlined in fig. 1.1) and towards the western side of the rift, occurring down into medium altitude forest. There are endemic species found towards the Ituri forest, which is why figure 1.1 has the extension in the northwest that captures the extent of these species. Birds are probably the only taxa where we could confidently look at subspecies distributions (there is much greater controversy in the taxonomy of the other taxa at the subspecies level than in birds). Sites to the south would rank higher if subspecies were included.

Figure 3.2 summarises the results in GIS. Species richness is high around the central part of Virunga National Park and Queen Elizabeth National Park with another large circle on Itombwe Massif. Endemic species are generally found towards the central part of the Rift while threatened species seem to form two clusters; one around Nyungwe, Kahuzi Biega and Itombwe and another around Rwenzori and west of Lake Edward.



a b c

Figure 3.2 A summary of the results for the bird data represented geographically. Each site that has non-zero data is represented by a circle of varying size depending on the number of species. a) bird species richness; b) endemic birds; c) threatened birds (CR, EN and VU).

SECTION 4: REPTILES

Rwenzori three-horned Chamaeleon, an endemic species. A.Plumptre, WCS

M. Behangana[1], D. Meirte[2], A.J. Plumptre[3], K. Howell[4] and H. Hinkel[5]

4.1 Summary

A total of 175 species of reptile have been recorded in 33 sites of the Albertine Rift for which we could obtain records. This is about 14% of all reptiles found on mainland Africa. There are 16 species endemic and three near-endemic to the Albertine Rift. The Virunga National Park in DRC has a recorded list of 109 species and is the richest of the protected areas in the Albertine rift. Kahuzi Biega National Park ranks second with 69 species and Kibale National Park with 56 ranks third. Virunga National Park, with 11 species, has more species endemic to the Albertine Rift than any other site followed by Rwenzori Mountains National Park (9) and Nyungwe Forest (8). Few reptiles have been classified by IUCN criteria and only 2 from the rift are threatened and a further 2 IUCN-listed. No site has more than one of these four IUCN-listed species. Nine sites can protect more than 90% of species in the rift and only seven sites are required to protect all endemic, near-endemic and threatened species.

Au total 175 espèces de reptiles ont été enregistrées dans les 33 sites du Rift Albertin pour lesquelles nous avions pu obtenir les données acceptables. C'est environ 14% de tous les reptiles du continent Africain. On compte 16 espèces endémiques et trois espèces proche de l'endémisme au Rift Albertin. Le Parc National des Virunga en RDC compte 109 espèces et il est le plus riche des aires protégées du Rift Albertin. Le Parc National de Kahuzi Biega est le deuxième avec 69 espèces et le parc National de Kibale, le troisième avec 56 espèces. Le Parc National des Virunga, avec 11 espèces, a plus d'espèces endémiques au Rift Albertin que tout autre site, suivi du Parc National des Monts Ruwenzori (9) et la Forêt de Nyungwe (8). Quelques reptiles ont été classifiées suuivant les critères de l'UICN et 2 espèces seulement du Rift sont menacées et au plus 2 sur la liste de l'UICN. Aucun site n'a plus d'une espèce des quatre espèces de reptile menacées de la liste de l'UICN.Neuf sites

[1] Makerere University Institute of Environment and Natural Resources
[2] Royal Museum of Central Africa, Tervuren
[3] Wildlife Conservation Society
[4] University of Dar es Salaam
[5] Independent consultant

peuvent protéger plus de 90% d'espèces dans le Rift et seulement sept sites sont necessaires pour protéger toutes les espèces endémiques et menacées.

4.2 Introduction

Due to their cryptic nature and the fact that many are poisonous, reptiles are less studied than mammals and birds and hence lists for this taxon are not as complete. They tend to be less mobile than the birds and mammals though and are therefore important to include in any analysis of the biodiversity of the Rift because certain species may show high specificity to a site. Of the 175 species listed for the sites in the Rift 24 (13.7%) were only recorded from one site and 40% of species were found at three sites or fewer. Unfortunately the collections that have been made in this region tend to be by a few collectors and they only sampled in certain locations. Only 13 sites had anything like reasonable numbers on their lists and it is clear that those sites with the highest numbers are the sites that have been most intensively surveyed. It is very probable that more species could be fairly easily added to the lists for most sites.

4.3 Information sources

A variety of sources were used to compile the reptile list for the 33 sites where surveys have taken place. These sources are listed below by country. However there is great discrepancy between the intensity of the surveys at these sites. The authors of this chapter have also contributed many records.

Uganda

Pitman (1974) was used as a starting point for reptiles in Uganda. Drewes and Vindum (1998) provided a species list for Bwindi Impenetrable National Park and Vonesh (1998) put together a list for Kibale National Park. Spawls et al. (2002) identify localities for species for east Africa using general maps and these were used to assign species to a site if this was either mentioned in the text or if the map distribution was unequivocal. M. Behangana, from recent surveys, provided several records.

Rwanda

Hinkel and Fisher (1988) was used to develop a list of species for Virunga volcanoes and Nyungwe forest. This was augmented by de Witte (1941) for the Virunga volcanoes. Dowsett (1990) also provided a list for Nyungwe Forest. D. Meirte extracted lists of specimen locations from the database at the Royal Museum of Central Africa in Tervuren.

DR Congo

De Witte (1941) produced a list of reptiles for Virunga National Park and mapped the distributions of chameleons in central Africa (de Witte, 1965) and Hinkel in Fischer (1996) provided a list for Kahuzi Biega National Park. D. Meirte extracted lists of specimen locations from the database at the Royal Museum of Central Africa in Tervuren.

Burundi

No data were obtained for Burundi

Tanzania
Spawls et al. (2002) was used to compile a list of reptiles for Gombe and Mahale Mountains parks.

All species names in the old lists were carefully updated to current names using the database of the collections at the Royal Museum of Central Africa, Tervuren, to ensure that species were not duplicated. The EMBL database (www.reptile-database.org) was also used to check names and query subspecies. Endemic species were determined by D. Meirte using the database at the Royal Museum of Central Africa at Tervuren.

4.4 Results

4.4.1 Species richness

A total of 175 species of reptile were identified, occurring in 33 sites for which data were compiled. This is 13.6% of the total number of reptiles recorded for the mainland of Africa (total from WWF database). Virunga National Park has the highest number of reptiles with 109 species or 62.3% of the total number of reptiles from these sites in the Albertine Rift. Kahuzi Biega National Park ranked second with 69 species, and Kibale National Park came third with 56 species (Table 4.1).

Table 4.1 The total number of species compiled, number of Albertine Rift (AR) endemic and near-endemic species, number of threatened species and total number of IUCN-listed species. Virunga Park is divided into five sectors due to its size and numbers are given separately for each sector as well as the total.

Site	SPP no.	AR endemic species	Near-endemic species	Threatened CR,EN, VU	Total IUCN threatened
Murchison Falls NP	32	0	0	1	1
Bugungu WR	9	0	0	0	0
Karuma WR	15	0	0	0	0
Budongo FR	48	1	0	0	1
Bugoma FR	9	0	0	0	0
Itwara FR	10	0	0	0	0
Lendu plateau	6	0	2	0	0
Semliki WR	33	0	0	1	1
Semliki NP	49	0	1	0	0
Rwenzori Mountains NP	34	9	0	0	0
Kibale NP	56	3	3	0	0
Kasyoha-Kitomi FR	9	0	0	1	1
Kalinzu-Maramagambo FR	9	0	0	0	0
Kyambura WR	12	0	0	0	0
Queen Elizabeth	34	0	0	0	0
Bwindi Impenetrable NP	34	6	2	0	0
Mafuga FR	17	2	0	0	0
Echuya FR	4	0	0	0	0
Virunga Volcanoes	43	7	1	0	0
Virunga south	53	8	1	0	0
Virunga central	55	4	0	0	0
Virunga north	39	2	2	0	0
PNVi Rwenzori	61	6	0	0	0
PNVi total	109	11	3	0	0
West of Lake Edward	6	3	1	0	0
Nyungwe NP	43	8	2	0	1
Kahuzi Biega NP	69	7	3	0	1
Kibira NP	3	2	0	0	0
Bururi FR	1	1	0	0	0
Lac Ruzizi	3	0	0	0	0

Itombwe Massif	35	5	2	0	0
Gombe NP	1	0	0	0	0
Mahale Mountains NP	4	0	0	0	0
Mt Kabobo	6	2	0	0	0
Mbizi FR	1	0	0	0	0
Marungu Massif	6	0	0	0	0
L. Tanganyika	13	0	0	0	1
L. Rukwa	7	0	0	0	0

4.4.2 Endemism

A total of 16 Albertine Rift endemic reptiles were identified with 3 endemic subspecies (Table 4.2). Given the problems with the taxonomy of reptiles and amphibians a decision was made to focus solely on species as was made with the other taxa. Virunga National Park had 11 endemic species and three near-endemic species followed by Rwenzori National Park (9 endemic species) and Nyungwe Forest (8 endemic and two near-endemic species).

Table 4.2 The endemic and near-endemic species of reptile that occur in the Albertine Rift.

Family	Species	Endemic(END) or Near Endemic (NE)
Chamaeleonidae	*Bradypodion carpenteri*	END
Chamaeleonidae	*Bradypodion xenorhinum*	END
Chamaeleonidae	*Chamaeleo johnstoni*	END
Chamaeleonidae	*Chamaeleo rudis*	END
Chamaeleonidae	*Chamaeleo schoutedeni*	END
Chamaeleonidae	*Bradypodion adolfifriderici*	NE
Chamaeleonidae	*Chamaeleo ituriensis*	NE
Colubridae	*Lycodonomorphus bicolor*	END
Colubridae	*Philothamnus ruandae*	END
Gekkonidae	*Cnemaspis quattuorseriata*	NE
Lacertidae	*Adolfus vaueresellі*	END
Scincidae	*Leptosiaphos blochmanni*	END
Scincidae	*Leptosiaphos graueri*	END
Scincidae	*Leptosiaphos hackarsi*	END
Scincidae	*Leptosiaphos luberoensis*	END
Scincidae	*Leptosiaphos meleagris*	END
Scincidae	*Leptosiaphos rhodurus*	END
Typhlopidae	*Leptotyphlops latirostris*	END
Viperidae	*Atheris nitschei*	END

4.4.3 Threatened species

Two categories of IUCN-listed species were analysed: 1. threatened (including critically threatened, endangered and vulnerable) and 2. all IUCN-listed species (CR, EN, VU and lower risk and data deficient species). Only two reptiles are threatened (*Trionyx triunguis* and *Osteolamus tetraspis*) and four (two additional data deficient species) are IUCN-listed in the Rift. This low number is a reflection of the lack of information on the distribution of these reptiles and hence the difficulty in assigning them IUCN classifications. A revised list of threatened reptiles in the process of being developed (S. Stuart pers. comm.) No site has more than one threatened or IUCN-listed species (Table 4.1).

4.4.4 Complementarity analysis

A complementarity analysis was made of the reptile data set (33 sites). The analysis selected those sites with the highest number of endemic, near-endemic and IUCN-listed species initially until all of these species had been selected and then selected those sites that contributed the most number of additional species.

Virunga National Park was selected first followed by Itombwe Massif and Lake Tanganyika. The first seven sites 'captured' all endemic, near-endemic and threatened reptiles in at least one site and also accounted for 84% of all reptile species recorded for the Rift. 18 sites were required to include all species (Table 4.3).

It is interesting how high Lake Tanganyika ranked in the complementarity analysis. This is because there is an endemic snake, *Lycodonomorphus bicolor* and an IUCN-listed crocodile, *Crocodylus cataphractus* found in the lake rather than because it is particularly rich in reptiles. These two species may well occur in Gombe Stream or Mahale Mountains national parks but we did not find any such records. Unlike the mammals and birds the complementarity analysis did not select sites in the south of the Rift. This is primarily because the data for these sites is very poor and few reptiles have been collected here rather than because they are not important.

Table 4.3 Results of the complementarity analysis indicating the minimum number of sites that together would maximise the number of reptiles protected. The sites on the left were selected first to ensure 'capture' of the endemic, near endemic and threatened species.

Sites which added endemic/near-endemic/threatened reptiles			**Sites adding additional reptiles**		
Sites	Species added	ARE/IUCN added	Sites	Species added	ARE/IUCN added
Virunga Park	109	14	Kibale NP	6	0
Itombwe Massif	9	2	Semliki NP	4	0
Lake Tanganyika	9	2	Lake Rukwa	3	0
Nyungwe Forest	5	2	Kahuzi Biega NP	2	0
Murchison Falls NP	9	1	Queen Elizabeth NP	2	0
Semliki WR	6	1	Rwenzori NP	2	0
Rusizi National Park	3	1	Kyambura NP	2	0
			Budongo FR	1	0
			Gombe Stream NP	1	0
			Karuma WR	1	0
			Mbizi FR	1	0

4.4.5 Cluster analyses

A cluster analysis was performed on the reptile data set for sites with reasonable lists of reptiles and where collections had taken place at several times. As the Virunga Park is large and extends over several habitat types it was subdivided into 5 sectors (volcanoes, south, central, Rwenzori and northern sectors) and these separate areas were included in the cluster analyses.

The clusters obtained are not very clear and are probably affected by the fact the lists are probably incomplete. There is a savanna set (Queen Elizabeth, Murchison Falls and Semliki Wildlife Reserve) although interestingly this does not cluster with the central Virunga Park, which is also savanna but has been better collected. There is a cluster of central high altitude sites (Nyungwe, Bwindi and Virunga Volcanoes) but surprisingly the northern sector of Virunga Park clusters with this group. Kahuzi Biega Park and Kibale Park cluster together but this is because these two sites have been more intensively surveyed than other sites and lists are more complete.

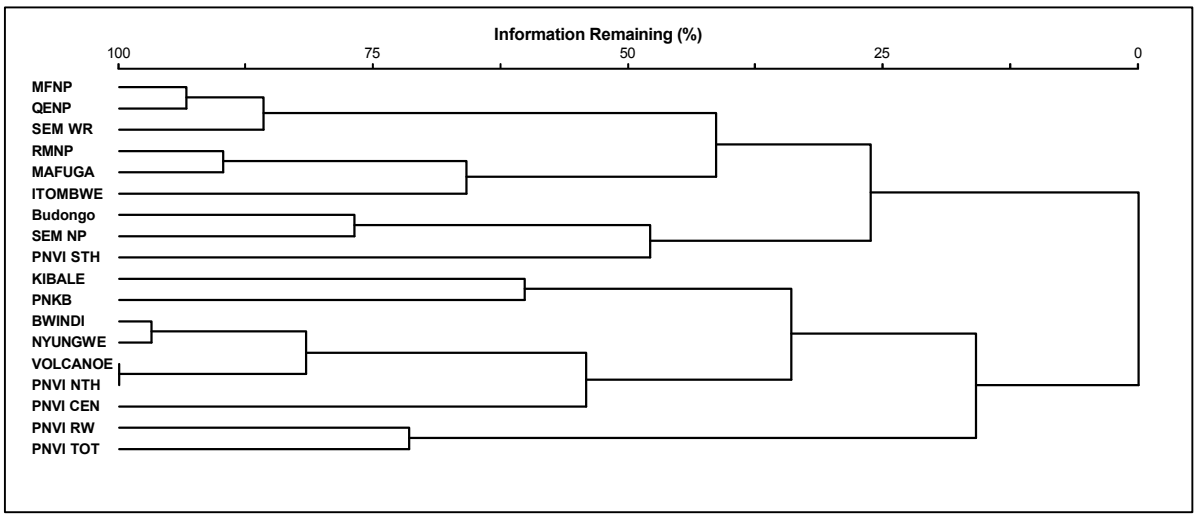


Figure 4.1 A cluster dendrogram for the reptile data set. The Virunga Park (PNVi) is separated into five subsectors (Volcanoes, south – PNVi sth, central – PNVI cen, north – PNVI nth and Rwenzori – PNVI RW). MFNP=Murchison Falls park, QENP=Queen Elizabeth park, PNKB=Kahuzi Biega park, SEM=Semliki, RMNP=Rwenzori mountains park.

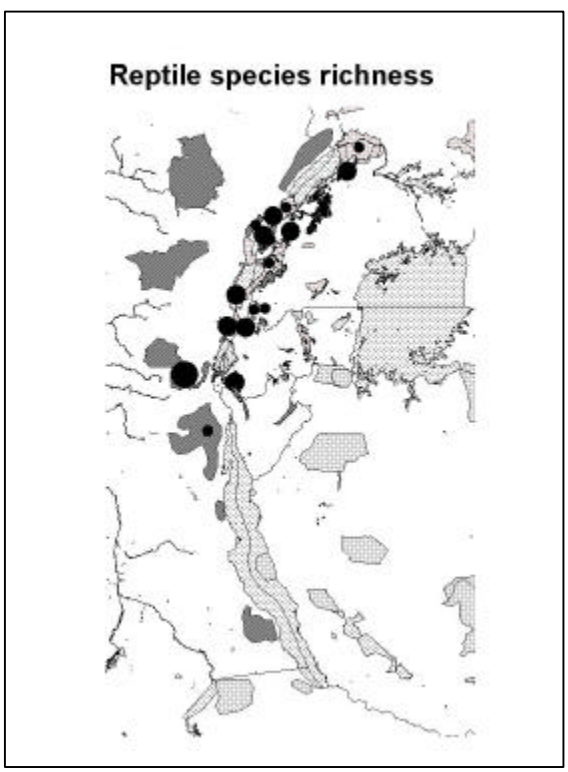
4.5 Discussion

These results show that the Albertine Rift is not as rich for reptile species as it is for mammals and birds. A total of 175 species occur in this part of Africa of which 10.3% are endemic or near-endemic and 2.2% are listed under IUCN criteria. It is clear that these results are provisional and could probably be greatly increased with more collection effort in the region.

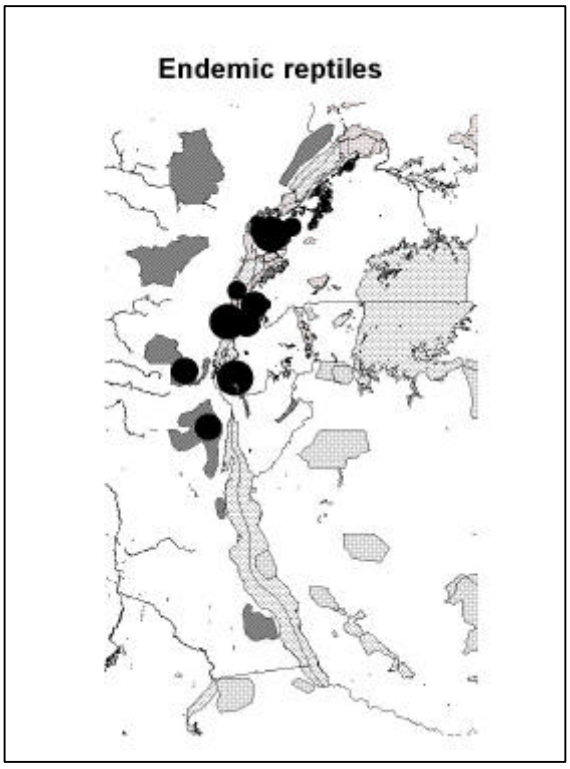
Virunga National Park is by far the richest park for species in part because it has been well surveyed but also because it is large in size and contains a variety of habitat types. Interestingly Rwenzori Park in Uganda, which is contiguous with the Rwenzori sector of Virunga Park, only has about half the number of species that are found in the Virunga sector. This may be partly due to the fact that natural vegetation only occurs above about 2,500 metres on the Uganda side but drops down to 700 metres on the Congo side but it also indicates that surveys could probably increase the number of species markedly even in sites which are thought to be one of the better surveyed sites.

Sites that deserve further attention and collection include the southern sites: Mahale Mountains and Gombe Stream National Parks, and Marungu Massif and Mt Kabobo which have very few species recorded. Other sites that need work include Itombwe Massif, Queen Elizabeth National Park, Kasyoha-Kitomi, Bugoma and Kalinzu Forest Reserves and Murchison Falls National Park. Rusizi National Park in Burundi has two species that have not been recorded from elsewhere in the sites we looked at in the rift and should be surveyed more intensively (we compiled a list of only 4 species for the park in total).

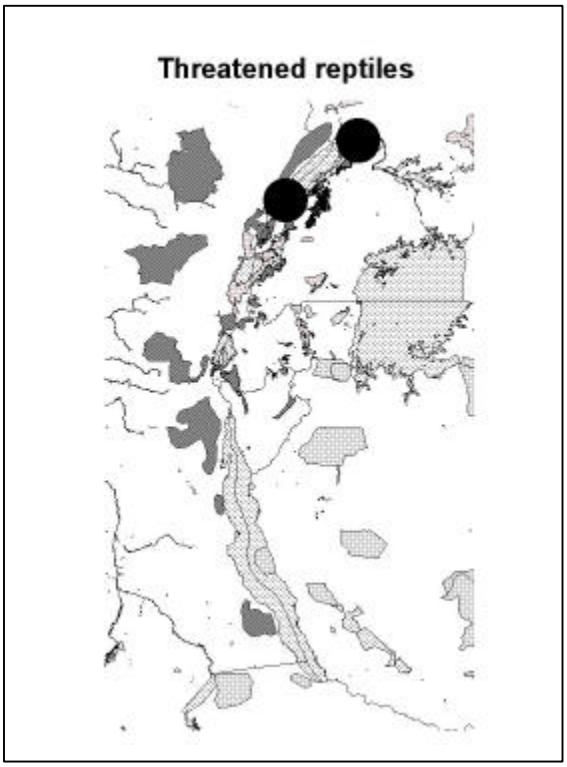
Figure 4.2 summarises the results in GIS. Species richness is relatively evenly spaced along the Rift while endemism is generally concentrated around the central portion of the Rift. Threatened species have only been found in the northern part of the rift but this is due to the low numbers of threatened species in the 2000 IUCN Redlist.



a



b



c

Figure 4.2 A summary of the results for the reptile data represented geographically. Each site that has non-zero data is represented by a circle of varying size depending on the number of species. a) reptile species richness; b) endemic reptiles; c) threatened reptiles (CR, EN and VU).

SECTION 5: AMPHIBIANS

Treefrog in Giant Lobelia. A.J.Plumptre, WCS

M. Behangana[1], D. Meirte[2], A.J. Plumptre[3], K. Howell[4] , S. Stuart[5], and H. Hinkel[6]

5.1 Summary

A total of 119 amphibian species have been recorded in the 27 sites of the Albertine Rift for which we could obtain records. This is about 19% of all amphibians found on mainland Africa. There are 34 species thought to be endemic to the Albertine Rift with an additional three near-endemic species. The Virunga National Park in DRC has a recorded list of 78 species and is the richest of the protected areas in the Albertine rift. Kahuzi Biega National Park in Uganda ranks second with 44 species and Bwindi Impenetrable and Kibale National Parks rank third with 33. Virunga National park has the highest number of endemic species (21) followed by Itombwe Massif (16) and Nyungwe Forest (15). The Virunga national Park also has the highest number of IUCN-listed species (21) with Itombwe Massif (15) and Nyungwe Forest (12) in second and third respectively. Itombwe Massif has more threatened species (CR, EN or VU) than other sites (11) followed by Virunga National Park (10) and Bwindi Impenetrable National Park (6). Seven sites can protect 40 of the 42 endemic and IUCN-listed species and at the same time protect 90% of all amphibian species recorded for the Albertine Rift. One endemic species and one near-endemic species are not found in any protected area.

Un total de 119 espèces d'amphibiens a été enregistré dans les 27 sites du Rift Albertin pour lesquels nous pourrions obtenir des données. Ceci représente 19% de tous amphibiens trouvés sur le continent africain. Il y a 34 espèce reconnues endémiques au Rift Albertin avec un supplément de trois espèces proche de l'endémisme. Le Parc National des Virunga en DRC compte 78 espèces et est le plus riche des aires protégées du Rift Albertin. Le Parc National de Kahuzi Biega en RDC occupe la deuxième place avec 44 espèces et le Bwindi Impenetrable National Parc et le Parc National de Kibale les troisièmes du rang avec 33. Le

[1] Makerere University Institute of Environment and Natural Resources
[2] Royal Museum of Central Africa, Tervuren
[3] Wildlife Conservation Society
[4] University of Dar es Salaam
[5] CABS - Conservation International
[6] Independent consultant

Parc National des Virunga a le nombre le plus élevé d'espèces endémiques (21) suivi par le Massif d'Itombwe (16) et la Forêt de Nyungwe (15). Le Parc National des Virunga a aussi le nombre le plus élevé d'espèces classées par l'UICN (21) avec le Massif d'Itombwe (15) et la Forêt de Nyungwe (12) respectivement deuxième et troisième. Le Massif d'Itombwe a plus d'espèces menacées (CR, EN ou VU) que les autres sites (11) suivi par le Parc National des Virunga (10) et le Bwindi Impenetrable National Parc (6). Sept sites peuvent protéger 40 des 42 espèces endémiques classées par UICN et protègent en même temps 90% de toutes les espèces d'amphibiens enregistrées dans le Rift Albertin. Une espèce endémique et une espèce de près de l'endémisme ne sont pas retrouvées nulle part dans les aires protégées.

5.2 Introduction

Amphibians have been collected in the Albertine Rift since the mid 1930s. However Amphibian taxonomy has changed greatly since this time and even today is in a state of flux. Consequently the names assigned to amphibians that were collected about 70 years ago are often incorrect and the original specimens need to be checked to verify which species they are. This is even true for specimens collected much more recently. It has been problematic pulling together species lists for sites in the Albertine Rift as a result. Sites within the rift have also been poorly surveyed and only 26 sites had any amphibian recorded. Few of these had very many records indicating that with more effort the number of species at most of these sites could be increased.

5.3 Information sources

A variety of sources were used to compile the amphibian list for the 26 sites where surveys have taken place. These sources are listed below by country. The authors of this chapter have also contributed many records. Schiotz (1999) was used to compile lists of treefrogs from various countries for sites where locations could be fairly accurately placed.

Uganda

Drewes and Vindum (1994, 1998) and Drewes, Vindum and O'Brien (1992) provided a species list for Bwindi Impenetrable National Park and Vonesh (1998) put together a list for Kibale National Park. Many records were provided by M. Behangana from recent surveys.

Rwanda

Hinkel and Fisher (1988) was used to develop a list of species for Virunga volcanoes and Nyungwe forest. This was augmented by de Witte (1941) for the Virunga volcanoes. Dowsett (1990) also provided a list for Nyungwe Forest.

DR Congo

De Witte (1941) produced a list of amphibians for Virunga National Park but the identifications need many corrections. The database at the Royal Museum of Central Africa for amphibians is in the process of being updated to reflect current amphibian taxonomy and we used the corrected data in this database to create lists of species for DRC and to add records to sites. Laurent (1972) increased the amphibian list of de Witte for Virunga National Park and corrected some mis-identifications. Laurent (1964) was used to compile a list of amphibians for the Itombwe Massif. Hinkel in Fischer (1996) provided a list for Kahuzi Biega National Park. Danny Meirte provided corrections to the taxonomy of the older literature and also added many species from the database at the Royal museum at Tervuren.

Burundi
No data were obtained for Burundi

Tanzania
No data were obtained for Tanzania.
All species names in the old lists were carefully updated to the recent names to ensure that species were not duplicated in the database. Frost (2002) was used to check names of species and ensure the taxonomy was consistent. D. Meirte derived endemic species from the database at the Royal Museum of Central Africa at Tervuren. The 2000 IUCN red data list does not list many amphibians and Simon Stuart at Conservation International is currently revising the list. The draft revised list was used in this analysis.

5.4 RESULTS

5.4.1 Species richness

A total of 119 species of amphibian were recorded for the Albertine Rift from 26 sites. This is 19.2% of the total number of amphibians recorded for the mainland of Africa (total from WWF database). About 18 of these sites have been surveyed reasonably intensively but it is likely that additional species could be added with further effort. Virunga National Park has the highest number of amphibians with 78 species or 65.5% of the total number of amphibians from these sites in the Albertine Rift. Kahuzi Biega National Park has 44 species recorded and Bwindi Impenetrable and Kibale National Parks rank third with 33 species (Table 5.1).

Table 5.1 The total number of species compiled, number of Albertine Rift (AR) endemic species, number of near-endemic species, number of threatened species and total number of IUCN-listed species. Virunga Park is divided into five sectors due to its size and numbers are given separately for each sector as well as the total.

Site	SPP no.	AR endemic species	Near Endemic species	Threatened CR,EN, VU	IUCN-listed species
Murchison Falls NP	14	0	0	0	1
Karuma WR	16	0	0	0	1
Budongo FR	29	1	1	1	1
Kitechura FR	15	0	0	0	0
Matiri FR	13	1	0	0	0
Itwara FR	19	1	0	0	0
Semliki WR	12	0	0	0	1
Semliki NP	21	1	0	0	1
Rwenzori Mountains NP	24	6	0	1	3
Kibale NP	33	5	1	3	5
Kasyoha-Kitomi FR	24	4	0	2	2
Kalinzu-Maramagambo FR	23	3	0	2	2
Kyambura WR	11	0	0	0	0
Queen Elizabeth NP	10	1	0	1	1
Bwindi Impenetrable NP	33	11	1	6	9
Mafuga FR	1	1	0	0	0
Echuya FR	14	3	0	1	2
Virunga Volcanoes	47	16	2	9	14
Virunga north	50	7	1	4	9
Virunga central	45	10	1	5	10
Virunga south	31	10	0	4	8
PNVi Rwenzori	54	10	1	6	11

Virunga total	78	21	2	10	21
West of Lake Edward	6	6	0	3	5
Nyungwe NP	31	15	0	5	12
PNKB total	44	13	0	4	10
Kibira NP	1	0	0	0	0
Bururi FR	4	4	0	1	2
Itombwe Massif	23	16	0	11	15
Mt Kabobo	8	7	0	5	7
Marungu	19	1	0	0	2

Table 5.2 The endemic species of amphibian that occur in the Albertine Rift with their IUCN threatened species status. IUCN threats: EN=endangered; VU=vulnerable; DD=data deficient; NT=near threatened. AR=Albertine Rift endemic; NE=near-endemic species.

Family	Species	IUCN	AR endemic
Herpelidae	*Boulengerula fischeri*	DD	AR
Hyperoliidae	*Hyperolius atrigularis*	DD	AR
Hyperoliidae	*Hyperolius ferrugineus*	DD	AR
Hyperoliidae	*Hyperolius xenorhinus*	DD	AR
Bufonidae	*Laurentophryne parkeri*	DD	AR
Hyperoliidae	*Leptopelis fenestratus*	DD	AR
Hyperoliidae	*Leptopelis fiziensis*	DD	AR
Petropedetidae	*Phrynobatrachus sulfureogularis*	DD	AR
Arthroleptidae	*Schoutedenella vercammeni*	DD	AR
Pipidae	*Xenopus ruwenzoriensis*	DD	AR
Ranidae	*Afrana ruwenzorica*	EN	AR
Hyperoliidae	*Chrysobatrachus cupreonitens*	EN	AR
Hyperoliidae	*Hyperolius leleupi*	EN	AR
Hyperoliidae	*Hyperolius leucotaenius*	EN	AR
Petropedetidae	*Phrynobatrachus asper*	EN	AR
Arthroleptidae	*Cardioglossa cyaneospila*	NT	AR
Hyperoliidae	*Leptopelis karissimbiensis*	NT	AR
Petropedetidae	*Phrynobatrachus acutirostris*	NT	AR
Petropedetidae	*Phrynobatrachus dalcqi*	NT	AR
Petropedetidae	*Phrynobatrachus versicolor*	NT	AR
Hyperoliidae	*Callixalus pictus*	VU	AR
Hyperoliidae	*Hyperolius castaneus*	VU	AR
Hyperoliidae	*Hyperolius chrysogaster*	VU	AR
Hyperoliidae	*Hyperolius frontalis*	VU	AR
Petropedetidae	*Phrynobatrachus bequaerti*	VU	AR
Arthroleptidae	*Schoutedenella hematogaster*	VU	AR
Arthroleptidae	*Schoutedenella pyrrhoscelis*	VU	AR
Pipidae	*Xenopus vestitus*	VU	AR
Pipidae	*Xenopus wittei*	VU	AR
Ranidae	*Afrana desaegeri*		AR
Hyperoliidae	*Afrixalus orophilus*		AR
Hyperoliidae	*Hyperolius discodactylus*		AR
Hyperoliidae	*Leptopelis kivuensis*		AR
Petropedetidae	*Phrynobatrachus petropedetoides*		AR
Petropedetidae	*Phrynobatrachus rouxi*	DD	NE
Hyperoliidae	*Hyperolius langi*	EN	NE
Hyperoliidae	*Hyperolius diaphanus*	VU	NE

5.4.2 Endemism

A total of 34 endemic and three near-endemic amphibians were identified for the Rift (Table 5.2). Virunga National Park had the highest number of endemic species (21) followed by Itombwe Massif (16) and Nyungwe Forest (15). One endemic (*Schoutedenella vercammeni*) and one near-endemic species (*Phrynobatrachus rouxi*) were not recorded from any of the sites for which we could find species lists.

5.4.3 Threatened species

Two categories of IUCN-listed species were analysed: 1. threatened (including critically threatened, endangered and vulnerable) and 2. all IUCN-listed species (CR, EN, VU and Near-threatened and data deficient species. The red list for amphibians is currently being revised and the draft list was used in this analysis. A total of 16 amphibians are threatened and 37 are IUCN-listed in the rift. The Virunga national Park has the highest number of IUCN-listed species (21) with Itombwe Massif (15) and Nyungwe Forest (12) in second and third places respectively. Itombwe Massif has more threatened species (CR, EN or VU) than other sites (11) followed by Virunga National Park with 10 and Bwindi Impenetrable National Park with six (Table 5.1).

5.4.4 Complementarity analysis

A complementarity analysis was made of the amphibian data set (all 26 sites). The analysis selected those sites with the highest number of endemic and near-endemic, and IUCN-listed species initially until all of these species had been selected and then selected those sites that contributed the most number of additional species.

Virunga National Park was selected first followed by Itombwe Massif and Marungu Massif. These three sites accounted for 80.7% of all amphibian species and 85.7% of endemic and IUCN-listed species respectively. Seven sites were necessary to protect all endemic and IUCN-listed amphibians found at these sites and 10 sites were required to capture all amphibian species (Table 5.3). Two species that were IUCN-listed were not recorded at any of the sites but are known to be endemic or near-endemic to the rift. These were *Schoutedenella vercammeni* and *Phrynobatrachus rouxi*.

Nearly all sites that are selected to include endemic and IUCN-listed species occur in DRC. This is in part because we did not have species lists for Tanzanian sites that probably would have formed part of the selection for sites in the southern end of the rift.

Table 5.3 Results of the complementarity analysis indicating the minimum number of sites that together would maximise the number of amphibians protected.

Sites which added endemic/threatened amphibians			**Sites adding additional amphibians**		
Sites	Species added	ARE/IUCN added	Sites	Species added	ARE/IUCN added
Virunga NP	78	26	Budongo FR	3	0
Itombwe Massif	9	8	Bwindi NP	2	0
Marungu Massif	9	2	Rwenzori NP	1	0
Kahuzi Biega NP	7	1			
Semliki NP	3	1			
Mt Kabobo	1	1			
Bururi FR	1	1			

5.4.5 Cluster analyses

A cluster analysis was performed on the amphibian data set. As the Virunga Park is large and extends over several habitat types it was subdivided into 5 sectors (volcanoes, south, central, Rwenzori and northern sectors) and these separate areas were included in the cluster analyses.

The clusters group into five main groups. A large group is formed of the northern savanna and mostly lower altitude forest areas and includes Murchison Falls, Queen Elizabeth, Semliki, and Rwenzori National Parks and Budongo, Kasyoha-Kitomi, Kalinzu-Maramagambo and Echuya Forest Reserves and, Karuma, Semliki, and Kyambura Wildlife Reserves. Itombwe Massif is in it's own cluster indicating the uniqueness of this site. A cluster of high altitude sites includes Virunga Volcanoes, Virunga South, Bwindi Impenetrable, and Kibale National Parks with Nyungwe Forest. Kahuzi Biega National Park also forms a cluster on its own and finally four sectors of the Virunga National Park are closely related in their amphibian fauna.

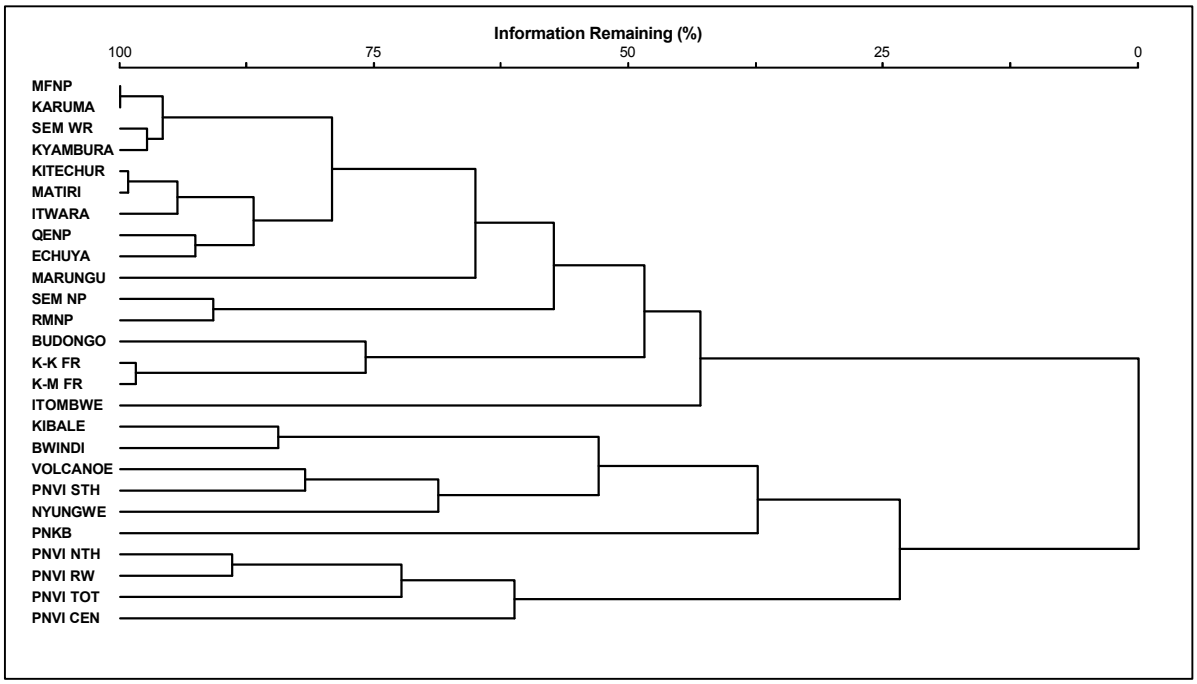


Figure 5.1 A cluster dendrogram for the amphibian data set. The Virunga Park (PNVi) is separated into five subsectors (Volcanoes, south – PNVi sth, central – PNVI cen, north – PNVI nth and Rwenzori – PNVI RW). MFNP=Murchison Falls park, QENP=Queen Elizabeth park, PNKB=Kahuzi Biega park, SEM=Semliki, KK=Kasyoha-Kitomi, K-M=Kalinzu–Maramagambo forests, RMNP=Rwenzori mountains park.

5.5 Discussion

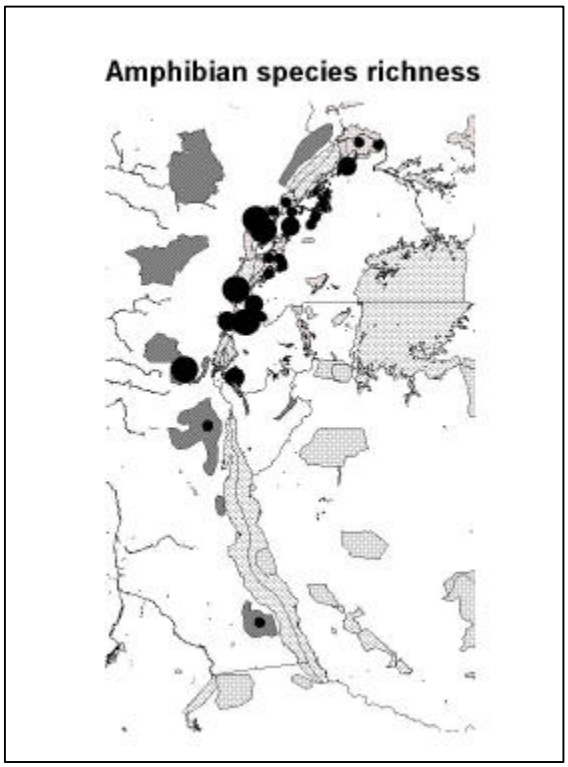
Amphibians species are relatively numerous in the Albertine Rift with 19% of amphibian species on the continent occurring in this region. This is despite the fact that many sites need further collecting and study. A large percentage of the amphibians are endemic to the Rift (28.7% of the species listed) and nearly one third of species are considered to need some form of IUCN-listing (31%). Amphibians are declining around the world and few sites are actively monitoring this taxon,

particularly in Africa. This is in part due to the difficulties in identifying species and the problems that exist with their taxonomy.

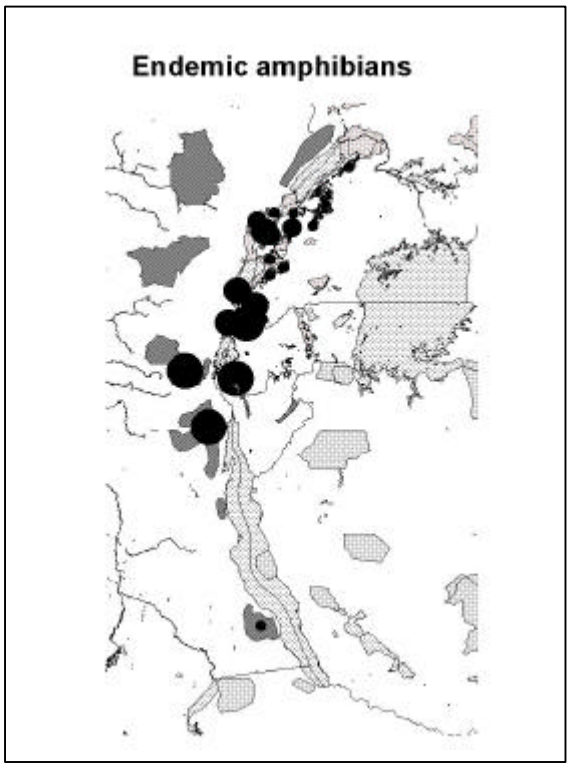
Itombwe Massif is the richest site for threatened species and yet it has no protected status. It also has not been very intensively surveyed for amphibians and it is likely more species could be found with only a little more effort. Virunga National Park once again ranks very high with whatever ranking method is employed indicating its importance for conservation in the Albertine Rift.

All sites need further survey work but areas that need particular attention should include Mahale Mountains and Gombe Stream National Parks, Marungu Massif and Mt Kabobo, Itombwe Massif, Kahuzi Biega National Park, Queen Elizabeth National Park and Semliki Wildlife Reserve.

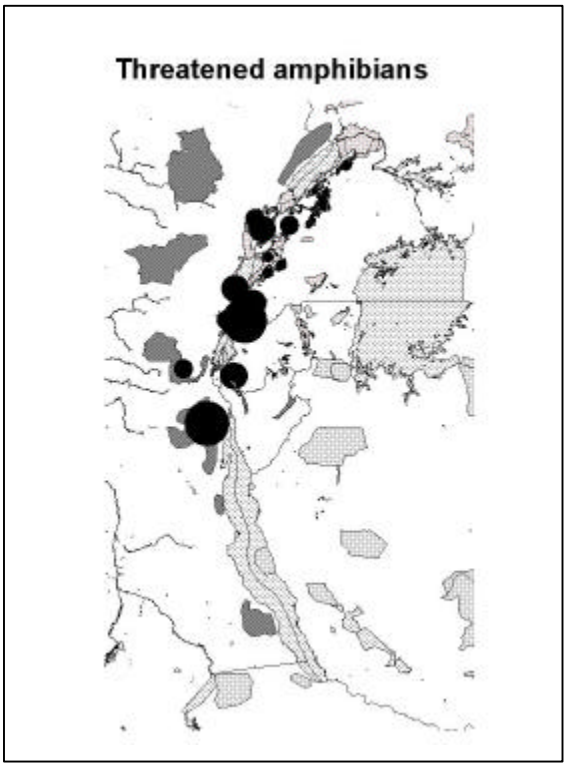
Figure 5.2 summarises the results using GIS. Species rich sites tend to be clustered near high altitude sites or sites which show good altitudinal variation. Endemism and threatened species are generally found in the central portion of the Rift.



a

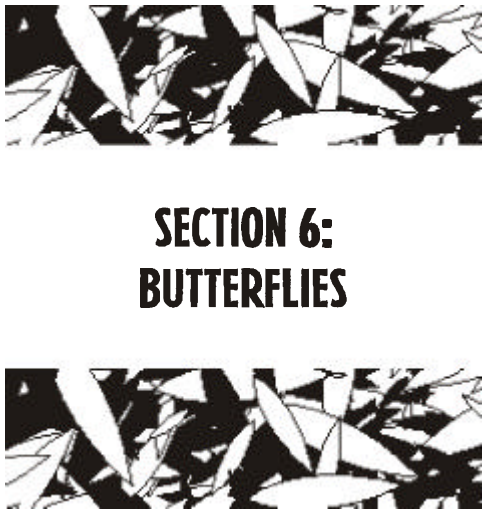


b



c

Figure 5.2 A summary of the results for the amphibian data represented geographically. Each site which has non-zero data is represented by a circle of varying size depending on the number of species. a) amphibian species richness; b) endemic amphibians; c) threatened amphibians (CR, EN and VU).



Butterfly in Kalinzu Forest Reserve, Uganda. T. Furuichi.

T.R.B. Davenport[1] and A.J. Plumptre[1]

6.1 Summary

Butterfly diversity in the Albertine Rift is considerable, though to date inconsistently documented across the region. It was not possible, therefore, to assemble species lists for all sites, and so an annotated list of species endemic to the Albertine Rift was compiled. This represents the first checklist to document specifically the endemic butterflies of these parts of Uganda, Democratic Republic of Congo, Rwanda, Burundi, Tanzania and Zambia.A total of 117 endemic species were identified. Bwindi Impenetrable National Park had more species endemic to the Albertine Rift than any other site (42), with Nyungwe Forest Reserve (21), and Virunga National Park (21) ranking second. Compared to other areas, forests in Uganda have been relatively well surveyed. There is a need, therefore, for more surveys in selected sites across the Rift in order to permit more accurate interpretation of the data.

Les papillons du Rift Albertin sont nombreux et compte tenu du temps, il n'était pas possible de rassembler les listes existentes pour tous les sites. Néanmoins, il a été possible de dresser la liste des espèces endémiques au Rift Albertin. Au total, 117 espèces endémiques ont été identifiées. Le Bwindi Impenetrable National Park avait beaucoup plus d'endémiques que tous les autres sites (42) avec la Réserve Forestière de Nyungwe (21) et le Parc National des Virunga (21), deuxième. Néanmoins, ces chiffres sont préliminaires parce que la distribution des données de ces espèces endémiques est moindre. Les forêts en Ouganda ont été rélativement inventoriées en comparaison à d'autres sites et il y a nécessité de faire des études intensives dans plusieurs sites du rift.

6.2 Introduction

This chapter provides a checklist of the butterflies (Rhopalocera) endemic to the Albertine Rift. Resources did not permit the compilation of species lists for all sites and consequently this annotated list of species was compiled. Carcasson (1964) noted that the Ruwenzori-Kivu region of Africa was particularly rich in montane butterflies and contained many endemic species. However, until now no list had been

[1] Wildlife Conservation Society

compiled documenting all species endemic to the Albertine Rift. This represents the first checklist to document specifically the endemic butterflies of these parts of Uganda, Democratic Republic of Congo (DRC), Rwanda, Burundi, Tanzania and Zambia. Some 117 species are listed, all of which are found exclusively within the Albertine Rift. Whilst no checklist of this nature can ever be considered comprehensive, it is hoped that the list is as complete and topical as current knowledge permits. Drawn from the available literature and personal observations, the document provides information on each endemic species including recorded localities, as well as broader details on the Albertine Rift itself.

6.3 INFORMATION SOURCES AND ACKNOWLEDGEMENTS

Information has been drawn from a variety of sources including Carcasson (1961; 1975), D'Abrera (1980; 1997), Henning (1988), Kielland (1990), Larsen (1991), Ackery, et al. (1995), Davenport (1996), Howard & Davenport (1996), Congdon & Collins (1999), Congdon, Gardiner & Bampton (2001), as well as numerous workers from earlier parts of the last century (e.g. Butler, Carpenter, Evans, Heron, Jackson, Joicey, Neave, Rebel, Rogers, Stempffer, Talbot, van Someren). Additional information came from collections held at Makerere University Zoology Museum, Kampala and the National Museums of Kenya, Nairobi. Steve Collins (ABRI, Nairobi) provided considerable and invaluable information, and we are very grateful to Colin Congdon (Tanzania) and Alan Gardiner (Zambia) for very useful comments on an earlier draft.

The sites where butterflies were collected are given place names in the literature. These were located on maps and tentative lists of the numbers of endemic species generated for each site where collections had been made. This is necessarily a first cut at this list because several collections of species had a district or even a country (in the case of Rwanda and Burundi) as collecting locations. These were not assigned to a site. Consequently the number of endemics species listed per site in this chapter should be considered a minimum.

6.3.1 Taxonomy

The higher classification of butterflies follows Kielland (1990) and Congdon and Collins (1999). Thus, four superfamilies (Papilionoidea, Lycaenoidea, Nymphaloidea and Hesperoidea) and nine families (Papilionidae, Pieridae, Lycaenidae, Riodinidae, Satyridae, Danaidae, Nymphalidae, Acraeidae and Hesperiidae) are recognised. Species are consistent, as far as possible, with Kielland (1990), Ackery *et al.*, (1995) and Congdon and Collins (1999). The African distribution details and ecological affinities follow Davenport (1996).

6.4 INFORMATION PROVIDED

The list is arranged systematically to species level and alphabetically thereafter. As far as possible this conforms to the taxonomic sequences in the literature. Each species has been ascribed one of ten habitat types (although only five are associated with species in this list) based on the literature and personal observations in the field (Davenport, 1996; Howard and Davenport, 1996). These ecological affinities belong to three major categories, namely forest-dependent species (F-species), characteristic of closed canopy forest habitats; forest non-dependent species (f-species), which may be recorded in closed-canopy forest but are not necessarily dependent upon it, and are more often encountered in a variety of forest edge, degraded forest and woodland habitats including Miombo (*Brachystegia*) in Tanzania; and non-forest (open habitat)

species include those characteristic of a range of open savannah, grassland and arid habitats (**O**).

The species' altitudinal range, if known or limited, has been given and expressed as metres above sea level. Each species has also been supplied with a list of countries in the Albertine Rift from which it has been recorded. Species that are endemic also to one of the six countries considered are marked accordingly. Finally, locality records are given for all butterflies where possible or known. In some instances, specific localities are not known and thus regions (such as north Kivu, western Uganda or Ufipa) are given.

There is confusion in the literature regarding distributions, particularly for the older records. Inevitably names and locations change with time and this is especially so in former colonies. For example in Uganda, Kibale has been referred to as Toro, Daro or Mpanga, the latter being problematical as there is also an Mpanga forest near Kampala. Bwindi Impenetrable has been termed as Kayonza or Kamengo (a name also given more usually to Semliki). As far as possible, the 'old names' have been changed to their currently used ones.

6.4.1 Why butterflies?

Being amongst the most colourful and conspicuous of invertebrate taxa, as well as diurnal in habit, more is known about the ecology and taxonomy of butterflies than any other major insect group. Whilst there remains a considerable amount to learn particularly about early stages, compared with most invertebrates much is understood about butterfly biology and ecology (Vane-Wright and Ackery, 1984). Often comprising distinct communities, suites of butterfly species may be specific to geographical sub-regions and diverse ecological conditions (Howard and Davenport, 1996). These traits contribute to the value of butterflies as biological indicators and much research has been carried out over the past decade to support this (Kremen, 1992; 1994; Sparrow *et al* 1994; Beccaloni and Gaston, 1995; Howard *et al.,* 1997; 1998).

The unequivocal environmental and dietary requirements of many species mean that their presence or absence can communicate much about a habitat and its health. Butterflies respond quickly to environmental changes and there is now considerable data on how particular species contend with alterations in land-use, and thus may play a valuable role in ecological monitoring (Daily and Ehrlich, 1995). The influence of seasonality on the presence or absence of adults of certain species, and on their morphology, as well as knowledge of species ecology must always be considered. However, the compilation of species lists may be used both qualitatively and quantitatively, to comment on a habitat (its condition and vegetation) and to identify conservation and monitoring needs. Increasingly, therefore, butterflies are being used as tools in ecological monitoring strategies (Pollard and Yates, 1993; Sparrow *et al.,* 1994).

6.5 NUMBER OF ENDEMIC SPECIES

As far as can be ascertained there are 117 species of butterfly from 49 genera endemic to the Albertine Rift, amounting to approximately 3.2% of the total fauna for the continent including Madagascar. This figure is impressive, particularly when compared to the total of 78 species that are known to be endemic to the Eastern Arc Mountains of southern Kenya and Tanzania (Congdon, Gardiner & Bampton, 2001). Of these 117 species, 21 are endemic to Tanzania, 22 to DRC, 21 to Uganda, 2 to

Rwanda and 1 to Zambia. The remaining 50 species are distributed amongst the six nations with 16 species records for Burundi, 44 for DRC, 32 for Rwanda, 9 for Tanzania, 44 for Uganda and 1 for Zambia.

Endemic taxa are consistently distributed across the families with 3 Papilionidae, 8 Pieridae, 50 Lycaenidae, 8 Satyridae, 28 Nymphalidae, 8 Acraeidae and 12 Hesperiidae represented. Only Riodinidae and Danaidae, the two smallest African families (represented by a total of 12 and 20 species respectively) are not present in this list. In terms of habitat preferences, 55 species are forest dependent (F), 1 forest lowland (FL) and 44 forest highland (FH), 11 species are forest non-dependent, 6 are from open habitats and 1 from open highland habitats. Thus 85.5% of the total are forest dependent, 9.4% forest non-dependent and 5.9% from open habitats.

The sites within the rift with the greatest number of endemic species include Bwindi Impenetrable National park, Nyungwe Forest Reserve, Virunga National Park and Kahuzi Biega National Park (Table 6.1). The sites in Uganda have probably been collected more intensively than other sites because of the biodiversity surveys undertaken by the Uganda Forest Department in the early 1990s (Davenport 1996; Howard and Davenport, 1996) and so the very large difference between Bwindi and other sites may be in part a result of this extra collecting effort.

Table 6.1 Numbers of Albertine rift endemic species found at sites where collections have been made.

Site	Number of Albertine rift endemic species
Bwindi Impenetrable National Park (U)	42
Nyungwe Forest Reserve	21
Virunga National Park region (DRC)	21
Kahuzi Biega National Park region (DRC)	19
Rwenzori Mountains National park (U)	14
Echuya Forest Reserve (U)	14
Mafuga Forest Reserve (U)	14
Mahale Mountains National Park region (T)	11
Semuliki National Park (U)	10
Kibale National Park (U)	8
Mbizi forest – Ufipa plateau region (T)	5
Gombe Stream National Park region (T)	4
West of Lake Edward region (DRC)	4
Bugoma Forest – Kagombe Forest region (U)	4
Lendu plateau region (DRC)	3
Kalinzu-Maramagambo Forest Reserves (U)	3
Itombwe Massif region (DRC)	2
Budongo Forest Reserve (U)	2
Northern Zambia region (Z)	2

6.6 Discussion

This list is strictly limited to the area delineated in Figure 1.1. Had, for example, forests in the western shores of Lake Victoria (Sango Bay in Uganda and Minziro in Tanzania) been included, this list would approach 200 species. A considerable number of taxa are restricted to south west Uganda, eastern DRC and the lake

Victoria shoreline. Indeed there are many similarities with the ecology of the lakeshore forests and the western highland forests (Howard & Davenport, 1996).

Similarly, the assumed boundary of the Albertine Rift cuts through eastern Ituri. If this were extended west to include more of this region, or north to include parts of southern Uele, a number of additional DRC endemics would be included. For example, *Argiolaus bergeri,* Stempffer 1953 (from Yindi and Kibali-Ituri), *Hypokopelates tenuivittata,* Stempffer 1951, (Epulu), *Cupidesthes minor,* Joicey & Talbot, 1921(Avakubi and Ituri river), *Euriphene (Euriphene) rotundata,* Holland 1920 (Medje), *Euphaedra intermedia,* Rebel 1914 (North Kivu, Uele and Itoa River), *Euphaedra sinuosa,* Hecq 1974 (Beni and Uele) are all forest DRC endemics that have been ommitted.

Undoubtedly there are gaps in this list, particularly in respect to localities. Inevitably a list of this nature is a reflection of collectors and their preferences and research projects. Uganda's forests have been relatively well surveyed in comparison with other sites (Davenport, 1996) and there is a need for surveys in most of the Albertine Rift sites outside Uganda. There is much less published literature available about the butterfly fauna of Burundi. Moreover, many parts of DRC have presumably never been sampled. That notwithstanding a total of 117 species represents a very significant number of endemic taxa, further illustrating the considerable significance of the region for conservation.

6.7. THE CHECKLIST

No	Species	Author	Date	Hab	Altitude	Country	Localities							
	PAPILIONOIDEA													
	PAPILIONIDAE (SWALLOWTAILS)													
	Papilioninae (Swallowtails)													
1	*Papilio leucotaenia*	Rothschild	1908	**FH**	2100-2300	B, DC, R, U	Bx	Dx	R8	U3	R6			
2	*Papilio ufipa*	Carcasson	1961	**FH**	> 2000	T*	T19							
3	*Graphium gudenusi*	Rebel	1911	**FH**	1900-2100	B, DC, R, U	Bx	D12	R6	U3				
	PIERIDAE (YELLOWS & WHITES)													
	Pierinae (Whites)													
4	*Mylothris alberici*	Dufrane	1940	**FH**	> 1800	DC, R, U	D9	D25	Rx	U8				
5	*Mylothris croceus*	Butler	1896	**FH**	> 1800	DC, R, U	D7	D13	R6	U3	U7	U8	U9	
6	*Mylothris celisi*	Berger	1981	**F**		DC*	D21							
7	*Mylothris mafuga*	Berger	1981	**F**	> 1600	DC, U	D4	U3	U8					
8	*Mylothris ochrea*	Berger	1981	**F**		DC, R	D8	D37	R6					
9	*Mylothris polychroma*	Berger	1981	**F**		B, DC, R	Bx	D37	R6					
10	*Mylothris ruandana*	Strand	1909	**FH**	> 1600	B, DC, R, U	Bx	D13	R9	U3	R6			
11	*Mylothris schoutedeni*	Berger	1952	**F**		DC*	D8							
	LYCAENOIDEA													
	LYCAENIDAE (BLUES, COPPERS, HAIRSTREAKS)													
	Lipteninae (Liptenids)													
12	*Alaena bjornstadi*	Kielland	1973	**O**	1400-1700	T*	T32	T33						
13	*Alaena kiellandi*	Carcasson	1965	**O**	1000-1700	T*	T10	T22	T27	T31				
14	*Telipna kayonza*	Jackson	1969	**F**	1400-2400	U*	U3							

15	*Telipna sheffieldi*	Bethune-Baker	1926	**F**	1300-2000	U*	U7							
16	*Telipna plagiata*	Joicey & Talbot	1921	**F**		DC*	D20							
17	*Ornipholidotos kigoma*	Kielland	1983	**F**	900-1300	T*	T9	T15	T21					
18	*Mimacraea paragora*	Rebel	1911	**F**		DC*	D39							
19	*Toxochitona ankole*	Stempffer	1967	**F**	1200-2000	U*	U5	U7						
20	*Toxochitona vansomereni*	Stempffer	1954	**FH**	1600-2600	U*	U3							
21	*Liptena subsuffusa*	Hawker-Smith	1933	**FH**	1500-2000	DC*	D19							
22	*Falcuna iturina*	Stempffer & Bennett	1963	**F**		DC, U	D7	D33	U11					
23	*Falcuna semliki*	Stempffer & Bennett	1963	**F**		DC*	D2							
24	*Micropentila bunyoro*	Stempffer & Bennett	1965	**F**		DC, T, U	D33	Tx	U1					
25	*Iridana bwamba*	Stempffer	1964	**F**	600-800	U*	U11							
26	*Iridana obscura*	Stempffer	1964	**F**	600-800	U*	U7	U11						
27	*Epitola bwamba*	Jackson	1964	**F**	600-800	U*	U11							
28	*Epitola cyanea*	Jackson	1964	**F**	600-800	U*	U11							
29	*Epitola mittoni*	Jackson	1964	**F**	600-800	U*	U7	U11						
30	*Epitola pulverulenta*	Dufrane	1953	**F**		DC*	D34							
	Miletinae (Harvesters & Woolly Legs)													
31	*Spalgis jacksoni*	Stempffer	1967	**f**	600-800	T, U	T7	T9	U11					
32	*Lachnocnema disrupta*	Talbot	1935	**f**		Za, U	U3	Z1						
33	*Lachnocnema inexpectata*	Libert	1996	**f**		T*	T14							
	Theclinae (Strong Blues)													
34	*Spindasis dufranei*	Bouyer	1991	**F**		DC*	D10	D13	D23					
35	*Spindasis tanganyikae*	Kielland	1990	**f**	900-2000	T*	T10	T22	T31					
36	*Epamera mongiro*	Stempffer	1969	**F**	600-800	U*	U11							
37	*Epamera pseudofrater*	Stempffer	1962	**FH**	1400-2600	U*	U3							
38	*Epamera pseudopollux*	Stempffer	1962	**FH**	1400-2600	T, U	T4	T5	T29	U3				
39	*Iolaphilus henryi*	Stempffer	1961	**F**	1400-2600	U*	U3							
40	*Argiolaus kayonza*	Stempffer & Bennett	1958	**FH**	1400-2600	U*	U3							
41	*Argiolaus montana*	Kielland	1978	**f**	1450-2200	T*	T5	T17	T30	T32	T34			
42	*Argiolaus sp. nr. iturensis*	Joicey & Talbot	1921	**FH**	> 2000	T*	T19							
43	*Hypolycaena jacksoni*	Bethune-Baker	1906	**FH**	1400-2600	B, DC, R, U	Bx	D11	D13	Rx	U3	U4	U7	U9
44	*Pilodeudorix ankoleensis*	Stempffer	1953	**F**	1500	U*	U5							
45	*Pilodeudorix zelomina*	Rebel	1914	**FH**	1200-2600	B, DC, R, U	Bx	D14	Rx	U3	U4	U8		
46	*Virachola edwardsi*	Gabriel	1939	**FH**	1400-2800	DC, U	D38	U9						
47	*Virachola ufipa*	Kielland	1978	**f**	1600-2200	T*	T1							
48	*Leptomyrina makala*	Bethune-Baker	1908	**F**		DC, U	D13	U12						
	Polyommatinae (Weak Blues)													
49	*Anthene rufomarginata*	Bethune-Baker	1910	**F**		DC*	D22							
50	*Anthene ruwenzoricus*	Grünberg	1911	**FH**	1500-3000	DC, U	D38	U9						
51	*Uranothauma lunifer*	Rebel	1914	**FH**	1400-2800	DC, R, T, U	D13	Rx	T17	U3	U4	U8		
52	*Harpendyreus argenteostriata*	Stempffer	1961	**FH**	1800-2400	DC, R, U	D29	R6	U4					
53	*Harpendyreus kisaba*	Joicey & Talbot	1921	**FH**	2100-2450	DC, R	D36	R3	R7	R6				
54	*Harpendyreus reginaldi*	Heron	1909	**OH**		DC, R, U	D13	D38	Rx	U3	U9			
55	*Harpendyreus marlieri*	Stempffer	1961	**FH**	2800	DC*	D29							
56	*Lepidochrysops carsoni*	Butler	1901	**O**		Z*	Z2							
57	*Lepidochrysops chala*	Kielland	1981	**O**	2000-2200	T*	T1	T19						
58	*Lepidochrysops mpanda*	Tite	1961	**O**	1700-2000	T*	T24	T29						

59	*Thermoniphas albocaerulea*	Stempffer	1956	**FH**	1400-2600	U*	U3							
60	*Thermoniphas caerula*	Stempffer	1956	**FH**	1400-2600	U*	U3							
61	*Thermoniphas kigezi*	Stempffer	1956	**F**	1400-2600	U*	U3	U4						
	NYMPHALOIDEA													
	SATYRIDAE (BROWNS & RINGLETS)													
	Biinae													
62	*Gnophodes grogani*	Sharpe	1901	**FH**	1400-2600	DC, R, U	D31	U3	U4	U8	R6			
	Elymniinae													
63	*Bicyclus aurivillii*	Butler	1896	**FH**	> 1500	B, DC, R, U	Bx	D17	D38	R5/ R6	U4	U8	U9	U10
64	*Bicyclus mahale*	Congdon, et al.	1999	**F**	900	T*	T6							
65	*Bicyclus matuta*	Karsch	1894	**FH**	1400-2600	B, DC, R, U	Bx	D13	D16	R6	U3	U8	U9	
66	*Bicyclus neustetteri*	Rebel	1914	**FH**	1400-2600	DC, R, U	D13	D24	U3	R6				
67	*Bicyclus persimilis*	Joicey & Talbot	1921	**FH**	1400-2600	B, DC, R, U	Bx	D38	Rx	U9				
68	*Bicyclus similis*	Condamin	1963	**FH**	1600-2300	T*	T11							
69	*Bicyclus tanzanicus*	Condamin	1983	**f**	1500-2300	T*	T5	T17	T28	T29				
	NYMPHALIDAE (BRUSHFOOTED BUTTERFLIES)													
	Charaxinae (Charaxes)													
70	*Charaxes alticola*	Grünberg	1911	**FH**	1400-2700	DC, R, U	D13	R4	U3	U4				
71	*Charaxes gerdae*	Rydon	1989	**f**	900-1400	T*	T10	T27						
72	*Charaxes grahamei*	van Someren	1969	**F**	800-1500	T*	T6	T7	T17	T20	T25			
73	*Charaxes mafuga*	van Someren	1969	**FH**	1400-2600	B, R, U	Bx	R6	U3	U8				
74	*Charaxes montis*	Jackson	1956	**FH**	1400-2600	DC, R, U	D13	U3	U8	U9	R6			
75	*Charaxes opinatus*	Heron	1909	**FH**	1400-2600	B, DC, R, U	Bx	D13	Rx	U3	U9			
76	*Charaxes schiltzei*	Bouyer	1991	**FH**	1400-2600	B, R, U	Bx	R6	U3					
77	*Charaxes turlini*	Minig & Plantrou	1978	**FH**		R*	R1	R2						
	Nymphalinae (Nymphalids)													
78	*Cymothoe collarti*	Overlaet	1942	**F**	1800	DC, R	D5	R6						
79	*Cymothoe howarthi*	Rydon	1981	**F**		DC*	D13							
80	*Cymothoe ochreata*	Grose-Smith	1890	**F**		DC, U	D1	D7	D13	D18	U1	U2	U11	
81	*Pseudathyma debruynei*	Hecq	1990	**F**		DC*	D26							
82	*Kumothales inexpecta*	Overlaet	1940	**F**	> 1400	DC, R, U	D15	R6	U3	U4	U8			
83	*Euriphene (Euriphene) alberici*	Dufrane	1945	**F**	1050	DC*	D28							
84	*Euriphene (Euriphene) excelsior*	Rebel	1911	**F**		B, DC, R, U	Bx	D13	Rx	U3				
85	*Euriphene (Euriphene) ituriensis*	Jackson & Howarth	1957	**F**		DC*	D7	D33						
86	*Bebearia hargreavesi*	D'Abrera	1980	**FH**	>1500	DC*	D25							
87	*Euphaedra barnsi*	Joicey & Talbot	1922	**FH**	1300-1600	DC, R	D13	Rx						
88	*Euphaedra christyi*	Sharpe	1904	**F**		U*	U3	U5	U6	U7				
89	*Euphaedra confina*	Hecq	1992	**F**		T*	T26							
90	*Euphaedra cottoni*	Sharpe	1907	**F**	650-1000	DC*	D6							
91	*Euphaedra ducarmei*	Hecq	1977	**F**		DC*	D33							
92	*Euphaedra graueri*	Rothschild	1918	**FH**		DC*	D33							
93	*Euphaedra margueriteae*	Hecq	1978	**FH**	1400-2600	DC, R, U	D8	Rx	U3					
94	*Euphaedra olivacea*	Grünberg	1908	**F**		U*	U3							
95	*Euphaedra phosphor*	Joicey & Talbot	1921	**F**	800-1200	B, DC, T	Bx	D40	T3	T10	T17			
96	*Euphaedra xerophila*	Hecq	1974	**F**		DC*	D41							
97	*Neptis lugubris*	Rebel	1914	**FH**	1400-2600	DC, U	Dx	U3						

	ACRAEIDAE (ACRAEAS)													
98	*Acraea (Acraea) hamata*	Joicey & Talbot	1922	**FH**	> 2000	DC, R, T, U	D13	R7	Tx	U3	U4	U8	R6	
99	*Acraea (Acraea) kia*	Pierre	1990	**F**	1000	T*	T23							
100	*Acraea (Acraea) turlini*	Pierre	1979	**F**	2500	R*	R6							
101	*Acraea (Actinote) amicitiae*	Heron	1909	**FH**	1400-2600	B, DC, R, T, U	Bx	Dx	R6	Tx	U3	U4	U8	U9
102	*Acraea (Actinote) burgessi*	Jackson	1956	**FH**		DC, U	D33	U3	U4	U8	U9			
103	*Acraea (Actinote) grosvenori*	Eltringham	1912	**FL**	< 1600	DC, U	D33	U3	U4	U8				
104	*Acraea (Actinote) hecqui*	Berger	1981	**F**		DC*	D32							
105	*Acraea (Actinote) pierre*	Berger	1981	**F**		DC*	D30							
	HESPEROIDEA													
	HESPERIIDAE (SKIPPERS)													
	Pyrginae (Flats & Grizzled Skippers)													
106	*Celaenorrhinus hecqui*	Berger	1976	**F**		DC*	D27							
107	*Celaenorrhinus kivuensis*	Joicey & Talbot	1921	**F**	> 1400	DC, U	D35	U3						
	Hesperiinae (Grass Skippers)													
108	*Metisella alticola*	Aurivillius	1925	**FH**	1200-2600	DC, R, U	Dx	R10	U3	U9	R6			
109	*Astictopterus bruno*	Evans	1937	**O**		T*	T13	T16	T18					
110	*Parosmodes onza*	Evans	1956	**F**		U*	U3							
111	*Acleros neavei*	Evans	1937	**F**	< 1400	DC, T, U	D7	D40	Tx	U2	U11			
112	*Andronymus bjornstadi*	Congdon, et al.	1999	**F**	1100	T*	T30							
113	*Chondrolepis cynthia*	Evans	1936	**FH**	1200-2400	DC, U	D3	U3						
114	*Gretna bugoma*	Evans	1947	**F**		U*	U2							
115	*Platylesches fosta*	Evans	1937	**f**		T, U	T12	U7						
116	*Platylesches larseni*	Kielland	1992	**f**	1000	T*	T8							
117	*Zenonia crasta*	Evans	1937	**f**		B, DC, R, U	Bx	Dx	Rx	U3	U4	U9		

6.7.1 Key

	Country		**DRC**		**Rwanda**
B	Burundi	D1	Aruwimi river	R1	Bugesera
D	Democratic Rep. Congo	D2	Boga	R2	Karama
R	Rwanda	D3	Bugoi	R3	Kisaba
T	Tanzania	D4	Bukavu-Shabundo	R4	Mt Karissimbi
U	Uganda	D5	Djuga	R5	Mt Sabinio
Za	Zambia	D6	Irumu-Mawambwi-Beni	R6	Nyungwe
*	National endemic	D7	Ituri	R7	Rugege
		D8	Kahusha	R8	Rugoge
	Tanzania	D9	Kamuhima	R9	SW Rwanda
T1	Chala	D10	Kibali-Ituri	R10	Virunga
T2	Kahoko	D11	Kisaba	Rx	Unspecified locality

T3	Gombe	D12	Kitembo		
T4	Ipumba	D13	Kivu		**Zambia**
T5	Kampisa	D14	Kivu Mts	Z1	Kasama
T6	Kasoge	D15	Kivu-Rwenzori	Z2	Fwambo
T7	Kasye	D16	Kwidjwe Island	Z3	NW Zambia
T8	Katuma river	D17	Lake Kivu		
T9	Kefu	D18	Lesse		**Burundi**
T10	Kigoma	D19	Lowa valley	Bx	Unspecified locality
T11	Kungwe	D20	Lower Batahu river		
T12	LakeTanganyika shore	D21	Lubero-Mulo		**Uganda**
T13	Lindi river	D22	Makala	U1	Budongo
T14	Longerengene	D23	Mambasa	U2	Bugoma
T15	Lubalizi	D24	Maniema	U3	Bwindi*
T16	Luluvia river	D25	Masisi	U4	Echuya
T17	Mahale	D26	Mongbwalu	U5	Kalinzu-Maramagambo
T18	Marungu	D27	Mt Hoyot	U6	Kasyoha-Kitomi
T19	Mbizi	D28	Mt Kele	U7	Kibale*
T20	Mihumu	D29	Mt Muhi	U8	Mafuga
T21	Mishamu	D30	Mukandwe	U9	Mt Rwenzori*
T22	Mpanda	D31	Mushari	U10	Rwoho
T23	Mukuyu	D32	Musisi-Kahusi	U11	Semliki*
T24	Mweze	D33	N. Kivu	U12	Western Uganda
T25	Ntakatta	D34	Nakele river		
T26	Nyakanazi	D35	Niragongo		
T27	Sibwesa	D36	NW Kivu		**Habitat Types**
T28	Sisaga	D37	Nyamununye	F	Forest dependent
T29	Sitebi Mt	D38	Rwenzori	FL	Lowland forest dependent
T30	Tubira	D39	South Kivu	FH	Highland forest dependent
T31	Ufipa	D40	Lake Tanganyika shores	f	Forest non-dependent
T32	Usondo	D41	Uvira	O	Open habitats
T33	Uvinza	Dx	Unspecified locality	OH	Highland open habitats
T34	Wanzizi				
Tx	Unspecified locality				

SECTION 7: PLANTS

Giant Lobelia, Rwenzori Mountains.. A. Plumptre, WCS

A.J. Plumptre[1], G. Eilu[2], C. Ewango[1], P. Ssegawa[2], D. Nkuutu[1], R. Gereau[3], H. Beentje[4], A. D. Poulsen[5], E.Fischer[6], D. Goyder[4], T.R. Pearce[4] and D. Hafashimana[7]

7.1 Summary

A total of 5,793 plant species were compiled from lists and floras for the Albertine Rift. This number is about 14.5% of plant species in mainland Africa and about 23% of the Guineo-congolian, Afromontane and Zambesian phytochoria that form most of the Albertine Rift. Data for 22 sites where reasonable collections had been made contained 5,573 species (96% of the total). A total of 567 species endemic to the Albertine Rift have been tentatively identified but this is a work in progress and the number may change over time. However, we believe that we have identified most of the endemic species. Virunga National Park has the largest number of endemic species (230) of which 124 are found in the Virunga Volcanoes with Kahuzi Biega National Park (145) and Nyungwe Forest (137) in second and third place. Bwindi Impenetrable National Park and Budongo Forest Reserve have the largest number of threatened (CR/EN/VU) species (18) with Kasyoha-Kitomi Forest third (17). If data deficient and lower risk species are included, Budongo ranks highest (24) with Bwindi (22) and Kasyoha-Kitomi (21) in second and third places respectively. Reasonable collections of all plant groups were compiled for 14 sites. Trees have been more widely studied, however, and 22 sites had reasonable lists for this group. Whether trees or all plants were analysed, 90% could be protected in seven sites with over 97% of endemic species protected in these sites also. Twelve sites are required to protect all endemic and threatened plants from the 14 sites where relatively complete lists exist and 10 sites are required to protect all endemic and threatened trees.

[1] Wildlife Conservation Society
[2] Makerere University
[3] Missouri Botanical Garden
[4] Royal Botanic Gardens, Kew
[5] University of Copenhagen
[6] University of Stuttgart
[7] Uganda Forest Department

Au total, 5.793 espèces de plantes ont été compilées sur base des listes et la flore du Rift Albertin. Ce chiffre représente environ 14,5% d'espèces de plantes du continent Africain et environ 23% du biome Guinée-Congo, l'Afromontagne et du "phytochoria" qui forment le plus, le Rift albertin. Les données de 22 sites où les collections acceptables ont été faites contiendraient 5.573 espèces(96% du total). Un total de 567 espèces endémiques au Rift Albertin ont été provisoirement identifiées mais c'est un travail en progression et les chiffres peuvent changer à tout moment. Néanmoins, nous croyons que nous avons identifié la plupart des espèces endémiques. Le Parc National des Virunga a le nombre élevé d'espèces endémiques (230) dont 124 se retrouvent dans les volcans des Virunga et le Parc National de Kahuzi-Biega (145) et la forêt de Nyungwe (137), respectivement en deuxième et troisième place. Le Bwindi Impenetrable National Park et Budongo Forest Reserve ont le nombre élevé (18) d'espèces les menacées (CR/EN/VU) avec Kasyoha-Kitomi Forest (17), le troisième. Si les critères de l'UICN (Data deficiency et Lower risk species) sont pris en compte, Budongo Forest Reserve est de plus loin le premier (24), Bwindi Impenetrable National Park (22) et Kasyoha-Kitomi (21) en deuxième et troisième places. Les collections acceptables de tous les groupes de plantes ont été compilées pour 14 sites. Les arbres ont été largement étudiés et 22 sites avaient des listes acceptables, pour ce groupe. Même si les arbres ou toutes les plantes étaient analysés, 90% seraient protégés dans sept sites avec plus de 97% d'espèces endémiques protégées. Douze des 14 sites où les listes relativement complètes existent sont importants pour protéger toutes les plantes endémiques et menacées, et 10 sites sont importants pour protéger tous les arbres endémiques et menacés.

7.2 Introduction

Plant composition is what defines most habitats in the world and this in turn defines the presence or absence of many species of animal. Consequently we felt it was important to attempt to assess plant diversity in the Albertine Rift, although the effort in compiling species lists was considerably greater than any of the other taxa. Trees have been better surveyed than other life forms of plants in the Albertine Rift. However, many of the sites in the Albertine Rift are montane or submontane and hence do not have a great diversity of tree species. We felt it was important therefore to include all herbs, climbers and shrubs where possible so that the plant diversity was better reflected. Plant lists were compiled for as many sites as we could obtain good information, for all flowering plants, gymnosperms and ferns. Only one site had information on mosses and liverworts so these were omitted from the database.

7.3 Information sources

A variety of sources were used to compile plant lists for the 22 sites where surveys had taken place. These are listed below by country. The authors of this chapter have also contributed many unpublished records.

Uganda

The main starting point for Uganda was the tree surveys undertaken by the Uganda Forest Department (Howard and Davenport, 1996). Additional data was added by G. Eilu (climbers) A. Poulsen (1997 - terrestrial herbs) and D. Hafashimana for epiphytes for several forests. The Wildlife Conservation Society has also been surveying many of the rift forests over the past year and the species identified were incorporated in the database (D. Nkuutu). Lock (1977) provided a list of species for Queen Elizabeth National Park. Nabanyumya (1991) listed trees for Kalinzu and Maramagambo forests. Synnott (1985) provided a checklist of plants for Budongo Forest Reserve.

Rwanda
Plant species lists for the Virunga Volcanoes were obtained from Burtt (1934), Robyns (1948-1955), the Herbarium at the Karisoke Research Station and Troupin (1978-1988). Plant species for Nyungwe were compiled from Troupin (1978-1988), Troupin (1992), Plumptre *et al.* (2002) and the herbarium at the Projet Conservation de la Forêt de Nyungwe.

DR Congo
Robyns (1948-1955) provided a relatively complete list for Virunga National Park and Fischer (1996) provided a list for Kahuzi Biega national Park.

Burundi
No plant lists were obtained for sites in Burundi.

Tanzania
A list of plants of Gombe was provided by Roy Gereau from his surveys there. Toshisada Nishida kindly provided a list of plants eaten by chimpanzees for Mahale Mountains National Park. Additional species for Mahale were obtained from Vollesen and Bidgood (1996) and Vollesen and Bidgood (1999). A species list for Mbizi forest was compiled from Mwasumbi (2000) and a list of collections by Ruffo and Kisena (1987).

Zambia
No plant lists have been compiled for sites in Zambia as yet.

Many of the plant species listed in the above publications are synonyms of existing names. Lebrun and Stork (1991-1997) was used to correct synonyms to a standardised list of names.

A list of endemic plants to the Albertine Rift was compiled by Paul Ssegawa, Andrew Plumptre and Ewango Ndomba using the List of East African Plants (LEAP), the Flora of Tropical East Africa, the Flora du Congo, du Rwanda et du Burundi, Flore du Cameroun, and Flora Zambesiaca. Species names were also standardised using Lebrun and Stork (1991-1997). Henk Beentje, David Goyder and Tim Pearce helped comment on species in families that have not been published in these floras. This list is very much a provisional list as new species are still being discovered regularly and because not all families have been checked thoroughly.

7.4 Results

7.4.1 Species richness

A total of 5,793 species of plant were identified as occurring in the 22 sites for which data were compiled. This is 14.5% of the total number of the estimated 40,000 plant species found on the mainland of Africa (Davis, Heywood and Hamilton, 1994). Of these 5,793 plants, 821 were trees, 499 grasses, 186 climbers, 360 ferns and the rest were other herbs and shrubs. Much of the Albertine rift is part of the Guineo–Congolian phytochorion with parts of the Afromontane and Zambezian phytochoria. These phytochoria are estimated to have 12,000, 4,000 and 8,500 species respectively (Davis, Heywood and Hamilton, 1994). The Albertine Rift therefore contains at least 23.6% of the flora of these three phytochoria. Virunga National Park had the largest species list with 2,077 species (Table 7.1) followed by Bwindi Impenetrable National Park (1,405 species) and Mahale Mountains National Park (1174 species). However only 14 sites had reasonable species lists of non-tree

species and so analyses of the sites with good data for trees were made separately from the sites with total species lists. The richest site for tree species was Budongo Forest Reserve (449 species) followed by Kalinzu-Maramagambo forests (442 species) and Kasyoha-Kitomi Forest Reserve (419 species).

7.4.2 Endemism

A total of 567 endemic plant species have been identified to date for the Albertine Rift region as defined in figure 1.1. Eleven near endemic species, which occur further south in Zambia towards Lake Malawi, could be considered but for the analyses here they have been omitted. Virunga National Park contains the most number of endemic species (230) with Kahuzi Biega National park (145 species) and Nyungwe Forest (137 species) ranking second and third respectively. The Virunga Volcanoes, part of which occurs within the Virunga National Park, has 124 endemic species and contributes greatly to the richness of endemics in this park (Table 7.1). Only 495 of these 567 endemic species (87.3%) occurred in the sites for which we compiled data.

Table 7.1 The total number of species compiled, number of tree species, number of Albertine Rift (AR) endemic species, number of threatened species and total number of IUCN-listed species. Virunga National Park is divided into five sectors due to its size and habitat types and numbers are given separately for each sector as well as the total. *= reasonably surveyed for all plants groups (incl. ferns, herbs, climbers and shrubs).

Site	Species no.	No. Tree species	AR endemic species	Threatened CR,EN, VU	IUCN listed species
Murchison Falls NP	149	145	1	5	8
Budongo FR *	1064	449	29	18	24
Bugoma FR	256	245	7	12	14
Kagombe FR	211	201	3	5	9
Kitechura FR	113	108	2	0	2
Matiri FR	113	105	2	2	3
Itwara FR	258	248	7	10	15
Semliki NP	333	318	7	14	18
Rwenzori Mountains NP *	696	199	55	5	7
Kibale NP *	532	330	16	12	17
Kasyoha-Kitomi FR *	901	419	41	17	21
Kalinzu-Maramagambo FR *	787	442	34	12	17
Queen Elizabeth *	950	288	22	5	7
Bwindi Impenetrable NP *	1405	393	74	18	22
Mafuga FR	115	100	7	2	2
Echuya FR *	423	131	32	1	2
Virunga Volcanoes *	878	81	124	4	5
Virunga south *	510	58	45	0	1
Virunga central *	863	120	44	2	2
Virunga Rwenzori *	537	80	99	2	2
Virunga north *	326	77	36	2	3
Virunga Total *	2077	264	230	10	10
Nyungwe Forest *	1105	230	137	7	9
Kahuzi Biega National Park *	1171	218	145	9	12
Gombe NP *	510	112	12	0	2
Mahale Mountains NP *	1174	220	39	9	12
Mbizi/Ufipa *	765	76	30	1	1

7.4.3 Threatened species

Two categories of threatened species were analysed: 1. threatened (including critically threatened, endangered and vulnerable) and 2. all IUCN-listed species (CR, EN, VU and lower risk and data deficient species). Species conservation status was taken from the IUCN red list of threatened species (Hilton-Taylor, 2000). This is currently a conservative list and mainly includes plant species being used commercially. It is currently being updated to produce a more comprehensive list of species. A total of 40 species are threatened and 51 are IUCN-listed in the Albertine Rift. Budongo Forest and Bwindi Impenetrable National Park have the largest number of threatened species (18) with Kasyoha-Kitomi Forest Reserve running a close second (17). Similarly these three forests rank as the highest three for IUCN-listed species with 24, 22 and 21 threatened species respectively (Table 7.1).

7.4.4 Complementarity analysis

A complementarity analysis was made of both the total plant data set (14 sites) and the total tree data set (22 sites). The analysis selected those sites with the highest number of endemic (Albertine Rift and near-endemic) and IUCN-listed species (all categories) initially until all of these species had been selected and then selected those sites that contributed the most number of additional species.

Virunga National Park was selected first followed by Kahuzi Biega National Park and Mahale Mountains National Park for the total plant data set. These three sites accounted for 64.9% of all plants at the 14 sites and 84.2% of endemic and threatened species. Twelve sites were necessary to protect all endemic and threatened plants in at least one site and all 14 sites were necessary to protect all plant species. However, these sites only contained 47 threatened species out of the 51 found at all sites and 380 endemic species of the 567 found within the Albertine Rift. Bwindi Impenetrable National Park, Nyungwe Forest and Budongo Forest Reserve were the first three sites to be selected respectively for the tree data set. These three sites contributed 77.7% of the total number of trees and 84.6% of endemic and threatened trees. Ten sites were required to protect all endemic and threatened trees in at least one site and 21 of the 22 sites were required to protect all tree species (Table 7.2).

Once again the complementarity analyses select sites at both ends of the Albertine Rift (Budongo FR (north) and Mahale Mountains NP (south)). In both cases, however, two sites, which have montane floras, are selected as the first two sites indicating that it is the montane forests that have more of the endemic and threatened species.

7.4.5 Cluster analyses

A cluster analysis was performed on both the tree data set and the total plant data set. As the Virunga Park is large and extends over several habitat types it was subdivided into 5 sectors (volcanoes, south, central, Rwenzori and northern sectors) and these separate areas were included in the cluster analyses.

The clusters for the total plant data set group into five main groups (Fig. 7.1). These are: 1. low-mid altitude forests (Budongo, Kibale, Kasyoha-Kitomi, Kalinzu-Maramagambo and Bwindi); 2. mainly high altitude forests (Rwenzori (Uganda and DRC), Echuya, Virunga Volcanoes and Virunga south – Gombe, Mbizi/Ufipa and Virunga north are in this group also; 3. Mahale Mountains park forms its own group; 4. Nyungwe and Kahuzi Biega form a group of medium altitude forests in the center

of the Albertine Rift; and 5. the savanna sites (Queen Elizabeth, Virunga central and all the Virunga National Park).

Table 7.2 Results of the complementarity analysis indicating the minimum number of sites that together would maximise the number of plants and also the number of trees.

All plant species (14 sites)			Tree species (22 sites)		
Sites	Species added	ARE/IUCN added	Sites	Species added	ARE/IUCN added
Virunga Park	2077	240	Bwindi Impenetrable NP	397	46
Kahuzi Biega NP	692	82	Nyungwe Forest	95	22
Mahale Mountains NP	850	36	Budongo FR	178	9
Budongo Forest	423	18	Virunga NP	46	7
Mbizi/Ufipa	467	16	Mahale Mountains NP	38	2
Nyungwe Forest	180	16	Kasyoha-Kitomi FR	21	1
Bwindi Impenetrable NP	374	7	Murchison Falls NP	18	1
Gombe Stream NP	110	4	Kahuzi Biega NP	16	1
Kasyoha-Kitomi FR	92	2	Semliki NP	11	1
Kibale NP	13	2	Rwenzori Mountains NP	9	1
Queen Elizabeth NP	172	1	Mbizi/Ufipa	10	0
Rwenzori Mountains NP	59	1	Queen Elizabeth NP	8	0
Echuya FR	46	0	Gombe Stream NP	3	0
Kalinzu-Maramagambo FR	18	0	Kibale NP	2	0
			Echuya FR	2	0
			Kalinzu-Maramagambo FR	2	0
			Itwara FR	2	0
			Kagombe FR	1	0
			Kitechura FR	1	0
			Matiri FR	1	0
			Mafuga FR	1	0

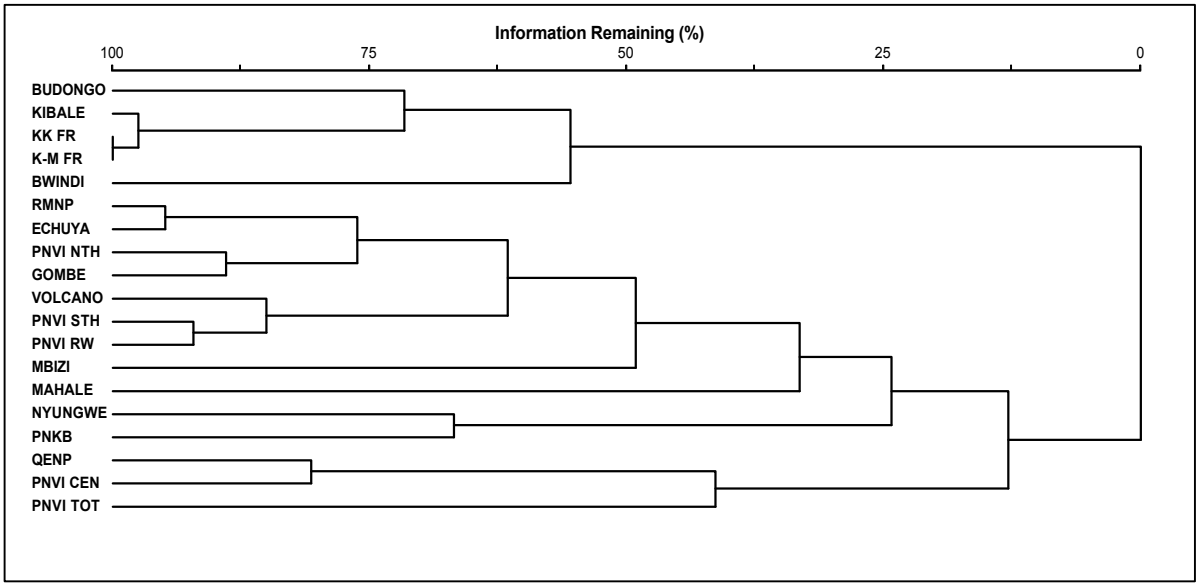


Figure 7.1 A cluster dendrogram for the total plant data set. The Virunga National Park (PNVi) is separated into five subsectors (Volcanoes, south – PNVi sth, central – PNVI cen, north – PNVI nth and Rwenzori – PNVI RW). QENP=Queen Elizabeth park, PNKB=Kahuzi Biega park, KK=Kasyoha-Kitomi Forest Reserve, K-M=Kalinzu–Maramagambo forests, RMNP=Rwenzori mountains park.

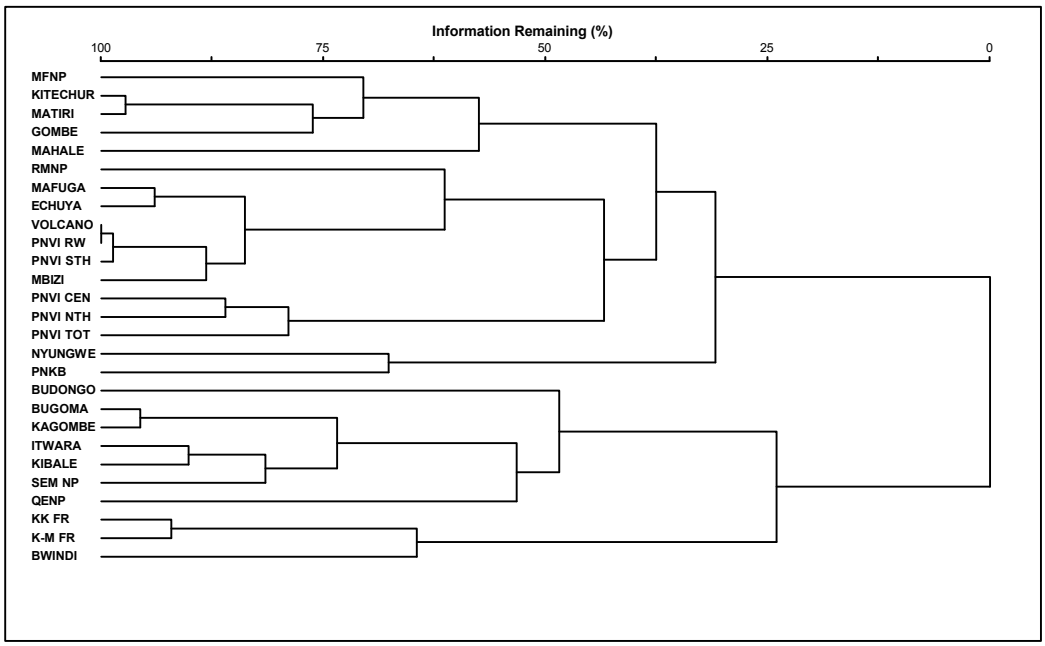


Figure 7.2 Cluster dendrogram for the sites with reasonable lists of tree species. The Virunga National Park (PNVi) is separated into five subsectors (Volcanoes, south – PNVi sth, central – PNVI cen, north – PNVI nth and Rwenzori – PNVI RW). MFNP=Murchison Falls Park, QENP=Queen Elizabeth Park, PNKB=Kahuzi Biega Park, SEM=Semliki, KK=Kasyoha-Kitomi Forest Reserve, K-M=Kalinzu–Maramagambo forests, RMNP=Rwenzori Mountains Park.

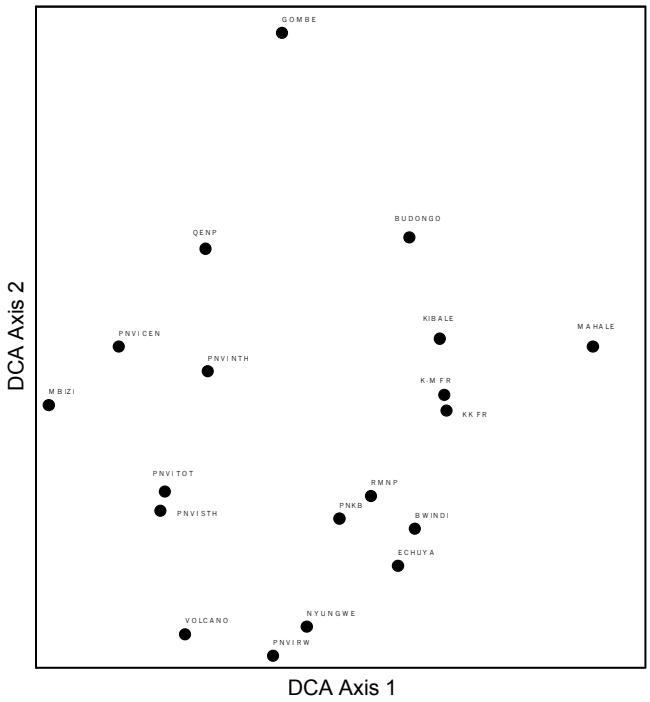


Figure 7.3 The first two axes of a detrended corrspondence analysis of the total plant data set. Points that are close to each other are more closely related in species composition.

The cluster analysis for the tree data set for the 22 sites (and 5 sectors of Virunga park) forms roughly six groups (Figure 7.2): 1. Woodland sites with lower altitude scrubby forest (Murchison Falls, Kitechura, Matiri, Gombe and Mahale); 2. High altitude forests (Rwenzori (Uganda and DRC), Mafuga, Echuya, Virunga Volcanoes, Virunga south and again Mbizi/Ufipa; 3. Virunga central, north and the whole Virunga park form a cluster; 4. Nyungwe and Kahuzi Biega also form a cluster again; 5. Lower altitude forest and woodland (Budongo, Bugoma, Kagombe, Itwara, Kibale, Semliki and Queen Elizabeth); 6. Forests in sw Uganda (Kasyoha-Kitomi, Kalinzu-Maramagambo and Bwindi).

7.4.6 Ordination of sites

For the case of the plants ordinations were carried out to assess the associations of sites separately to the cluster analyses. Detrended correspondence analysis was used to ordinate the two data sets using detrending by segments. The first two axes were plotted to show the associations between sites visually

The data for the total plant species shows that the three sites in Tanzania are very different and explain much of the variation in the data set. This is probably because there are several species that have been newly identified at these sites and these help to differentiate them because they are not found at other sites.

The ordination of the tree data shows a closer relationship between the three Tanzanian sites although Mbizi/Ufipa is still pretty distinct. The first DCA axis separates the higher altitude forests on the right from the lower altitude and savanna woodland sites on the left.

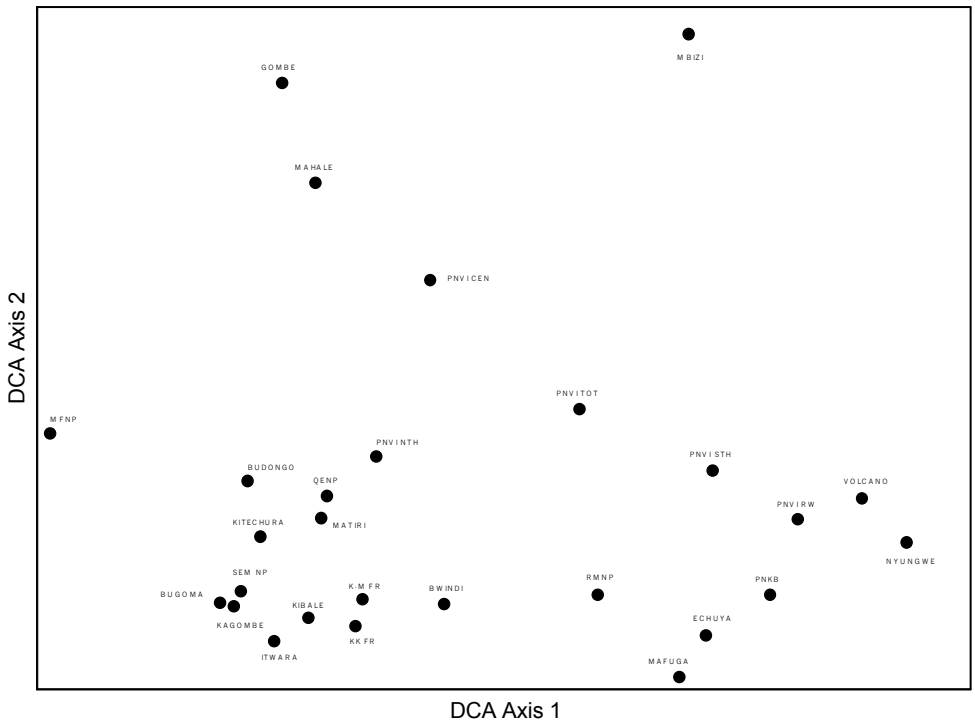


Figure 7.4 The first two axes of a detrended correspondence analysis of the tree data set. Points that are close to each other are more closely related in species composition.

7.5 Discussion

Linder (1998) identified the western rift mountains as an area of high species richness and endemism for 794 species of plants. This study compiled lists for many more species and confirms that the Albertine Rift is an important site for endemic species and total species diversity. It is also very clear how little is known about the plant composition of much of the Albertine Rift. Many sites had few plants listed in the floras and consequently were not analysed here. With time and funds more species would be certainly added to these lists if the herbaria with collections could be catalogued and collection sites identified. The sites with high tree species richness were forests in Uganda that have been fairly intensively surveyed. These are unlikely to represent true richness, as it would be expected that the lowland forest in Kahuzi Biega and northern Virunga parks would be found to have more species if collections were made.

However with the lists we have Virunga National Park ranks highest in terms of species numbers and in numbers of endemic and threatened species because of its large size and diverse habitats. Kahuzi Biega National Park and Nyungwe Forest are important sites also but are similar floristically so that if one site is selected in the complementarity analysis the other does not appear until later. Bwindi Impenetrable National Park is important for endemic and threatened tree species and Mahale Mountains National Park also is important in terms of plant diversity. Studies of plant diversity in sub-Saharan Africa show that western and southern Tanzania and northern Zambia is a region of high plant diversity (Lebrun and Stork, 1991-1997) and hence it is not surprising that Mahale has a high diversity.

Several sites in the rift need surveying because they could potentially be important sites. In particular the Itombwe Massif should be surveyed because it is rich in other taxa (both diversity and endemism). Similarly the Marungu Massif and Mt Kabobo could be important sites for endemic species as these areas have been isolated from other parts of the rift and most likely have new species to science. The northern sector of Virunga Park has not been surveyed very intensively and has fewest species for any of the five sectors despite being lowland tropical forest that would be expected to be most species rich. The flora (Robyns, 1948-1955) for this park does not include ferns either. Consequently the numbers of plants for this park could increase much further. The lowland sector of Kahuzi Biega national park probably has many more species than the current list also.

Figure 7.5 summarises the results using GIS. Plant species richness is relatively evenly spread along the rift while tree species richness is much higher in the lower elevation forests in Uganda. Endemism is higher nearer the central part of the Rift but threatened species mirror the pattern on the tree species richness. This is because most threatened plants are trees, which have economic value.

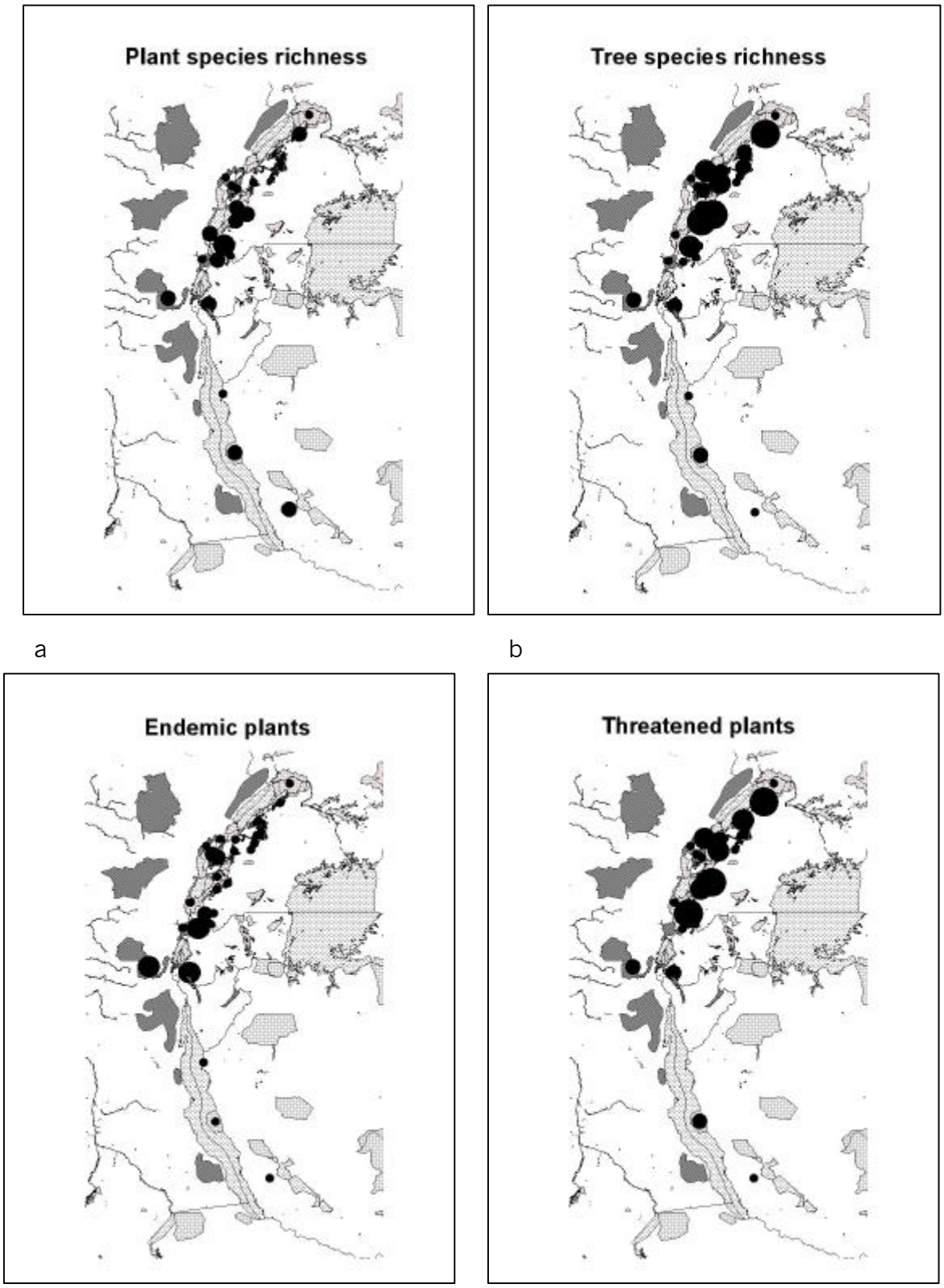


Figure 7.5 A summary of the results for the plant data represented geographically. Each site that has non-zero data is represented by a circle of varying size depending on the number of species. a) Total plant species richness; b) Tree species richness; c) endemic plants; d) threatened plants (CR, EN and VU).

SECTION 8: THE LAKES

Weaver at nest in Papyrus swamp. A.J.Plumptre, WCS

A.J.Plumptre[1], L. Chapman[1,2], and G.Patterson[1]

8.1 Summary

The lakes of the Albertine Rift are some of the richest in the world for freshwater fish species. The data on species richness for some of the Rift lakes is poor as they have not been thoroughly surveyed. New species can still be found, and many remain undescribed. The high rate of speciation of the cichlid family has contributed to the high species numbers and endemism. Lake Tanganyika contains the highest number of known species of fishes of the five large lakes of the Albertine Rift (Albert, George, Edward, Kivu and Tanganyika) with around 325 species of which 250 are cichlids. Lake Edward and George (connected by the Kazinga Channel) rank second with 81 species known to date and 60 cichlids. The percentage of endemic cichlids to each lake in four of the five large lakes is high (greater than 90%) except for Lake Albert (36%). Lake Tanganyika has 289 endemic fish species, while lakes Edward and George with a combined total of 56 endemic species (Snoeks, 2000). At least 366 species are known from these lakes that are endemic to the Albertine rift but this will be a minimum estimate for the Rift region as it only totals the numbers of species known to be endemic to each lake, and does not take into account the minor lakes, wetlands and rivers in the region. In addition, there are many species yet to be described. There is also high endemism and diversity of other groups in these lakes, particularly mollusks, crabs and ostracods.

Les Lacs du Rift Albertin sont parmi les plus riches du Monde pour les espèces de poissons d'eaux douces. Les données sur la richesse en espèces de tous les lacs sont pauvres parce que les lacs n'ont pas été largement étudiés et de nouvelles espèces peuvent être découvertes à tout moment. Le taux d'évolution d'espèces des Cichlidés a contribué de trop pour ce qui est du nombre et de l'endémisme des espèces. Le Lac Tanganyika contient le nombre le plus élevé d'espèces de poissons connues des cinq lacs avec environs 325 espèces dont 250 Cichlidés. Le Lac Edouard et Georges occupent la deuxième place avec 81 espèces connues aujourd'hui et 60 Cichlidés. Le pourcentage des Cichlidés

[1] Wildlife Conservation Society
[2] University of Florida at Gainesville

endémiques à chaque lac, parmi les quatre des cinq larges, est élevé (plus de 90%) sauf pour le Lac Albert (36%). Le Lac Tanganyika a 289 espèces de poissons endémiques (à ce lac) et les Lacs Albert et Georges, avec un total combiné, ont 56 espèces endémiques. Au moins 366 espèces connues de ces lacs sont endémiques au Rift Albertin mais ceci est une estimation minimum vu que les résultats ne donnent seulement que le nombre des espèces endémiques pour chaque lac.

8.2 Introduction

The large lakes in the Albertine Rift (Albert, George, Edward, Kivu and Tanganyika) are known to be important for speciation in fish as well as other groups of aquatic organisms including mollusks, crabs and ostracods. For this report it was not possible to pull together existing lists for these species in the lakes because of the lack of time and manpower available. However, these five lakes are important sites for endemic species and should be included as part of any analysis of the biodiversity of the Albertine Rift. Instead figures for species richness and endemism were compiled from existing literature and reviews of these lakes.

8.3 Taxonomy of fishes and the radiation of cichlid fishes

Much of the richness of the fish fauna of these lakes is due to the radiation of the cichlids (Cichlidae). Since the lakes were formed this group has evolved rapidly to fill many of the vacant niches in the lakes. Consequently this group has probably been better studied than some fish taxa (Patterson and Makin, 1998). However, the cichlids are being revised (Snoeks, 2000); many new species are being described, and many existing species could be split as a result of genetic analyses. In addition, there are key areas in the region that remain relatively unexplored, in particular Lake Edward. Lake George is better known, although the extensive wetland around the lake remains nearly unexplored. The Lake Edward-George system is very exciting biogeographically because it represents the confluence of the Albertine and Victoriine faunas. Preliminary excursions to Lake Edward in the past 10 years have yielded many new species of cichlids; and these fishes radically alter our understanding of the biogeography and evolution of the region.

8.4 Biodiversity of the lakes in the Albertine Rift

Despite the problems with taxonomy and the low sampling effort for some of these lakes there have been attempts to predict their total species richness (Snoeks, 2000). Lake Tanganyika contains the largest diversity of fishes of the five large lakes in the Albertine Rift. This is in part due to its size (32,000 km^2) and its age since any major geological process such as volcanic eruptions affected it. The other lakes have all been affected by volcanic eruptions or changes in water flow that could have influenced the fish fauna in the lakes (Beadle, 1974, Kaufman, Chapman and Chapman, 1996, Snoeks, 2000). Tanganyika is the second deepest lake in the world and the volume of water it contains and diversity of habitats also contributes to its high species richness (Kaufman, Chapman and Chapman, 1996). As a result of these factors it also has the largest number of endemic species (Table 8.1).

Tanganyika has been more isolated than the other lakes through geological time, and the level of the lake has fluctuated with changing geological and climatic patterns. Its long period of isolation is reflected in very high endemism (98% of the cichlids, and 89% of all fishes in the lake). It has an extraordinary richness of endemic cichlids (an estimated 250 species); it also has by far the richest non-cichlid lacustrine fish assemblage in East Africa (Lowe-McConnell 1993, Snoeks 2000, Table 8.1).

Table 8.1 The estimated age since major changes in geology affected the lake, species richness of fish and endemism of the major lakes in the Albertine Rift (adapted from Snoeks, 2000).

Lake	Age since last major change	Total fish species	% of total = cichlids	No. endemic fish species	% Cichlids that are endemic	% of all fish species endemic
Albert	12-14,000	48	23	6	36	13
Edward-George	8-10,000	81	74	56	92	69
Kivu	11-14,000	23	70	15	94	65
Tanganyika	10 million	325	77	289	98	89

There are fewer surveys of other taxa in these lakes but Lake Tanganyika has some detailed information (Patterson and Makin, 1998) that shows a high percentage endemism in invertebrate groups (Table 8.2). Although not as high as the endemic cichlids and fish the levels of endemism in these invertebrate groups is still higher than that in the other vertebrate groups (see chapters 2-5) in the region.

Table 8.2 Diversity and endemism of other groups in Lake Tanganyika (Patterson and Makin, 1998)

Taxa	Number of species	Number endemic	Percentage endemic
Copepoda	68	33	49
Ostracoda	85	74	87
Mollusks	75	46	61

8.5 Economic importance of the lakes

The five large lakes in the rift and their associated fish fauna are all highly important sources of revenue for local fishing communities. The fisheries that lake Edward and George sustain are some of the most productive in the world and of great importance to the economies of the people that live on the shores of the lakes. Introduced species such as the Nile Perch, which were introduced to boost the economy of the fisheries, have had a major impact on the biodiversity of these lakes by reducing species richness through predation. However, recent over fishing has led to the reduction in size of Nile Perch and some of the endemic cichlids that were thought to be extinct are reappearing. It is probable that they have survived in the wetlands that border these lakes.

Management of these fisheries therefore has to take into account the impacts on biodiversity as well as the livelihoods of the local people. Some degree of over fishing of Nile Perch seems desirable provided the stocks are not drastically reduced so that the off take of fish is too low. All the lakes in the Rift cross international boundaries which provides an additional challenge for the management of the fisheries.

8.6 Discussion

The number of endemic fish species listed in Table 8.1 greatly exceeds the number of endemic mammal, bird, reptile, and amphibian species of the region. Often the Albertine Rift is referred to as a region of high biodiversity and endemism, but this reference is made primarily to the montane and submontane forests. The lakes and their very high levels of fish species should be included when considering the Albertine Rift because they are in fact richer in endemic species than the terrestrial vertebrates. Only the plants have a greater number of endemic species (chapter 7).

There is still a need to undertake more surveys of the aquatic fauna in these lakes. In particular, Lake Edward is poorly known and many more species are probably awaiting discovery in this lake.

SECTION 9: THREATS TO SITES

Snare in Virunga volcanoes.. A.J..Plumptre, WCS

A.J.Plumptre[1], N. Laporte[2,3] and D. Devers[3]

9.1 Summary

The common category of threats that sites within the Albertine Rift face are reviewed briefly and data on forest loss analyzed from satellite images is presented. Forest loss over the past 10-15 years has varied between sites within the rift but has been particularly severe east of Lake Albert in western Uganda and also in eastern congo around Kahuzi Biega National Park and the Itombwe Massif. Hunting of large mammals has led to the reduction of their numbers within forests and savannas over the past 20 years across all sites in the rift. Timber exploitation is not that great at most sites but has the potential to become a major threat in DRC when the civil war ends and access to the forests improved. Mining for minerals has led to invasion of protected areas in DRC and the resulting campments have hunted wildlife extensively around the mining sites. Mining for oil is only just beginning but also has the potential to become a major threat to protected areas in the northern end of the Albertine rift. The most threatened sites in the rift occur in DRC and include both the parks and the unprotected sites such as the Itombwe Massif, Marungu Massif and Mt Kabobo. Virunga and Kahuzi Biega national parks are severely threatened by encroachment for land, settlement in fishing villages and heavy poaching for bushmeat.

L'ensemble de catégories communes des menaces auxquelles les sites du Rift Albertin font face sont brièvement examinées et les données présentées sur l'analyse de la perte des forêts à partir des images sattélitaires. La perte des forêts durant les 10-15 dernières années a varié suivant les sites du rift. Mais, elle a été particulièrement sévère à l'Est du Lac Albert àl'ouest de l'Ouganda et aussi à la partie est du Congo autour du Parc National de Kahuzi-Biega et du Massif d'Itombwe. La chasse des grands mammifères a conduit à la réduction de leur nombre dans les forêts et les savanes des sites du Rift au courant des vingt dernières années. L'exploitation du bois n'est pas aussi importante pour tous les sites mais peut devenir une menace majeure en RDC quand la guerre se termine et l'accès

[1] Wildlife Conservation Society
[2] Woods Hole Research Center
[3] University of Maryland

dans les forêts s'améliore. L'exploitation minière a conduit à l'invasion des aires protégées en RDC et les personnes qui ont occupé ces sites y ont largement pratiqué la chasse. L'exploitation du petrole est tout juste à son début mais peut potentiellement devenir une menace majeure aux aires protégées à l'extrême nord du Rift Albertin. Les sites les plus menacés se trouvent en RDC et incluent les parcs et les aires non protégées comme le Massif d'Itombwe, le Massif Marungu et le Mont Kabobo. Les Parcs Nationaux des Virunga et de Kahuzi-Biega sont très gravement menacés par l'empiètement des terres, le tassement des villages des pêcheurs et une grande chasse (braconnage) pour la viande sauvage.

9.2 INTRODUCTION

Threats to protected areas and species are important factors when considering the prioritisation of sites for conservation. If a very species rich site is so threatened that it may be difficult to protect it may be better to invest scarce conservation funds in less threatend but complementary sites. The threats that the protected areas face in the Albertine Rift are numerous and vary by region and country. Some are very specific to a site such as the mining around Queen Elizabeth National Park which leads to heavy metal pollution, while others are more general such as poaching by local communities for bushmeat, and occur in many sites. It is not possible to detail every threat, in the summary we present here, for each site. Therefore this chapter will focus on the differences that occur between countries in the types of threats the sites face and in particular look at changes that have occurred over the past 15-20 years in this region.

This region has experienced a series of civil wars over the past 20 years with fighting in Uganda, Burundi, Rwanda and eastern DRC leading to the decimation of wildlife and loss of the integrity of protected areas. The wars have exacerbated the threats because protected area staff have not been able to patrol effectively because of the dangers involved, and with the breakdown in law and order local people have engaged in illegal activities with immunity. However, apart from direct hunting of wildlife by armies we do not consider civil war as a threat in itself in this chapter. The settlement of refugees has affected protected areas more directly but primarily through activities that are described below.

9.3 HABITAT LOSS

The forested areas of the Albertine Rift are the sites of the greatest terrestrial diversity of species and in particular the endemic species. This habitat type is severely threatened in the rift as a result of the increasing human population in this part of Africa. Human population density now reaches 6-700 people per square kilometre in the central part of the rift and there is a great demand for farmland and firewood for cooking. This is leading to deforestation and forest degradation in the region.

Satellite images of the Albertine rift were analysed by Nadine Laporte, Miroslav Honsak, and Didier Devers at the University of Maryland to provide an estimate of current forest cover (using images from 1999, 2000 and 2001) and also to study forest loss between the mid 1980s and the most recent images. Due to the difficulty in obtaining cloud-free images of this part of the world, the analysis of landcover change in the Rift compared satellite images from 1986/7 with images from 1995-1999 for most of the area under study. In one area however (zone 1 in Fig. 9.1) it was possible to obtain cloud free images from 1999-2001—these particular images were analysed as part of a study for the GEF PDFb process for the Albertine Rift implemented by WWF (Plumptre, 2002).

The Landsat-7 images, the most recent ones, were georeferenced, with less than 1 pixel (< 30m) error, into the EarthSat Corporation's GeoCover™ orthorectified Landsat-5 image base map using a 2nd order polynomial function and the Nearest Neighbor resampling scheme. Once the images were georeferenced to each other they were processed using standard image processing methods, eg unsupervised classification. The resulting classification—forest, nonforest, water, or cloud—provided the analyst with diachronic landcover values over the region, which were then used to estimate forest loss and to compute table 9.1

Finally a mosaic of the images covering the region was created using standard mosaicking techniques, including histogram matching and feathering of the overlap areas, to provide images—one for mid-eighties, one for late nineties—of the entire Albertine Rift Area.

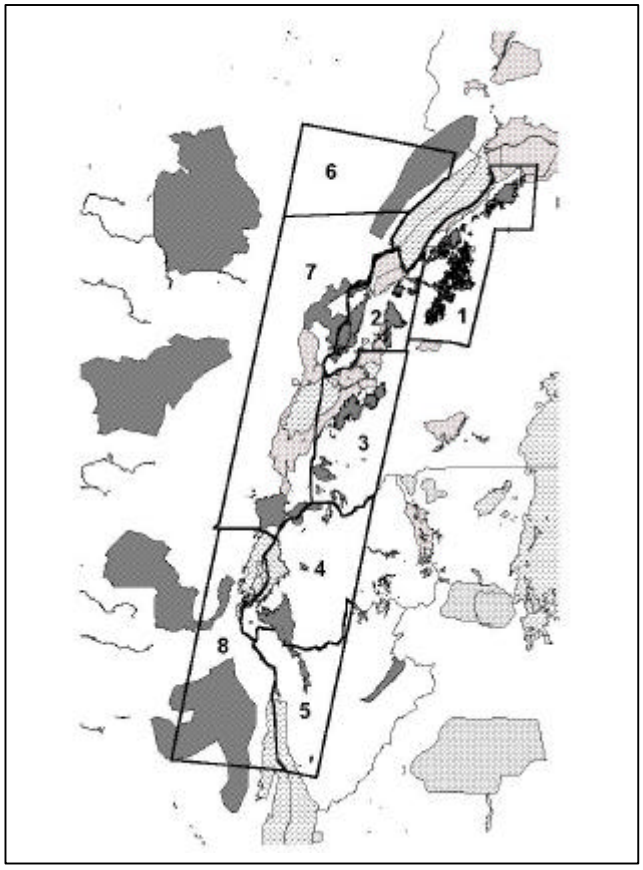


Figure 9.1 Eight areas or 'zones' analysed for change in forest cover since the mid 1980s. Analyses compared satellite images from 1986-1987 with satellite images from 1995-1999 (zones 2-8) and 1999-2001 (Zone 1).

The region under study was divided into eight areas or 'zones' within which threats/human pressures and governance and policy were similar. Comparison between these zones showed that forest loss varied markedly (Table 9.1). A large area of forest has been lost in the northern part of the rift in Uganda around Budongo and Bugoma Forest Reserves (zone 1). Closer analysis shows that most of this loss has

been outside these reserves on unprotected land. It is interesting to note though that this loss is greater in area than the forest loss in the zones in DRC despite the fact that zone 7 and 8 are much larger in total area. Zone 1 has been analysed over a longer time period (an additional 3-5 years) but this doesn't account for the marked difference in forest loss.

The sites referred to in previous chapters with significant forest loss include Kahuzi Biega National Park where there has been much destruction of forest between the highland and lowland parts of the park. Similarly there has been forest loss in Virunga National Park around sites neighbouring refugee camps, which were established at the time of the Rwandan genocide. Itombwe Massif has suffered a fair amount of forest loss because it is not a protected area and there has been farming taking place there for many years. Nyungwe Forest in Rwanda and Kibira Park in Burundi have also lost forest cover during the war in these countries and the conversion of forest to agriculture or the effects of fires which have burnt large areas of the forest during El-Nino years.

Table 9.1 Forest cover and forest loss in the eight zones mapped in fig. 9.1. These figures exclude areas of cloud cover in either the 1980s or 1990s images and hence are lower than the real value. If the clouds are randomly located then the percentage cover and percentage forest loss should be reasonable estimates of the total loss.

Zone	Forest cover 1980s (km^2)	Percentage of zone forested	Area of forest lost (km^2)	Percentage loss
1	3237.8	27.6	507.8	15.7
2	1302.0	19.6	58.0	4.5
3	1807.7	16.7	24.9	1.4
4	752.5	6.0	33.4	4.4
5	351.7	5.6	15.2	4.3
6	7428.6	57.0	117.6	1.6
7	10377.1	38.8	310.3	3.0
8	8686.9	41.3	492.9	5.7

Other types of habitat loss have occurred in recent years with encroachment of savanna parks and buffer reserves, particularly around the Queen Elizabeth and Virunga National Parks. These two parks border Lake Edward and several fishing villages have expanded over the past 15-20 years leading to loss of land for wildlife also.

9.4 Hunting wildlife

Hunting large mammals for meat takes place in all of the sites in the Albertine Rift. At most sites the activity is illegal under the national laws for each country but the inability of institutions to enforce the laws has led to various degrees of poaching. Ungulates are primarily targeted because they yield more meat than other mammals although where these have been hunted to very low numbers poachers will target smaller mammals. In Uganda, Rwanda, Burundi and Tanzania local people tend not to eat primate meat but in DRC primates are hunted intensively. A survey of the highland sector in Kahuzi Biega National Park by WCS in 2000 showed that Grauer's gorilla numbers had been nearly halved by hunting following three years of civil war in DRC when park staff could not protect the park.

Many of the forests in the rift have low numbers of ungulates, particularly the duikers and bushpigs. Monitoring of these species in Nyungwe forest following the genocide in Rwanda showed continued declines even while control of the forest was being regained following the civil war. Buffalos have been driven to extinction in many sites through over hunting and surveys by WCS in Uganda show that densities are probably too low to be viable in the long term in any forested site. Only those forests with connections to savanna sites still have some buffalos left in the forest (Kibale park and Virunga Volcanoes).

Hunting elephants for the ivory trade is not a major threat in most countries in the Rift because they have few elephants left to hunt. It is primarily taking place in DRC and even here many elephants have been killed for their meat rather then their ivory in recent years (J. Mapilanga pers. comm.).

Hunting takes place in forests using snares or dogs and nets in Rwanda, Uganda and Tanzania but more actively with guns in DRC. In the savanna parks hunting is often carried out with guns or snares.

9.5 Harvesting plant products

9.5.1 Timber

The forest areas left in the Albertine Rift are small and commercial timber exploitation is mostly by pitsawing operations rather than mechanised with sawmills. An exception is the operations in Budongo and Kalinzu forests in Uganda. There is interest in opening up parts of eastern DRC to mechanised harvesting and sawmilling operations are beginning to become established. At present these cannot function easily because of the civil war and the poor condition of roads but once peace comes to the country it is likely that large areas of forest will be harvested for timber. Pitsawing is leading to the degradation of habitat in areas where timbers of high economic value are present but on the whole harvesting is illegal in most sites and only takes place rarely.

9.5.2 Non-timber forest products

Harvesting firewood, rattan cane, medicinal plants and honey takes place in all the forests in the rift. Given the high density of people living around these forests these activities have the potential to degrade the habitat over time unless the activities are monitored and controlled. Rattan cane in Uganda has been depleted from most of the reserves near the main market of Kampala and is now being harvested from forests within the Albertine Rift for sale to this market rather than for local consumption as it was historically used. The Uganda Wildlife Authority has been working with its partners to develop monitoring programmes and controlled use of non-timber forest products in several of its protected areas and Bwindi Impenetrable National Park probably has the most comprehensive programme to date.

Charcoal has been made at many sites within the rift and is of greater concern because often it is made on site within the forest. Fires used to make the charcoal often burn more widely and destroy forest. In most forests in the rift charcoal making is illegal but does take place at a small scale.

9.6 Mining

Mining of minerals is not common in the Albertine Rift but has affected sites in Rwanda, Uganda and DRC. In DRC, particularly in the Kahuzi Biega National Park,

many miners have settled in the park to mine for columbo-tantalite, diamonds and gold and in the process degrade the habitat through the mining activity and also hunt wildlife to feed themselves. In some parts of Kahuzi Biega people are now selling rats in local bushmeat markets implying that the larger mammals have been completely hunted out (J.Hart pers. comm.). Pressure is being put on the companies that buy the minerals to buy from sources that are not fuelling civil war or destroying the environment.

Oil exploration has been taking place around Lake Albert over the past 10 years and exploratory drilling is now taking place. Several of the protected areas, including Queen Elizabeth, Semliki, Murchison Falls and Virunga National Parks and Budongo, Bugoma and Itwara Forest Reserves all fall within concessions for oil exploration. If significant amounts of oil are discovered under these protected areas great pressure will be put on them to either allow drilling or de-gazette them all together.

9.7 Fire

Fire affects the savanna parks annually. Some fire is necessary for these parks as part of the natural processes that have maintained the grasslands over time, however the intensity of burning is much higher than it should be and is probably leading to degradation of the grasslands and loss of species. Fires come from outside the parks where people burn their fields and do not control the fires or are set deliberately within the park to drive animals towards hunters.

Fires also occur in forests and can lead to major changes in the vegetation of the forest. Nyungwe Forest has been burnt several times and large areas of hillside are now devoid of trees as a result. Fires are usually set to collect honey from the trees by smoking the bees out and then get out of control but burning wood to create charcoal in the forests also creates fires.

9.8 Other threats

There are many other threats that could be listed here which are specific to each site. Some general threats that are common across several sites include:

a. the presence of exotic or invasive species – species such as black wattle, Lantana, Mauritius thorn as well as other plants are invading many of the reserves and preventing regeneration of native species.
b. pollution from human activities inside or outside the sites – mining of lime and copper around Queen Elizabeth Park has polluted areas of the park. Similarly the pollution of rivers with detergents or mercury (in the case of mining) upstream of protected areas has led to losses of fish species
c. impacts of tourism activities such as vehicle driving (off road and the killing of wildlife on the roads), and
d. disease risks from people and their domestic animals. Disease transmitted by tourists is a particular risk to ape tourism activities and is being monitored closely at gorilla tourism sites but less so at chimpanzee tourism sites.

9.9 Sites most affected

The sites within the rift that are most threatened are firstly those which have no protected status and secondly those in DRC affected by the civil wars. Those with no status include Itombwe Massif, Mt Kabobo, Marungu Massif and the Lendu plateau. Woodland to the east of Mahale Mountains Park may also be vulnerable as refugees from the Burundi civil wars move down and settle near the park. This area may be

important for conservation and needs more surveying to determine this before it is lost.

Kahuzi Biega and Virunga National Parks are suffering particularly from the civil wars and have problems with people encroaching to farm and settle in the parks, widespread bushmeat hunting, mining activities and destruction of habitat through the collection of firewood and making of charcoal. These two parks consistently ranked high for species richness and endemism but are also highly threatened at present. Their large size will help them weather some of the impacts of these threats but they have already lost a high percentage of their large mammals. Already the game reserves around Virunga Park have been lost to encroachment over the years since the park was created in 1925. It is very possible that these parks could be completely lost if pressure is not exerted on everyone involved to protect what remains of these sites.

SECTION 10: PRIORITISING SITES FOR CONSERVATION

Summit of Rwenzori Mountain.. A.J..Plumptre, WCS

A.J.Plumptre[1]

10.1 Summary

A prioritisation of the sites in the Albertine Rift is made based on species richness, endemism and numbers of IUCN threatened species. Equal weighting is given to each of five taxa (mammals, birds, reptiles, amphibians and plants). Sites are classified into those that have high, medium and low species numbers for total species richness, and endemic and threatened species. Eight sites rank highly for both criteria and are considered the most important sites for conservation in the Albertine Rift. These are: Virunga, Kahuzi Biega, Semliki, Kibale, Bwindi Impenetrable National Parks, Itombwe Massif, Nyungwe Forest and Lake Tanganyika. Large areas of contiguous habitat are important for the long-term conservation of species in the Rift. Landscapes of contiguous protected areas or sites are described and the suggestion made that collaboration occurs between institutions or between countries to manage these as contiguous units. The Virunga Landscape which encompasses the Virunga National Park and contiguous protected areas is incredibly rich in total species, endemic and threatened species. This region may be one of the most diverse on the planet. These landscapes are important to maintain biological, geological and evolutionary processes that occur at large scale and these are discussed.

La prioritisation des sites du Rift Albertin est plus basée sur la richesse d'espèces, l'endémisme et le nombre d'espèces menacées de l'UICN. La même considération est attribuée à chacun des cinq taxa (les mammifères, les oiseaux, les reptiles, les amphibiens et les plantes). Les sites sont classifiés suivant qu'ils ont un nombre élevé, moyen et bas suivant la richesse en espèces et des espèces endémiques et menacées. Huit sites se classent premiers considérant les deux critères et sont considérés les plus importants pour la conservation dans le Rift Albertin. Ceux-ci sont: Les Parcs Nationaux de Virunga, Kahuzi Biega, Semuliki, Kibale, Bwindi Impenetrable, le Massif d'Itombwe, la Forêt de Nyungwe et le Lac Tanganyika. Les larges aires d'habitats contigus sont importantes pour la conservation à long terme des espèces du Rift. Les paysages des aires ou sites protégés contigus sont décrits et la suggestion a fait que la collaboration soit effective entre les

[1] Wildlife Conservation Society

institutions ou entre les pays pour gérer ces sites comme des unités contiguës. Le Paysage de Virunga qui entoure le Parc National des Virunga et les aires protégées contiguës est incroyablement riche pour toutes les espèces, les espèces endémiques et menacées. Cette région peut être l'une des plus diversifiées sur la planète. Ces paysages sont importants pour maintenir les processus biologiques, géologiques et évolutionnistes qui se produisent à grande échelle et ceux-ci sont présentés.

10.2 Introduction

The availability of funds for conservation in Africa is limited. Ideally all the sites described in this report should receive high levels of financial support given the species richness and endemism of the Albertine Rift. However reality dictates that certain sites should be given priority over others. How should priorities be set for these sites? Here I use the biodiversity data presented in the previous chapters to look at priority sites within the Rift initially and to select an initial set of high priority sites. I then look at other factors that should be considered when setting priorities, such as size of site, integrated landscapes and biological and evolutionary processes. Rather than rank all sites for priority I produce a list of high, medium and lower priority sites.

Ranking using species data requires subjective decisions to be made. The data lists are incomplete, only five taxa can be used in this study of the rift because the species data are not collated or available for other taxa and it makes the assumption that these taxa are acting as good surrogates for other taxa. If total numbers of species are used to rank sites then plants will dominate the rankings because of the larger number of species. The general public may wish to rank sites on their mammal and bird fauna because these are the two taxa that are most popular and which attract most attention. Alternatively it might be better to prioritise sites on species that have economic value and can attract tourists or provide livelihood to local communities. Weightings could be made for certain species or certain taxa to incorporate these ideas. Here I have decided to weight taxa equally so that a high number of species of mammals at a site receives the same rank as a high number of plants irrespective of the actual number of species.

10.3 Ranking using species data

10.3.1 Species richness

Total species richness is potentially useful for prioritising sites because as a measure it will incorporate the diversity of habitats and hence capture the diversity of other taxa that may be highly specific to certain habitats (eg. certain insect groups). However, it also is very strongly influenced by the area of a site and the effort that has been put into surveys at the site. Here I only use data from sites that have had a reasonable survey effort (greater than 5 on the scoring system described in section 1.4.1).

Table 10.1 indicates ranking of sites for each of the five taxa based on species richness and calculates a mean rank across all taxa and then ranking these values. Taking a mean rank rather than a computing a total score is necessary to avoid the problems that occur when sites do not have good data and hence are not ranked at all.

Table 10.1 The rankings of species richness for the five taxa for which data are available for the Albertine Rift and for sites that have been relatively intensively sampled. The rank scores of the mean ranking across all taxa are given. Ranking is from 1 for the highest number to the maximum number of sites for which data were compiled.

Site	Mammals		Birds	Reptiles	Amphib.	Plants		Mean rank	
	All	Large				Tree	All	All	Large /tree
Murchison Falls NP	5	5	4	12	16	16		11	12
Bugungu WR		24							31
Karuma WR		14			14			21	20
Budongo FR	8	14	11	5	6	1	6	5	6
Bugoma FR		21	22			10		30	23
Kagombe FR	21	25	31			14		35	29
Kitechura FR	20	29	33		15	19		31	32
Ibambaro FR		31							38
Matiri FR	22	31	32		18	20		32	36
Itwara FR	19	28	24		12	9		26	26
Lendu plateau			14					19	18
Semliki WR		11	7	11	19			15	15
Semliki NP	9	14	6	4	11	6		6	9
Rwenzori Mountains NP	6	17	20	8	7	15	11	13	17
Kibale NP	4	4	13	3	3	5	12	4	2
Kasyoha-Kitomi FR	17	21	15		7	3	8	14	14
Kalinzu-Maramagambo	14	19	9		9	2	9	12	10
Kyambura WR		18	5		20			17	19
Queen Elizabeth NP	7	3	2	8	21	7	7	10	8
Bwindi Impenetrable NP	3	8	10	8	3	4	2	3	5
Mafuga FR		31	30	13		21		29	30
Echuya FR	18	29	29		16	17	14	27	28
Virunga NP	1	1	1	1	1	8	1	1	1
West of Lake Edward		25	8					8	22
Nyungwe NP	9	10	17	6	5	11	5	9	10
Kahuzi Biega NP	2	2	12	2	2	13	4	2	4
Idjwi island			28					36	37
Kibira NP	12	13	23					24	24
Bururi FR	23	23	26					33	33
Lac Ruzizi NP			25					34	35
Itombwe Massif	11	5	3	7	9			6	3
Gombe Stream NP		19	18			18	13	22	25
Mahale Mountains NP	15	7	19			12	3	15	16
Mt Kabobo			21					28	27
Mbizi FR		25	27			22	10	25	34
Marungu Massif			16		12			20	20
Sumbu NP	13	8						18	7
Mweru-Wantipa NP	16	11						23	13

10.3.2 Endemic species

Prioritising by the number of endemic species will focus on those species that are specific to the Albertine Rift (Table 10.2). Focusing on these species will weight the prioritisation for upper and lower montane forest species because most of the endemic species fall in this category.

Table 10.2 The rankings of numbers of endemic species for the six taxa for which data are available for the Albertine Rift and for sites that have been relatively intensively sampled. The rank scores of the mean ranking across all taxa are given. Rankings as in table 10.1.

Site	Mammals	Birds	Reptiles	Amphib.	Butterfly	Plants	Mean rank
Murchison Falls NP	19	21	11	18		22	30
Bugungu WR	19						34
Karuma WR	19			18			31
Budongo FR	19	21	10	12	18	11	22
Bugoma FR	19	21			12	15	25
Kagombe FR	19	21			12	19	29
Kitechura FR	19	21		18		20	37
Ibambaro FR	19						34
Matiri FR	12	21		12		20	23
Itwara FR	19	21		12		15	25
Lendu plateau		14			16		20
Semliki WR	19	21	11	18			28
Semliki NP	12	13	11	12	9	15	15
Rwenzori Mountains NP	3	7	2	7	5	5	5
Kibale NP	8	16	8	8	10	13	11
Kasyoha-Kitomi FR	11	17		9		6	12
Kalinzu-Maramagambo FR	12	15		10	16	8	17
Kyambura WR	19	21		18			36
Queen Elizabeth NP	19	21	11	12		12	20
Bwindi Impenetrable NP	2	6	6	6	1	4	4
Mafuga FR	10	12	9		5	15	10
Echuya FR	7	10		10	5	9	8
Virunga NP	1	3	1	1	2	1	1
West of Lake Edward	19	5			12		15
Nyungwe NP	5	4	3	4	2	3	2
Kahuzi Biega NP	4	2	4	5	4	2	2
Idjwi island		17					27
Kibira NP	6	7					6
Bururi FR	12	11					14
Lac Ruzizi NP		20					38
Itombwe Massif	9	1	7	2	18		7
Gombe Stream NP	12	21			12	14	19
Mahale Mountains NP	12	17			8	7	13
Mt Kabobo		9					9
Mbizi FR	12	21			11	10	18
Marungu Massif		21		12			24
Sumbu NP	19				18		31
Mweru-Wantipa NP	19				18		31

Prioritising by total species richness ensures that all the generalist species and those that are migrant are included whereas a focus on the endemic species helps exclude the species of lower conservation concern. However many endemic species are locally abundant and are not of great conservation concern either.

10.3.3 IUCN threatened species

When it comes to focusing on scarce conservation resources it may be better to prioritise by IUCN threatened species (critical, endangered and vulnerable). Table 10.3 uses the number of threatened species to rank the sites.

Table 10.3 The rankings of IUCN threatened species (CR, EN, VU) for the five taxa for which data are available for the Albertine Rift and which have been relatively intensively sampled. The rank scores of the mean ranking across all taxa are given.

Site	Mammals	Birds	Reptiles	Amphib.	Plants	Mean rank
Murchison Falls NP	12	6	1	14	13	13
Bugungu WR	25					37
Karuma WR	15			14		25
Budongo FR	12	21	2	10	1	13
Bugoma FR	15	21			5	21
Kagombe FR	19	27			13	30
Kitechura FR	25	27		14	21	34
Ibambaro FR	31					38
Matiri FR	31	27		14	17	35
Itwara FR	31	27		14	9	31
Lendu plateau		12				16
Semliki WR	15	14	1	14		15
Semliki NP	12	5	2	14	4	8
Rwenzori Mountains NP	3	12	2	10	13	9
Kibale NP	5	14	2	7	5	7
Kasyoha-Kitomi FR	19	21		8	3	17
Kalinzu-Maramagambo FR	19	21		8	5	18
Kyambura WR	19	10		14		24
Queen Elizabeth NP	9	6	2	10	13	9
Bwindi Impenetrable NP	5	10	2	4	1	4
Mafuga FR	25	27	2		17	26
Echuya FR	25	19		10	19	27
Virunga NP	2	2	2	2	8	2
West of Lake Edward	25	2				20
Nyungwe NP	19	6	2	5	12	11
Kahuzi Biega NP	1	2	2	6	10	3
Idjwi island		21				33
Kibira NP	5	6				6
Bururi FR	25	14				29
Lac Ruzizi NP		14				22
Itombwe Massif	3	1	2	1		1
Gombe Stream NP	15	19			21	28
Mahale Mountains NP	9	21			10	19
Mt Kabobo		14				22
Mbizi FR	24	27			19	36
Marungu Massif		27		14		32
Sumbu NP	9					12
Mweru-Wantipa NP	5					5

Ranking by the number of threatened species will focus on those species of greatest conservation concern but to rank sites within the Albertine Rift it is probably preferable to focus on both the endemic and threatened species and hence capture both groups.

10.3.4 IUCN threatened species and endemic species

A final prioritisation was made combining the number of threatened species with the endemic species. The complementarity analyses in the previous chapters focussed on selecting sites for their endemic or threatened species although they included all

IUCN-listed species. Here I focus on the threatened species only and the endemic species (Table 10.4).

Table 10.4 The rankings of endemic and IUCN threatened species (CR, EN, VU) for the five taxa for which data are available for the Albertine Rift. The rank scores of the mean ranking across all taxa are given. Rankings as in table 10.1.

Site	Mammals	Birds	Reptiles	Amphib.	Plants	Mean rank
Murchison Falls NP	16	22	9	17	20	22
Bugungu WR	30					37
Karuma WR	20			17		25
Budongo FR	12	22	9	14	8	14
Bugoma FR	20	22			15	26
Kagombe FR	25	30			19	35
Kitechura FR	27	30		24	22	36
Ibambaro FR						
Matiri FR	20	27		17	21	29
Itwara FR	30	30		17	16	34
Lendu plateau		14				15
Semliki WR	19	27	9	17		24
Semliki NP	10	13	9	14	14	12
Rwenzori Mountains NP	4	7	4	8	5	6
Kibale NP	7	16	7	6	12	9
Kasyoha-Kitomi FR	9	22		10	6	11
Kalinzu-Maramagambo FR	14	16		12	9	13
Kyambura WR	25	16		24		30
Queen Elizabeth NP	12	15	13	17	13	15
Bwindi Impenetrable NP	2	6	5	5	4	5
Mafuga FR	20	12	8		18	19
Echuya FR	10	10		12	10	10
Virunga NP	1	3	1	1	1	1
West of Lake Edward	30	4				23
Nyungwe NP	5	4	2	2	3	3
Kahuzi Biega NP	2	2	2	4	2	2
Idjwi island		20				28
Kibira NP	6	7				7
Bururi FR	27	11				26
Lac Ruzizi NP		22				32
Itombwe Massif	7	1	6	2		4
Gombe Stream NP	20	30			17	33
Mahale Mountains NP	16	20			7	18
Mt Kabobo		9				8
Mbizi FR	27	27			11	30
Marungu Massif		16		14		20
Sumbu NP	16					21
Mweru-Wantipa NP	14					15

This ranking is probably the most useful for conservation purposes because it combines both the threatened status of species with some of the specialisations and habitat selectivity that are exhibited by the endemic species.

10.4 TESTING SURROGACY

It is possible with these data to test how well one taxa predicts species richness or endemism in another taxa and therefore how well these taxa might be acting as surrogates for total biodiversity. Pearson correlations were made between the numbers of species, numbers of endemic species, numbers of threatened species and numbers of endemic+threatened species for all sites where scores for survey effort exceeded the value of five (Tables 10.5 and 10.6).

Table 10.5 Pearson correlation coefficients and 'p-values' for comparisons between the different taxa for total species richness and total number of endemic species. ** = p<0.01; ***= p<0.001

	Endemic species				
Species richness	Mammals	Birds	Reptiles	Amphibians	Plants
Mammals		0.742 ***	0.932 ***	0.798 ***	0.816 ***
Birds	0.762 ***		0.838 ***	0.909 ***	0.856 ***
Reptiles	0.810 **	0.497 p=0.08		0.866 ***	0.856 ***
Amphibians	0.773 ***	0.402 p=0.08	0.930 ***		0.969 ***
Plants	0.730 **	0.702 **	0.696 **	0.825 **	

Table 10.6 Pearson correlation coefficients and 'p-values' for comparisons between the different taxa for number of threatened species and number of threatened and endemic species. ** = p<0.01; ***= p<0.001

	Threatened and endemic species				
Threatened species	Mammals	Birds	Reptiles	Amphibians	Plants
Mammals		0.718 ***	0.906 ***	0.779 ***	0.860 ***
Birds	0.636 ***		0.832 ***	0.812 ***	0.870 ***
Reptiles	-0.28 ns	-0.15 ns		0.919 ***	0.885 ***
Amphibians	0.651 **	0.710 ***	-0.425 ns		0.966 ***
Plants	0.332 ns	0.240 ns	-0.282 ns	0.339 ns	

In general these results show that one taxa is a pretty good predictor of another taxa whether you look at species richness or endemism. Endemic species richness and threatened and endemic species are predicted well by other taxa and all predictions across sites were significant at P<0.001. Species richness was on the whole a reasonable predictor although birds did not predict reptile and amphibian richness very well. Threatened species numbers were not well predicted by other taxa. In particular the plants and the reptiles were not predicted by the other taxa. This may

be partly due to the fact that reptiles have not been classified under IUCN red list criteria very thoroughly and this is currently under review. The same is also true for plant species and most threatened species are those with economic importance. Plants listings are also being reviewed at present.

These results will be strongly affected by the size of a site, particularly for species richness but also for endemic and threatened species (Howard *et al.* 1998). The larger a site the more species it will have and hence the likelihood is increased of it having endemic and threatened species. However, area is not the only factor determining species richness and endemism and some sites that rank highly are actually fairly small (eg. Bwindi Impenetrable National Park – 325 km^2; Semliki National Park – 225 km^2; and Echuya Forest Reserve – 34 km^2). In this study we are interested in identifying those sites that are important for conservation. We are less interested in looking at the relative biological richness of sites when controlled for area but are more interested in the total species richness, and number of endemic and threatened species. Large sites will have more of these but at the same time large sites tend to conserve species more effectively than small sites (Soulé, 1987).

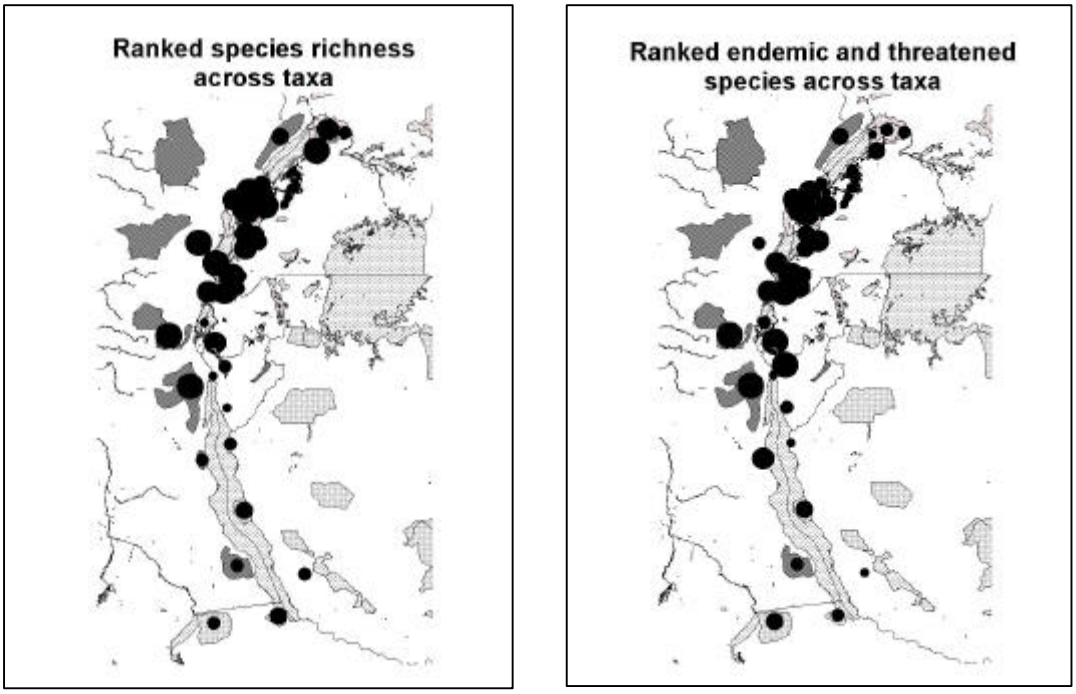


Figure 10.1 Ranked scores for sites based on a) the mean rank value for species richness and b) the mean rank value for the number of endemic and threatened species. The larger the circle the larger the number of species.

10.5 Important sites in the Albertine rift

Rather than ranking sites in sequential order it makes more sense to group sites into categories of high, medium and low rank. This is because the data for many sites are not complete, some mean ranking scores are based upon one taxon rather than a combination of several and the effort made in sampling sites still varies widely despite only selecting sites that have been reasonably well surveyed. Figure 10.1 shows the relative mean rankings across the five taxa (mammals, birds, reptiles, amphibians and plants) in five classes of rank (circles of varying radius) for species richness and endemic with threatened species. This figure gives some idea of which sites are more important. It also includes the five sub-sectors of the Virunga National Park so that these can be compared with other sites.

These two maps indicate that sites in the central portion of the Albertine Rift including the Virunga, Queen Elizabeth, Rwenzori, Bwindi Impenetrable and Semliki National Parks and the Nyungwe Forest, Kibira, Kahuzi-Biega National Parks and Itombwe Massif form two important regions within the Rift for conservation. Budongo Forest Reserve and Murchison Falls National Park rank highly for species richness. It is possible sites further down the Rift in Tanzania and south-eastern DRC would rank more highly with increased survey effort.

Comparing the rankings of species richness and the ranking of endemic and threatened species allows an analysis of relative importance for these two criteria. I grouped the sites into high (rank scores 0-12), medium (rank scores 13-24) and low (rank scores 25-38) scoring sites for both criteria and plotted the results in a two-way table (Table 10.7). The lakes were added to to this classification based on the richness and endemism of the fish fauna. It was not possible to include them in the ranking method above because the taxa being surveyed were very different and it was not possible to compare the lakes with the terrestrial habitats. However, given their high species richness and endemism they should be included in this summary.

Table 10.7 Relative rankings of sites for 'species richness' and 'endemic and threatened' species. Scores are obtained from table 10.1 (species richness) and table 10.4(endemic and threatened species). High=1-12; medium=13-24; low=25+.

	Endemic and threatened species		
Species richness	**High**	**Medium**	**Low**
High	Virunga NP Itombwe Massif Kahuzi Biega NP Semliki NP Kibale NP Bwindi Impenetrable NP Nyungwe FR Lake Tanganyika	Murchison Falls NP Budongo FR Kalinzu-Maramagambo Queen Elizabeth NP W. Lake Edward	
Medium	Rwenzori Mts NP Kasyoha-Kitomi FR Kibira NP Lakes Edward and George	Lendu plateau Semliki WR Mahale Mts NP Marungu Massif Sumbu NP Mweru-Wantipa NP	Karuma WR Kyambura WR Lake Albert
Low	Echuya FR Mt Kabobo	Bugoma FR Mafuga FR Lake Kivu	Kagombe FR Kitechura FR Matiri FR Itwara FR Idjwi Island Bururi FR Lac Ruzizi NP Gombe Stream NP Mbizi FR

Those sites that score highly in table 10.1 and table 10.4 are considered to be the most important sites because they rank highly on both species richness and number of endemic and threatened species. There are eight of these. The next important sites are those that rank highly for endemic and threatened species and medium for total species richness as species richness should receive a lower weighting than the numbers of endemic and threatened species. There are four of these. Sites that are high in endemic and threatened species but low in species richness can be grouped with those that have medium endemic
and threatened species but high species richness. There are seven of these. On the whole this classification seems to make sense intuitively and from what is known about these sites.

10.6 Landscape Conservation

10.6.1 Contiguous sites

Many of the protected areas or sites in the Albertine Rift are contiguous with other protected areas/sites or are still connected to these sites by relatively natural habitat. As such they form larger 'landscapes' whose species richness and number of endemic species will be larger than consideration of single sites. As a general rule the larger the conservation area, the better it is for the long-term conservation of its species and habitats. Many of these landscapes cross international boundaries or else connect sites that are managed by different institutions such as the forest reserves and national parks in Uganda. If these landscapes are to persist it is important that they are managed as one contiguous unit rather than independent sites because the connectivity between them could easily be lost if this is not taken into consideration.

Where do these landscapes occur? The largest and most critical of the landscapes includes the Virunga National Park in DRC, with the Parc National des Volcans in Rwanda, and Semliki, Rwenzori, Queen Elizabeth, and Kibale National Parks and Kasyoha-Kitomi and Kalinzu-Maramagambo Forest Reserves and Kyambura Wildlife Reserve (Figure 10.2). This 'Virunga landscape' covers about 12,860 km^2 and includes a wide variety of habitats and altitudes, ranging from 600-5,100 metres above sea level. It is also incredibly rich in species and endemic and threatened species (Table 10.8). There is nowhere else in Africa that can claim species numbers anything close to those found here and detailed studies of sites in the neotropics have fewer numbers than these (Gentry, 1990).

Other possible landscapes that could be managed as contiguous units include (Figure 10.3):

1. Nyungwe-Kabira forests: these two areas are contiguous across the Burundi-Rwanda border
2. Murchison Falls National park – Budongo-Bugoma-Kagombe-Itwara Forest Reserves- Semliki/Toro Wildlife Reserve: these sites link Murchison Falls to Semliki Wildlife Reserve through a corridor of forests reserves, grasslands and private forests. This landscape may be important for the gene flow in chimpanzee communities.
3. Kahuzi-Biega National Park – Tayna Community Reserve – Itombwe Massif: although not linked by protected areas there is still a fair amount of natural habitat between these sites and it may be possible to maintain linkages. It is also important to maintain the linkage between the upland and lowland sectors of Kahuzi Biega National Park.

4. Mahale Mountains – Ufipa plateau: much wild land still exists to the east of Mahale Mountains National Park and down towards Ufipa Plateau. It may be possible to protect parts of this region to enlarge the park.

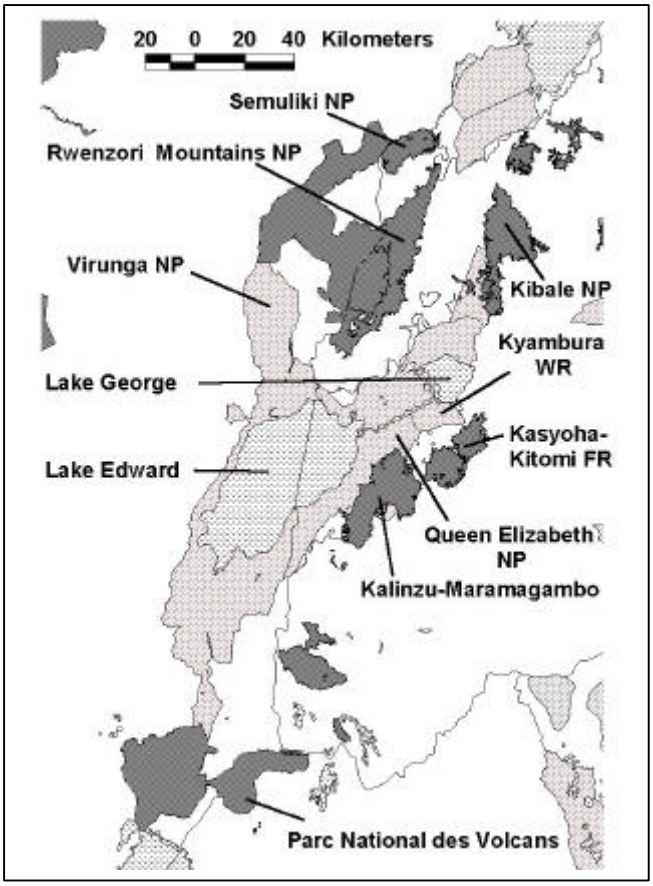


Figure 10.2 The various protected areas that form the Virunga landscape. Forested areas are shown in dark grey, savanna woodland in light grey and lakes stippled.

Table 10.8 Species richness and numbers of endemic and threatened species for the Virunga landscape.

Taxon	Species richness	Endemic species	Threatened species
Mammals	278	30	22
Birds	871	31	16
Reptiles	134	12	1
Amphibians	84	21	10
Fish	81	56	?
Plants	3,180	246	27

Other landscapes could include the catchment areas for the lakes and the need to manage the land uses to limit the pollution and sedimentation of the lakes.

10.6.2 Landscape Processes

It is important to manage these protected areas as landscapes because there are several biological, geological and evolutionary processes that occur at large scales and which need to be managed as such. Some examples of these processes include:

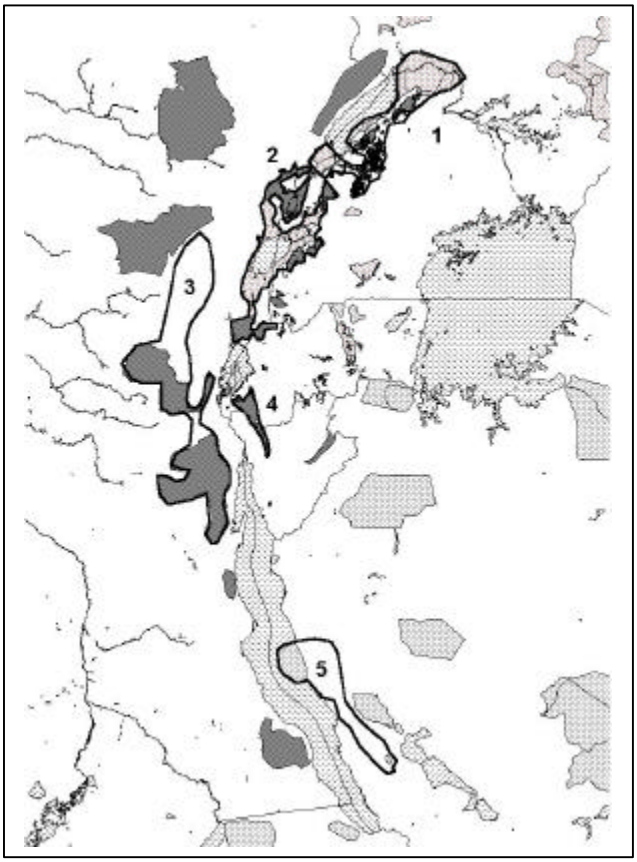


Figure 10.3 Landscape areas of the Albertine rift: 1=Murchison-Semliki corridor; 2=Virunga landscape; 3= Itombwe-Kahuzi Biega-Tayna landscape; 4=Nyungwe-Kibira landscape; 5=Mahale-Ufipa landscape.

1. *Climate change.* It is very probable that climate change is going to change habitats and species compositions of these sites within the Rift. Protecting a contiguous range of altitudes will ensure that species can migrate to sites that are still suitable as the climate changes.
2. *Evolutionary changes*. The mountains and lakes of the Rift have been important sites of evolutionary change. Ensuring a diverse, contiguous set of habitats will ensure that this process can continue.
3. *Migration of large mammals*. Certain species such as elephants and large ungulates are known to undergo migratory movements as a result of drought or variation in food availability. It is important to ensure the ability to migrate out of areas where food is scarce if these species are to survive as functional populations.
4. *Migration of birds*. The Rift is an important stopping point for migratory birds during their annual migration from Europe. Maintaining the sites where they stop and ensuring that disturbance is minimized will be necessary if these species are to survive.

5. *Natural fire regime*. Fire is an important component of the savannas and woodlands. Fire destroys the habitat and food supply, however, and there is a need for large contiguous areas of so that animals can find food in unburnt areas.
6. *Watershed function of forests*. Forests encourage rainfall and also soak it up releasing it slowly to the streams that feed local communities. Where forest has been cut from hillsides in the Rift streams have dried up (eg. Gishwati Forest in Rwanda, M. Schilling Pers. Comm..) and local people have suffered as a result. Enough forest needs to be maintained to ensure the constant supply of water to communities.
7. *Volcanic succession*. The active volcanoes in the southern Virunga National Park create a succession of highly specialized vegetation and its associated fauna, which can live on volcanic lava and degrade it over centuries to soil. Maintaining sufficient area to ensure these species survive is important, as the eruptions of the volcanoes have been regular and they are steadily destroying much of this habitat with recent lava flows.
8. *Interdependence of species*. Certain species require the presence of others to ensure their survival. For instance many woodpeckers create holes in trees that become nesting sites for other birds. Similarly many tree species require elephants or large primates to disperse their seeds and are declining at sites where these dispersers have become extinct (eg. Elephants in Budongo Forest Reserve).

Other examples can no doubt be thought of. Many of these processes will be lost if contiguous protected areas are not managed as a whole rather than as individual units. This necessarily requires close collaboration between institutions in the same country or between countries. Developing mechanisms for inter-institutional collaboration should be a priority in this region.

10.7 FUNDING CONSERVATION IN THE ALBERTINE RIFT

Given the importance of this region for global and national conservation there is a need to identify and lobby for significant funding. Given the high species richness of sites in the Albertine Rift it is possible to argue that you can protect more for less funding than elsewhere in Africa and hence get 'more bang for your buck'. However, there are constraints to funding conservation in this region:

1. The countries in the Albertine Rift are some of the poorest in the world and quite rightly governments are focussing on poverty alleviation as a priority. However, in some countries this is at the expense of conservation when these protected areas, their wildlife and natural scenery have the potential to create wealth through tourism. Civil wars in the region have severely hampered efforts to encourage tourism and consequently donors are beginning to move away from supporting it. The fact that insecurity has stifled tourism though, does not negate its economic potential in future and hence there is a need to maintain the investments that have taken place such that tourism can take off more easily. The gradual degradation of sites over time, particularly with the loss of large mammals will make it harder to attract tourists and hence it will require longer periods of recovery before tourism can earn as much as it potentially could do so with well stocked parks.

2. The boundary between DRC and Uganda, Rwanda, Burundi and Tanzania is also a boundary between two funding zones for most bilateral and multilateral donors. Yet it is the contiguity between sites that straddle this border that needs to be

maintained. Donors should review their policies about supporting conservation activities in this region so that it can include joint activities between DRC and these other countries.

3. Many of the important sites for conservation in this region have not been included under the Congo Basin Initiative, which is due to provide major support for conservation in the Congo Basin. Yet these sites are the most species rich of any in the Congo Basin. They have been omitted partly because of the civil war and the fact these sites are controlled by different groups. Yet it has been possible to channel funding to sites in DRC through the NGOs with the blessing of the government in Kinshasa as shown by the initiative of the UN Fund through UNESCO. This fund is supporting staff salaries and basic operating costs in the World Heritage Sites in DRC.

4. The high human population density puts great pressures on the protected areas in the Albertine Rift for land. There is a need to develop mechanisms that promote a positive behaviour towards conservation amongst local communities that live near the protected areas. One of the more successful methods that have been tried in the region is the Bwindi and Mgahinga Conservation Trust Fund that helps local community projects such as the construction of schools and clinics, and more recently provides loans for business enterprise development. This fund effectively is paying people not to destroy the parks while at the same time helping them develop alternative ways of making an income. This fund has received favourable reviews in many analyses and yet it has not been replicated elsewhere in the Rift. In part this is because donors seem to want to fund 'new ideas' rather than replicate successful ideas.

5. There is poor valuation of the benefits of protected areas to local communities and to the nation in each country. The value of watersheds in providing clean and disease free water and firewood, building poles and other non-timber forest products to people is rarely valued when assessing whether to alter its land use. There is increasing pressure in some countries in the Rift to encourage investment and business at the expense of natural habitats and their provision of goods to local communities.

There is a need to develop innovative ways of funding these protected areas over the long term. In some countries in the world water is taxed to business to help fund the protection of watersheds. This would be possible in the Rift as many people and businesses rely on the water that flows from the mountains, provided the taxes could be collected in a transparent manner. Another method would be an environmental tax on oil if it were found in the Rift to support a trust fund for protected areas. Given the importance of this region for conservation the global community should be made aware of it and encouraged to support conservation activities as a result.

10.8 Conclusions

The Albertine Rift has been shown in this report to be a region of incredible biodiversity. The numbers of species found here are greater than anywhere else on the African continent and rival some of the most diverse areas outside Africa. Using species to prioritise sites in the Rift has created a list of the most important sites for conservation in the Rift. However, it must be remembered that the comparisons are relative and that even sites that have ranked low for species richness and the number

of endemic and threatened species are richer than many sites in the world. We would not argue therefore that they be neglected as a result. Managing the landscapes that occur in the Rift would be a more sensible conservation strategy although it will require more resources, because it will maintain the connectivity and landscape processes that still occur in the Rift. Conservation in this region has been neglected recently because of civil conflict and there is a need to move it onto the agenda of many bilateral and multilateral donors.

SECTION 11: REFERENCES

Epauletted fruit bat. A.J..Plumptre, WCS

Ackery, P.A., Smith, C.R. and Vane-Wright, R.I. (1995). Carcasson's African Butterflies – An Annotated Catalogue of the Butterflies of the Afrotropical Region. The Natural History Museum, London, UK. pp 803.

d'Abrera, B. (1980). Butterflies of the Afrotropical Region. Lansdowne Press, Melbourne.

d'Abrera, B. (1997). Butterflies of the Afrotropical Region. Revised Edition. Part 1. Lansdowne Press, Melbourne.

Allan, C. (1994) *Kyambura Game Reserve: preliminary results of Frontier Uganda biological assessment*. Uganda Game Department/ Society for Environmental Exploration report.

Anonymous (1985) *Mahale: study for the proposed Mahale Mountains National park.* Final report, JICA, Tokyo

Ansell, W.F.H. (1978) *The Mammals of Zambia*. National Parks and Wildlife service, Chilanga, Zambia

Balmford, A. and Long, A. (1994) Across-country analyses of biodiversity congruence and current conservation effort in the tropics. *Conservation Biology* **9,** 1539-1547.

Balmford, A., Moore, J.L., Brooks, T., Burgess, N., Hansen, L.A., Williams, P. and Rahbek, C. (2001) Conservation conflicts across Africa. *Science* **291,** 2616-2619.

Beadle, L.C. (1974) *The inland waters of tropical Africa*. Longman,London.

Beccaloni, G.W. and Gaston, K.J. (1995). Predicting the species richness of neotropical forest butterflies: Ithomiinae (Lepidoptera: Nymphalidae) as indicators. *Biological Conservation*. **71,** 77-86.

Birdlife International (2000) *Threatened Birds of the World*. Barcelona and Cambridge, UK. Lynx Edicions and Birdlife international.

Brooks, T., Balmford, A., Burgess, N., Fjeldsa, J., Hansen, L.A., Moore, J., Rahbek, C. and Williams, P. (2001) Towards a blueprint for conservation in Africa. *Bioscience* **51,** 613-624.

Burtt, B.D. (1934) A botanical reconnaissance in the Virunga Volcanoes of Kigezi Ruanda, Kivu. *bulletin of Miscellaneous Information* **4,** 145-165, Royal Botanic Gardens. Kew.

Carcasson, R.H. (1961). The Acraea butterflies of East Africa (Lepidoptera, Acraeidae). *J.E. Africa Nat. Hist. Soc.* Special Supplement No 8.

Carcasson, R.H. (1964) A preliminary survey of the zoogeography of African butterflies. *East African Wildlife Journal* **2,** 122-157.

Carcasson, R.H. (1975). The Swallowtail Butterflies of East Africa (Lepidoptera, Papillionidae). E.W. Classey Ltd, Oxon, UK.

Congdon, T.C.E. and Collins, S.C. (1999). Kielland's Butterflies of Tanzania. Supplement. A.B.R.I. – Lambillionea. Nairobi. pp 143.

Congdon, T.C.E., Gardiner, A. and Bampton, I. (2001). Some endemic butterflies of Kenya, Tanzania and Malawi. (In press). pp 19.

Daily, G.C. and Ehrlich, P.R. (1995). Preservation of biodiversity in small rainforest patches: rapid evaluations using butterfly trapping. *Biodiversity and Conservation*. 4, 35-55.

Davenport, T.R.B. (1996). The Butterflies of Uganda - An Annotated Checklist. Uganda Forest Department, Kampala, Uganda. pp 48.

Davis, S.D., Heywood, V.H. and Hamilton, A.C. (1994) *Centres of Plant diversity: a guide and strategy for their conservation. vol 1. Europe, Africa, South West Asia and the Middle East.* WWF and IUCN.

Dehn, M. and Christiansen, L. (2001) Additions to the known avifauna of the Rwenzori Mountains National Park in western Uganda. *Scopus* **21,** 19-22.

Demey, R., Herroelen, P. & Pedersen, T. (2000) Additions and annotations to the avifauna of Congo-Kinshasa (ex Zaire). *Bull. Br. Ornithol. Cl.* **120,** 154-172.

Diamond, A.W. (1985) The selection of critical areas and current conservation efforts in tropical forest birds. In: *Conservation of Tropical Forest birds*. International council for Bird Preservation Technical Publication No. 4.pp 33-48 Birdlife International, Cambridge.

Dowsett, R.J. (1990) *Survey of the fauna and flora of Nyungwe Forest, Rwanda*. Tauraco Research Report No.3. 140 pp.

Dowsett, R.J., Dowsett-Lemaire, F., and van de Weghe, J.P. (undated) *Les oiseaux de la foret de Nyungwe*. Checklist published by the Projet Conservation de la foret de Nyungwe.

Drewes, R.C. and Vindum, J.V. (1998) *Reptiles of the Impenetrable Forest (including an addendum and corrigenda to the amphibian fauna)*. Unpublished report, California Academy of Sciences, San Francisco.

Drewes, R.C. and Vindum, J.V. (1994) Amphibians of the Impenetrable Forest, southwest Uganda. *Journal of African Zoology* **108,** 55-70.

Drewes, R.C., Vindum, J.V. and O'Brien, J.P. (1992) *Amphibiens of the Impenetrable Forest, Uganda*. Unpublished report, California Academy of Sciences, San Francisco.

Evans, M. and Balmford, A. (1992) Birds in the Ishasha sector of Queen Elizabeth National Park, Uganda. *Scopus*. **16,** 34-49.

Fischer, E. (1996) *Die vegetation des Parc National de Kahuzi-Biega, Sud Kivu, Zaire*. PhD thesis, Franz Steiner Verlag, Stuttgart. 240 pp.

Friedmann, H. and Williams, J.G. (1970) The birds of the Kalinzu Forest, southwestern Ankole, Uganda. *Contributions in science*. Series 195 of the Los Angeles County Museum of Natural History, California.

Frost, D.R. (2002) Amphibian species of the world: an online reference. Version 2.21. Electronic database available at: http://research.amnh.org/herpetology/amphibia/ index.html

Gaugris, Y., Prigogine, A. and van de Weghe, J.P. (1981) Additions et corrections à l'avifaune du Burundi. *Le Gerfaut* **71,** 3-39.

Gentry, A.H. (1990) *Four neotropical rainforests*. Yale University Press, New Haven.

Gnoske, T.P. and Marks, B.D. (1997) *Preliminary report of 1997 avifaunal surveys in SW Uganda: Bwindi Impenetrable National Park and Echuya Forest Reserve*. Unpublished report to Makerere University and the Field Museum of Chicago.

Henning, S.F. (1988). The Charaxinae Butterflies of Africa. Aloe Books, Johannesburg, South Africa.

Hilton-Taylor, C. (compiler) (2000) *2000 IUCN Red List of Threatened Species*. IUCN, Gland, Switzerland. 61pp.

Hinkel, H. and Fischer, E. (1988) *Reptiles et amphibiens du Rwanda et leurs environnement*. Johannes Gutenberg Universitat, Mainz, Germany.

Howard, P.C. and Davenport, T.R.B. (1996) *Biodiversity Reports.Vols 1-33*. Uganda Forest Department, Kampala.

Howard, P.C., Davenport, T.R.B., and Kigenyi, F.W. (1997). Planning conservation areas in Uganda's natural forests. *Oryx* **31,** 253-264.

Howard, P.C., Viskanic, P., Davenport, T.R.B., Kigenyi, F., Balthzer, M., Dickinson, C.J., Lwanga, J.S., Matthews, R.A. and Balmford, A. (1998) Complementarity and the use of indicator groups for reserve selection in Uganda. *Nature* **394,** 472-475.

Hutterer, R., van der Straeten, E., and Verheyen, W.N. (1987) A checklist of the shrews of Rwanda and biogeographical considerations of African soricidae. *Bonn. Zool. Beitr.* **38,** 155-172.

ICBP (1992) *Putting Biodiversity on the Map: global priorities for conservation*. ICBP, Cambridge.

INECN (undated) *Les oiseaux du Parc National de la Kibira*. INECN, Bujumbura.

Kalina, J. and Butynski, T. (1996) *checklist of the birds of the Bwindi Impenetrable Forest, Uganda*. East African Natural History Society, Nairobi. 26 pp.

Kaufman, L., Chapman, L.J. and Chapman, C.A. (1996) The great lakes. In: *East african ecosystems and their conservation*. pp 191-215 Eds: T.R. McClanahan and T.P. Young. Oxford University Press, Oxford

Kerbis Peterhans, J.C. (1997) *Updated list of small mammals documented with voucher specimens from Bwindi Impenetrable National Park and its immediate environs.* Unpublished list, ITFC library.

Kerbis Peterhans, J.C. and Austin, P.K. (1996) *Small mammal component of the biological inventory of Kabiranyuma swamp, Mgahinga National Park, Uganda*. Unpublished Report to ITFC, Uganda

Kerbis Peterhans, J.C., Kityo, R.M., Stanley, W.T. and Austin, P.K. (1996) Small mammals along an elevational gradient in Rwenzori Mountains National Park, Uganda. In: *The Rwenzori Mountains National Park, Uganda: Exploration, environment and biology.* Eds: Osmaston, H., Tukahirwa, J., Basalirwa, C., and Nyakaana, J. Proceedings of the Rwenzori Conference, Department of Geography, Makerere University, Uganda.

Kielland, J. (1990). Butterflies of Tanzania. Hill House, Melbourne and London.

Kingdon, J. (1989) *Island Africa: the evolution of Africa's rare animals and plants*. Princeton University Press, New Jersey.

Kremen, C. (1992). Assessing the indicator properties of species assemblages for natural areas monitoring. *Ecological Applications*. **2,** 203-217.

Kremen, C. (1994). Biological inventory using target taxa: a case study of the butterflies of Madagascar. *Ecological Applications*. **4,** 407-422.

Kunkel, I. and Kunkel, P. (1969) Contribution à la connaissance de l'avifaune de la forêt du Rugege (Rwanda). *Rev. Zoo. Bot. Afr.* **79,** 327-351.

Larsen, T.B. (1991). The Butterflies of Kenya. Oxford University Press.

Laurent, R.F. (1972) *Exploration du Parc National Albert: amphibiens*. Institut des Parcs Nationaux du Congo Belge, Bruxelles. 125 pp.

Laurent, R.F. (1964) Adaptive modifications in frogs of an isolated highland fauna in central Africa. *Evolution* **18,** 458-467.

Lebrun, J-P., and Stork, A.L. (1991-1997) *Enumeration des plantes a fleurs d'Afrique tropicale*. Editions des Conservatoire et jardin botaniques de la Ville de Geneve, Geneva.

Linder, H.P. (1998) Numerical analyses of African plant distribution patterns. In: *Chorology, Taxonomy and Ecology of the floras of Africa and Madagascar*. pp 67-86. Royal Botanic Gardens, Kew.

Lock, J.M. (1977) The vegetation of Rwenzori National Park, Uganda. *Bot. Jahrb. Syst.* **98,** 372-448.

Mollaret, H.H. (1961) *Biotopes de Haute Altitude: Rwenzori II et Virunga.* Exploration du Parc National Albert, Institut des parcs Nationaux du Congo et du Ruanda-Urundi, Bruxelles.

Moreau, R.E. (1943) A contribution to the ornithology of the east side of Lake Tanganyika. *The Ibis* **85,** 377-412.

Muhlenberg, M., Slowik, J. and Steinhauer, B. (undated) *Parc National de Kahuzi Biega.* Guide book, ICCN/GTZ.

Mwasumbi, L.B. (2000) *The diversity of Mbizi Forest Reserve, Sumbawanga*. Unpublished report for the Wildlife Conservation Society of Tanzania and University of Dar es Salaam. 54 pp.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., Fonseca, G.A.B.da, and Kent, J. (2000) Biodiversity hotspots for conservation priorities. *Nature* **403,** 853-858.

Nabanyumya, R.N. (1991) *Factors influencing tree species diversity of the medium altitude tropical moist forests of Kalinzu and Maramagambo in south western Uganda*. Unpublished MSc Thesis, Makerere University Institute for Environment and Natural Resources.

Olson, D.M., and Dinerstein, E. (1998) The global 200: a representation approach to conserving the earth's most biologically valuable ecoregions. *Conservation Biology* **12,** 502-515.

Omari, I., Hart, J.A., Butynski, T.M., Birhashirwa, N.R., Upoki, A., M'Keyo, Y., Bengana, F., Bashonga, M., and Bagurubumwe, N. (1999) The Itombwe Massif, Democratic Republic of Congo: biological surveys and conservation, with an emphasis on Grauer's gorilla and birds endemic to the Albertine rift. *Oryx* **33,** 301-322.

Patterson, G. and Makin, J. (1998) *The state of biodiversity in Lake Tanganyika – A literature review*. Chatham, UK. Natural Resources Institute

Peace Corps and ICCN (undated) *The mammals of the Kibira National Park, Burundi*. Checklist of species produced for ICCN.

Plumptre, A.J. (2002) *Extent and status of the forests in the Ugandan albertine Rift*. Unpublished report to UNDP/GEF and WWF.

Plumptre, A.J., Masozera, M., Fashing, P.J., McNeilage, A., Ewango, C., Kaplin, B.A., and Liengola, I. (2002) Biodiversity surveys of the Nyungwe forest Reserve in SW Rwanda. *WCS Working Paper* **No.19,** 95 pp.

Pollard, E. and Yates, T.J. (1993). Monitoring Butterflies for Ecology & Conservation. Chapman and Hall, UK.

Pomeroy, D. (2000) Birds, hotspots and congruence: a question of scale. *Ostrich* **71,** 438-441.

Poulsen, A.D. (1997) *Plant diversity in forests of western Uganda and eastern Zaire (preliminary results)*. AArhus University reports No. 36. 76pp, University of Copenhagen.

Prigogine, A. (1953) *Contribution à l'étude de la faune ornithologique de la région à l'ouest du lac Edouard*. Annales du Musee Royal de l'Afrique Centrale. Sciences Zoologiques No. 24. 117 pp. Tervuren, Belgium

Prigogine, A. (1960) *La faune ornithologique du Massif du Mont Kabobo*. Annales du Musee Royal de l'Afrique Centrale. Sciences Zoologiques No. 85. 46 pp. Tervuren, Belgium

Prigogine, A. (1967) La faune ornithologique de l'île Idjwi. *Rev. Zool. Bot. Afr.* **75,** 249-274.

Prigogine, A. (1971-1984) *Les oiseaux de l'Itombwe et de son hinterland*. Annales du Musee Royal de l'Afrique Centrale. Sciences Zoologiques No. 185, 223, 243. Tervuren, Belgium

Prigogine, A. (1985) Conservation of the avifauna of the forests of the Albertine Rift. In: *Conservation of Tropical Forest birds*. International council for Bird Preservation Technical Publication No. 4.pp 277-295 Birdlife International, Cambridge.

Robyns, W. (1948-1955) *Flore des Spermatophytes du Parc National Albert: Vols 1-3.* Institut des Parcs Nationaux du Congo Belge, Bruxelles.

Rosenzweig, M.L. (1995) *Species Diversity in Space and Time*. Cambridge University Press, Cambridge.

Schiotz, A. (1999) *Treefrogs of Africa*. Edition Chimaira, Frankfurt.

Schouteden, H. (1938) *Exploration du Parc National Albert: oiseaux*. Institut des Parcs Nationaux du Congo Belge, Bruxelles. 107 pp.

Schouteden, H. (1949) Contribution à l'étude de la faune ornithologique du Katanga (Congo belge). *Rev. Zool. Bot. Afr.* **62,** 158-174 and 322-371.

Schouteden, H. (1966) *La faune ornithologique du Burundi*. Musee Royal de l'Afrique Centrale. Documentation zoologique No. 11. 81 pp. Tervuren, Belgium 81 pp.

Snoeks, J. (2000) How well known is the icthyodiversity of the large East African Lakes. In Rossiter, A., and H. Kawanabe, eds. Ancient lakes: Biodiversity, ecology and evolution. *Advances in Ecological Research* **31,** 17-38. Academic Press.

Soulé, M.E. (1987) *Viable populations for conservation*. Cambridge University Press, Cambridge.

Sparrow, H.R., Sisk, T.D., Ehrlich, P.R. and Murphy, D.D. (1994). Techniques and guidelines for monitoring neotropical butterflies. *Conservation Biology*. **8,** 800-809.

Spawls, S., Howell, K., Drewes, R. and Ashe, J. (2002) *A field guide to the reptiles of East Africa*. Academic Press, London.

Stattersfield, A.J., Crosby, M.J., Long, A.J. and Wege, D.C. (1998) *Endemic Bird Areas of the World: priorities for biodiversity conservation*. Birdlife International Conservation series No. 7, Birdlife International, Cambridge.

Stanford, C. and Msuya, P. (1995) An annotated list of the birds of Gombe National Park, Tanzania. *Scopus* **19,** 38-46.

Stubblefield, L. (1993) *Semliki (Toro) Game Reserve: preliminary results of the Frontier Uganda biological assessment*. Uganda Game Department/Society for Environmental Exploration report

Synnott, T.J. (1985) *A checklist of the flora of Budongo Forest Reserve, Uganda, with notes on ecology and phenology*. C.F.I. Occasional Papers No. 27, University of Oxford.

van der Straeten, E. and Kerbis Peterhans, J.C. (1999) *Praomys degraaffi*, a new species of Muridae (Mammalia) from central Africa. *South African Journal of Zoology* **34,** 80-90.

Vollesen, K. and Bidgood, S. (1996) *Kew expedition to Tanzania: January-May 1994*. Unpublished report, 45pp.

Vollesen, K. and Bidgood, S. (1999) *Kew expedition to Tanzani: April-May 1997*. Unpublished report, 57 pp.

Thirgood, S.J. and Heath, M.F. (1994) Global patterns of endemism and the conservation of biodiversity. In: *Systematics and Conservation Evaluation*. Eds: P.L.Forey, C.J.Humphries & R.I.Vane-Wright. Systematics Association special volume No. 50. pp 207-227. Clarendon Press, Oxford.

Troupin, G. (1978-1988) *Flore du Rwanda: Vols 1-4*. Musee Royal de l'Afrique Centrale. Tervuren and Institut National de Recherche Scientifique, Butare.

Troupin, G. (1992) *Mission d'etude sur la flore de la foret Nyungwe*. Unpublished report to Projet PASP II – UGZ3 – Nyungwe, Ministere de l'Agriculture de l'Elevage et des Forets. 70 pp.

Ulfstrand, S. and Lamprey, H. (1960) On the birds of the Kungwe-Mahari area in western Tanganyika territory. *Journal of the East African Natural History Society* **23,** 223-232.

Vane-Wright, R. and Ackery, P. (Eds.). (1984). Biology of Butterflies. (Symposium of the Royal Entomological Society of London, 11). Academic Press, London.

Verheyen, R. (1947) *Exploration du Parc National Albert: oiseaux*. Institut des Parcs Nationaux du Congo Belge, Bruxelles. 87pp.

Vonesh, J.R. (1998) *The amphibiens and reptiles of Kibale Forest, Uganda: herpetofaunal survey and ecological study of the forest floor litter community.* Unpublished MSc thesis, University of Florida.

White, F. (1983) *The vegetation of Africa: a descriptive memoir to accompany the UNESCO/AETFAT/UNSO vegetation map of Africa*. Natural Resources Research XX. Unesco, Paris. 356 pp.

Wilson, R. (1982) *The birds of the Parc National des Volcans*. Unpublished checklist, Mountain Gorilla Project, Rwanda.

Wilson, S.E. (1995) *Uganda National Parks: Bird and Mammal checklists for ten national parks in Uganda*. National Biodiversity Databank, Makerere University, Kampala.

Wilson, J.R. and Catsis, M.C. (1990) *A preliminary survey of the forests of the Itombwe mountains and the Kahuzi Biega national park extension, east Zaire: July-September 1989*. Unpublished report to ICCN and WWF.

de Witte, Z.G.F. (1938) *Exploration du Parc National Albert: mammiferes*. Institut des Parcs Nationaux du Congo Belge, Bruxelles.

de Witte, Z.G.F. (1941) *Exploration du Parc National Albert: batraciens et reptiles*. Institut des Parcs Nationaux du Congo Belge, Bruxelles. 261 pp.

de Witte, Z. G.F. (1965) *Les chaméléons de l'Afrique centrale*. Annales du Musee Royal de l'Afrique Centrale. Sciences Zoologiques No. 142. 200 pp. Tervuren, Belgium.

van de Weghe, J.P. and Loiselle, B.A. (1987) The bird fauna of Bururi Forest, Burundi. *Le Gerfaut* **77,** 147-164.

THE ALBERTINE RIFT TECHNICAL REPORTS

ISSN: 1543-4109

The Albertine Rift Technical Reports series has been developed to publish results from research activities that the Wildlife Conservation Society has undertaken with other partners in the region of the Albertine Rift. The aim of the series is to provide a mechanism for more detailed results to be published that would not ordinarily be published in scientific journals. We believe that it is essential that detailed records such as these are made so that future scientists and managers can use the results, particularly in future monitoring surveys. The series also publishes the results of workshops or syntheses of information that again would not be possible in a short scientific publication.

Previous reports:

No. 1: Hill, C.M., Osborn, F.V. and Plumptre, A.J. 2002. Human-wildlife conflict: identifying the problem and possible solutions. *Albertine Rift Technical Report* No. 1, 137 pp

No. 2: Plumptre, A.J., Cox, D. and Mugume, S. (2003) The Status of Chimpanzees in Uganda. *Albertine Rift Technical Report* No. 2, 69 pp

The Wildlife Conservation Society (WCS)
The Wildlife Conservation Society is dedicated to saving wildlife and wildlands to assure a future for threatened species such as elephants, gorillas, chimpanzees, cheetahs, tigers, sharks or lynx. That mission is achieved through a conservation program that protects some 50 living landscapes around the world, manages more than 300 field projects in 53 countries, and supports the largest system of living institutions in the USA – the Bronx Zoo, the New York Aquarium, the Wildlife Centres in Central Park, Queens and Prospect Park, and the Wildlife Survival Centre on St Catherine's Island, Georgia. We are developing and maintaining pioneering environmental education programmes that reach more than three million people in the New York metropolitan area as well as in all 50 United States and 14 other countries. We are working to make future generations inheritors, not just survivors.

WCS has been a driving force in conservation in Africa since the 1920s when the Bronx Zoo's first president, William Hornaday, initiated a programme to save the white rhinos of South Africa. Since this time the WCS Africa Programme has been characterised by pioneering conservation work such as the first field studies and census of the mountain gorillas by George Shaller in Congo (1959), creation of the Nouabale-Ndoki national park in Congo Republic (1993), Masoala park in Madagascar (1996), and Nyungwe National Park in Rwanda (2001). WCS focuses on the use of scientific information to manage conservation areas and as such has more field scientists on the ground than any other conservation organisation in the world. Currently the WCS Africa Programme works in 14 countries protecting a range of spectacular and diverse ecosystems across the continent. While Africa has some of the richest landscapes of the natural world it also faces extreme challenges of poverty, high human population growth and rapidly changing political systems. WCS Africa programme recognises these challenges and the subsequent pressures on biodiversity. Throughout its field-based programmes WCS works with governments, national institutions and local communities to conserve Africa's natural heritage for both Africans and the world at large.

To learn more about WCS visit: www.wcs.org

The Albertine Rift is one of the most biodiverse areas on the African continent. It has been independently identified as an 'endemic bird area' by Birdlife international, an 'ecoregion' by World Wildlife Fund and a 'biodiversity hotspot' by Conservation International. Studies have shown this region to contain more vertebrate species than anywhere else on the continent. This report summarises the findings of a compilation of species lists for various protected and ungazetted areas in the Albertine Rift. Six major taxa were selected which were thought to have been surveyed fairly extensively: mammals, birds, reptiles, amphibians, butterflies and plants. The diversity of the freshwater fish fauna is also summarised. The findings confirm the importance of this region for biodiversity conservation. This region contains 52% of all bird species, 39% of mammals, about 14% of plant and reptile species, and 19% of amphibian species on the continent. The species lists are used to determine conservation priorities in the Albertine Rift. The Virunga National Park in the Democratic Republic of Congo consistently ranks highly for all taxa studied. This park, Africa's first park, almost certainly has more species than any other in Africa.

Author biographies

Andrew Plumptre is the Director of the Wildlife Conservation Society's (WCS)Albertine rift Programme. He has been working in the Albertine rift since 1988 and has undertaken surveys and research in many of the forests in this region.

Mathias Behangana is a herpetologists based at Makerere University where he is studying the distribution of amphibians in the Albertine Rift. He has been studying amphibians for 10 years.

Tim Davenport manages WCS's southern highlands programme in sw Tanzania. He has been surveying butterflies in Africa for more than 10 years.

Charles Kahindo is a Congolese ornithologist based at Makerere University looking at the genetical differences between birds that are found in the Albertine Rift. He has undertaken surveys in many areas in eastern DRC.

Robert Kityo is curator of the musuem at Makerere University. He specialises in mammal taxonomy and research and has been working in this field for more than 10 years.

Ewango Ndomba is a WCS botanist working at the Centre de Formation et de Recherche en Conservation Forestière in the Ituri Forest, DRC. He has been undertaking research on the dynamics of four large plots in the Okapi Faunal Reserve.

David Nkuutu is a botanist working for the WCS Albertine Rift programme. He has been surveying the distribution of plants throughout the main forest reserves in western Uganda.

Isaiah Owiunji is an ornithologist working for the WCS Albertine Rift Programme and has been surveying bird populations for more than 10 years in Uganda. He is currently investigating the distribution of species within forests in western Uganda.

Paul Ssegawa is a botanist working at the Makerere University herbarium. He has been compiling an endemic list of plants for the Albertine rift for WCS.

Gerald Eilu is a lecturer at Makerere University Department of Forestry and Nature Conservation. He has undertaken surveys of lianas and herbs in many forests in Uganda.

WILDLIFE CONSERVATION SOCIETY