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The biodiversity of the Albertine Rift

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ABSTRACT

The Albertine Rift is one of the most important regions for conservation in Africa. It contains more vertebrate species than any other region on the continent and contains more endemic species of vertebrate than any other region on mainland Africa. This paper compiles all currently known species distribution information for plants, endemic butterfly species and four vertebrate taxa from the Albertine Rift. The literature on fish species richness and endemism is also reviewed to assess the importance of the larger lakes in the Rift for conservation. We use data from 38 protected and unprotected areas to prioritise sites within the Albertine Rift for conservation based upon their numbers of endemic and globally threatened species. Virunga and Kahuzi Biega National Parks and Itombwe Massif in Democratic Republic of Congo, Bwindi Impenetrable and Kibale National Parks in Uganda, and Nyungwe National Park in Rwanda rank highest in terms of numbers of both endemic and globally threatened species. Six conservation landscapes are described that include most of these sites and it is argued that a focus on these landscapes may be a more holistic method to ensure the safety of the priority areas of the Albertine Rift.

1. Introduction

The Albertine Rift is the most species rich region for vertebrates on the African continent (Brooks et al., 2001; Plumptre et al., 2003). This part of Africa contains the 'Mountains of the Moon' or Rwenzori Massif that includes Africa's third highest peak, the Virunga Volcanoes made famous by its mountain gorillas, active volcanoes in the Virunga National Park, and

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Lake Tanganyika – Africa's deepest lake. The Albertine Rift encompasses much of the western Rift valley down to southern Tanzania and northern Zambia. We define the region as extending from 30 km north of Lake Albert to the southern tip of Lake Tanganyika, including the valley, flanks of the escarpment and associated protected areas, and the range of species endemic to it (Plumptre et al., 2003). Various other publications also recognize the 'Albertine Rift' (Poulsen, 1997; Prigogine, 1985): it is an Endemic Bird Area according to BirdLife International (Stattersfield et al., 1998), WWF have defined it as a 'Global-200' priority ecoregion (Olson and Dinerstein, 1998; Burgess et al., 2004), and Conservation International (CI) has recognized it as part of the Eastern Afromontane Hotspot in their second global analysis (Brooks et al., 2004). There is much overlap in the definition of the Albertine Rift between these publications, but also some differences in geographical coverage as each analysis has used different criteria to delineate the region. WWF's Ecoregion focuses primarily on the montane forests and separates moorland from these forests, while BirdLife International's Endemic bird area is broader and includes the moorlands and highland swamps. CI's Eastern Afromontane Hotspot is broader still and includes the definition of the Albertine Rift used here (see below).

The Albertine Rift is not only important for its biodiversity but also for its ecological processes and ecosystem services. The savanna parks contained some of the highest biomasses of large mammals recorded on earth in the 1960s (Cornet d'Elzius, 1996). War and poaching have led to major decreases in the numbers of large mammals in these parks but most of the species are still present and could recover to former levels with good protection (Plumptre et al., 2007). The impacts of the browsing and grazing of the elephants, hippopotamuses, buffalos, and antelope species had a major influence on the vegetation of the parks (Delvingt, 1978) and as a result of the decline in numbers of these species it is thought the parks are changing (Eltringham, 1999). The volcanoes in the Virunga National Park are active and influence the ecology of a large portion of this park and its surroundings. The fisheries in some of the lakes are the most productive on the continent and provide a livelihood for many people (Beadle, 1974; Snoeks, 2000) and the rivers and streams flowing from the forests on the mountains provide clean water. In Rwanda, for example, it is estimated that more than 70% of people obtain water that comes from their national parks (Weber, 1989). The spectacular land formations and rich biodiversity of the Albertine Rift mean that it has great potential for tourism. Civil wars and international conflict over the past 30 years have hampered tourism development but when peace comes to the region there is enormous potential to develop world class tourism.

This paper summarises the existing literature on biodiversity surveys within sites in the Albertine Rift. It is the result of a collaborative effort between many different NGOs, protected area authorities and museums that have information about this region. Since 2001 the protected area authorities and their NGO partners have been developing a strategic framework for conservation in the Albertine Rift. At this time a core planning group was established, which developed the strategic framework for conservation in the Albertine Rift, that includes the Albertine Rift Conservation Society, Dian Fossey Gorilla Fund International, Institute for Tropical Forest Conservation, International Gorilla Conservation Programme, Makerere University Institute of Environment and Natural Resources, Wildlife Conservation Society (WCS) and WWF. The compilation of the biodiversity information was one aspect of this planning process and was led by WCS. This paper advances this collaborative effort by using the collated data to prioritise sites in the Albertine Rift for conservation according to their numbers of endemic and globally threatened species.

1.1. *The Albertine Rift region*

As part of this planning process a series of meetings were held between February 2001 and March 2003, when the framework was finally developed. During this process it was agreed that the definition of the Albertine Rift should be as inclusive as possible for the moment so that over time it could be refined (Plumptre et al., 2003). The current adopted definition therefore includes all the natural habitats within 100 km east of the border of Democratic Republic of Congo (DRC) and follows the 900 m contour line in eastern DRC, including the protected areas in northern Zambia (Fig. 1). The 900 m contour was selected because there are museum collections at the Royal Museum for Central Africa in Tervuren, Belgium, of Albertine Rift endemic bird species that were found as low as this altitude.

The total area encompassed is around 313,000 km^2 (Plumptre et al., 2003). The habitats range from the glaciers and rock at the top of the Rwenzori mountains (5100 m), down through alpine moorland (3400–4500 m), Giant *Senecio*

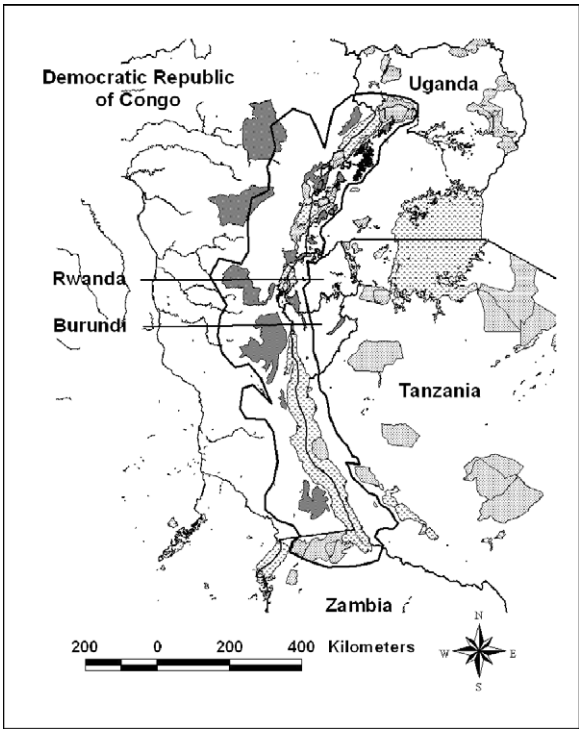

Fig. 1 – Map of the extent of the Albertine Rift as considered here. Forested protected areas (or surveyed areas) are in dark grey, savanna/miombo woodland protected areas are in lighter grey.

and *Lobelia* vegetation (3100–3600 m), giant heather (3000–3500 m), raised bogs (3000–4000 m), bamboo forest (2500–3000 m), montane forest (1500–2500 m), to lowland forest (600–1500 m), savanna woodland (600–2500 m) and savanna grassland (600–2500 m). Papyrus and *Carex* wetlands, together with lakes and streams, have their own unique habitat types varying from the rocky and sandy edges to the benthic and bathypelagic zones in the depths of the lakes. Several very specialised habitats also occur as a result of the volcanic activity in the Virunga National Park, including lava flows and their associated colonising vegetation, hot springs and species adapted to carbon monoxide and methane.

2. Methods

2.1. Biodiversity of the Albertine Rift

Initially WCS compiled lists of species from existing literature and by working with researchers at Makerere University, Uganda. Much of the literature was in unpublished reports or 'grey literature'. Data on mammals, birds, reptiles, amphibians, butterflies and plants were compiled, and information on some museum specimens collated with the help of museum experts (Royal Museum for Central Africa, Tervuren, Belgium; Missouri Botanical Gardens, USA; Field Museum, Chicago, USA, and Royal Botanic Gardens, Kew, UK) from 38 sites within the Albertine Rift (Fig. 2). We also reviewed the literature for fish species totals as it was recognized that the lakes in the Albertine Rift region are also important for conservation. We attempted to compile information from as many areas of the Albertine Rift as possible. Data on collections of amphibians and reptiles from the Royal Museum for Central Africa allowed some analysis to be made of species outside protected areas. Data from plant family descriptions and herbaria were also used to generate a preliminary list of endemic plant species, many of which are not found in the sites selected here. Not surprisingly, however, most of the sites selected were protected areas as that is where most surveys have been made in the Albertine Rift. However, some unprotected areas also had survey information, including the Itombwe Massif, Marungu Massif, high altitude areas west of Lake Edward and Mt Kabobo as well as areas around Mahale Mountains National Park. While not covering the whole Albertine Rift, these sites do include the larger protected areas and the largest areas of unprotected habitat.

The main sources used for each taxon were as follows:

2.1.1. Mammals

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). Dowsett (1990) produced a list of mammals for the Nyungwe Forest Reserve in Rwanda and this was combined with unpublished sightings from the Wildlife Conservation Society project in this forest and from Hutterer et al. (1987). A list for the Virunga Volcanoes was produced using de Witte (1938), Wilson (1995) and Hutterer et al. (1987). For DRC, de Witte (1938) reported on extensive surveys by Belgian scientists in the Virunga National Park. Muhlenberg et al. (undated) provided a list for Kahuzi Biega National Park and Omari et al. (1999) provided a list for Itombwe Massif. For Burundi, a list was obtained for Kibira National Park (Field Museum, Chicago (Kerbis Peterhans, in litt., FMNH database, Chicago), Peace Corps and INECN (undated). For Tanzania, lists were obtained for Gombe from the Gombe National Park website, for Mahale from Anonymous (1985) and for Mbizi from D. Moyer and W. Stanley's surveys. For Zambia, lists for Sumbu and Mweru-Wantipa National Parks were generated from the distribution records given by Ansell (1978).

2.1.2. Birds

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 WCS, and records compiled by Malcolm Wilson. Additional published records that were incorporated after expert peer review include Evans and Balmford (1992), Gnoske and Marks (1997), Kalina and Butynski (1996), Friedmann and Williams (1970), Dehn and Christiansen (2001), Stubblefield (1993), and Allan (1994). For Rwanda, Kunkel and Kunkel (1969), Dowsett et al. (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 WCS project in this forest. A list for the Virunga Volcanoes was produced using Schouteden (1938), Wilson (1982), and Wilson (1995). Schouteden (1938) reported on extensive surveys by Belgian scientists in the Virunga National Park in DRC and Verheyen (1947) added species to the northern part of the park. M. Languy provided additional observations. Muhlenberg et al. (undated) and Wilson and Catsis (1990) provided a preliminary list for Kahuzi Biega National Park and this was augmented by M. Herremans using the database of bird specimens at the Royal Museum for Central Africa in Tervuren. 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 Tshiaberimu. 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 et al. (1981) added species to this list and INECN produced a list for Kibira National Park in the mid 1980 s (INECN, undated). van de Weghe and Loiselle (1987) also produced a list for Bururi forest reserve. Neil Baker provided lists for Gombe Stream and Mahale Mountains National Parks

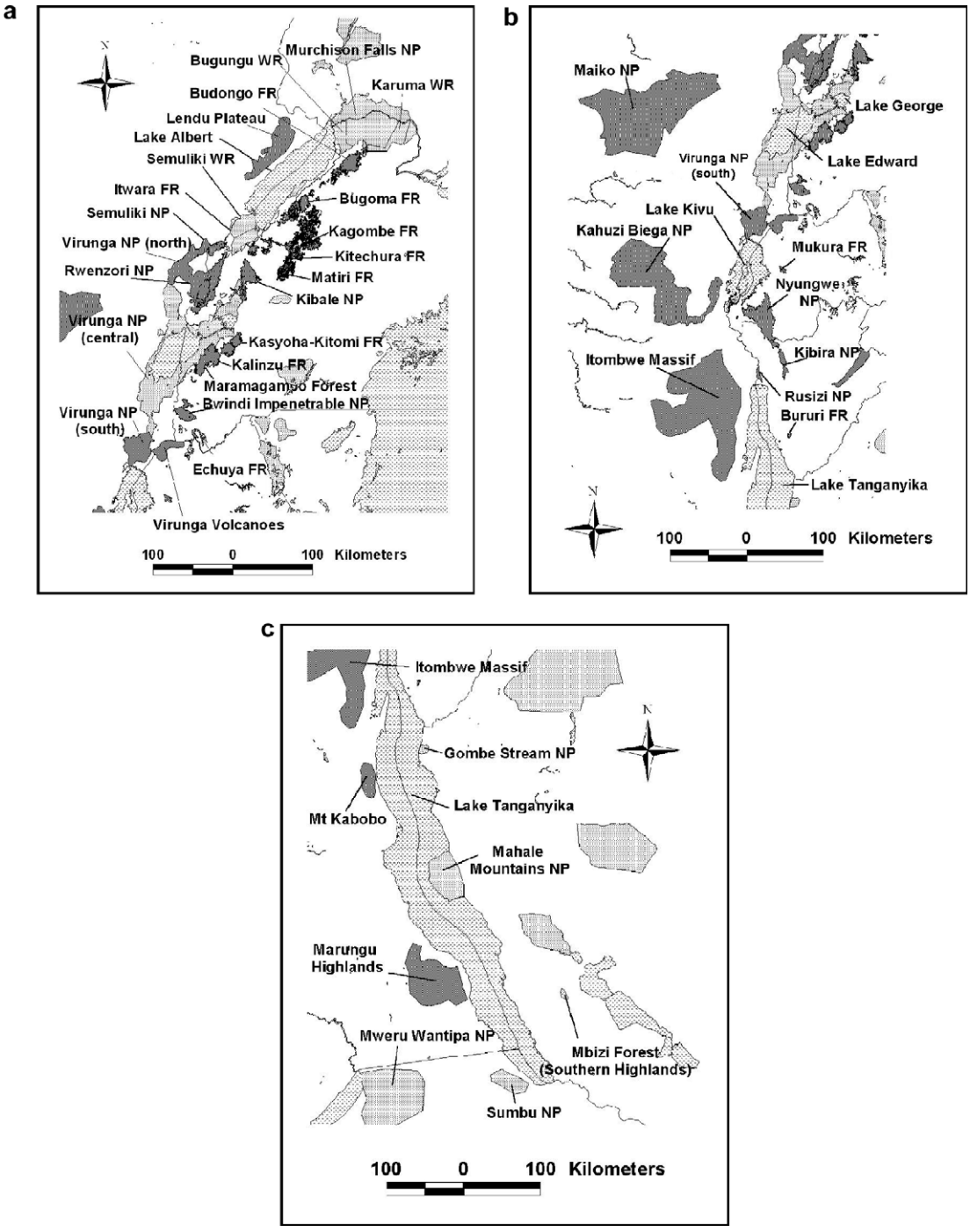

Fig. 2 – The northern (a), central (b) and southern (c) portions of the Albertine Rift showing the locations of the various protected areas (NP = national park; FR = forest reserve; WR = wildlife reserve) or ungazetted areas with species data (no suffix). Darker shaded areas are forested and lighter areas are savanna grassland or woodland.

from the Tanzania Bird Atlas database. 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.

2.1.3. *Reptiles*

Pitman (1938, 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. Hinkel and Fischer (1988) was used to develop a list of species for Virunga volcanoes and Nyungwe forest in Rwanda. 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 for Central Africa in Tervuren. For DRC, de Witte (1941) produced a list of reptiles for Virunga National Park and mapped the distributions of chameleons in central Africa (de Witte, 1965). D. Meirte extracted lists of specimen locations from the database at the Royal Museum of Central Africa in Tervuren. Only limited data were obtained for Burundi. Spawls et al. (2002) was used to compile a list of reptiles for Gombe and Mahale Mountains Parks in Tanzania.

2.1.4. *Amphibians*

Drewes and Vindum (1994, 1998) and Drewes et al. (1992) provided a species list for Bwindi Impenetrable National Park and Vonesh (1998) put together a list for Kibale National Park in Uganda. Many records were provided by M. Behangana from recent surveys. In Rwanda, Hinkel and Fischer (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. For DRC, de Witte (1941) produced a list of amphibians for Virunga National Park but the identifications needed updating. The database at the Africa Museum in Tervuren is in the process of being updated for amphibians to reflect current 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. D. Meirte provided corrections to the taxonomy of the older literature and also added many species from the database at the Royal Museum for Central Africa at Tervuren. Some data on distribution and systematics of tree frogs were taken from Schiøtz (1999). Only limited data were obtained for Burundi and none for Tanzania.

2.1.5. *Butterflies*

Information was 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 and Davenport (1996), Congdon and Collins (1999), Congdon et al. (2001), as well as numerous workers from earlier parts of the last century referenced in these publications. 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 C. Congdon (Tanzania) and A. Gardiner (Zambia) for very useful comments on an earlier draft.

2.1.6. *Plants*

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) Poulsen (1997, terrestrial herbs) and D. Hafashimana (epiphytes) for several forests. WCS has also been surveying many of the Rift forests over the past year and the species identified were incorporated in the database by 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. For Rwanda, plant species lists for the Virunga Volcanoes were obtained from Burtt (1934), Robyns (1948–1955), Troupin (1978–1988), and the herbarium at the Karisoke Research Station. Plant species for Nyungwe were compiled from Robyns (1948–1955), Troupin (1992), Plumptre et al. (2002) and the herbarium at the Project Conservation de la Forêt de Nyungwe. Robyns (1948–1955) provided a relatively complete list for Virunga National Park in DRC and Fischer (1996) provided a list for Kahuzi Biega National Park. No plant lists were obtained for sites in Burundi. For Tanzania, the 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, 1999). A species list for Mbizi forest was compiled from Mwasumbi (2000). Lebrun and Stork (1991–1997) was used to correct synonyms to a standardised list of names.

2.1.7. *Data cleaning and identification of species of conservation concern*

After six months of developing draft lists a meeting was convened by the core planning group to bring together experts from the region, particularly from museums and other institutions to review and augment the draft species lists. This meeting also addressed threats to these sites and refined the lists of endemic species for the Albertine Rift. Following this meeting there was another period of six months adding to the data and in particular checking species names and synonyms because taxonomy of many species has changed over the 70 years of publications that were used. WCS and Makerere University were involved in this data cleaning.

Numbers of endemic and globally threatened species were calculated for each site and used to prioritise sites in the Albertine Rift for conservation as follows. Endemic species lists were compiled with the help of experts in each taxonomic field. The mammal list came from Conservation International (J. Pilgrim) with additions by J. Kerbis Peterhans. The list compiled by Stattersfield et al. (1998) was used for birds. This publication recognized two areas of endemism in this region; the Albertine Rift and the Eastern Zairean Region of endemism. However, some species endemic to the Albertine Rift overlap substantially with those from the Eastern Zairean region (M. Herremans – data from Africa Museum at Tervuren) and the planning group made the decision that it was better to combine these two areas in this analysis. Lists of endemic reptile and amphibian species were compiled by D. Meirte. T. Davenport compiled a list of endemic butterfly species in collaboration with S. Collins, C. Congdon and A. Gardiner. E. Ndomba, P. Ssegawa, G. Eilu and A. Plumptre worked with botanists at the Royal Botanic Gardens, Kew, and Missouri Botanical Gardens to develop a preliminary list of endemic plant species based upon published family descriptions from most existing African floras (East Africa, Congo, Cameroon, Gabon, and Zambesiaca). This list is likely to miss many species because many families have not been described in DRC or East Africa. Endemic species lists are given in Plumptre et al. (2003) and are also at www.albertinerift.org. Globally threatened species were derived from the 2002 IUCN Red List (Hilton-Taylor,

2000 and updated lists on the associated website www.iucnredlist.org) and BirdLife International (2000).

2.2. *Ranking sites for conservation*

While there is a danger that ranking sites in terms of their conservation value can lead to the lower-ranked sites being sidelined, it is still important that priorities are identified given the limited human and financial resources available for conservation. However, even the poorest sites for which we have compiled data are rich, in a global context, have many restricted-range species, and therefore deserve conservation attention.

Ranking using species data requires subjective decisions, particularly when data are incomplete. Only five taxa (mammals, birds, reptiles, amphibians and plants) can be used in this study of the Rift because species data are not collated or available for other taxa. In the absence of more extensive data, we can only hope that these taxa act as good surrogates for others. Several aspects of surrogacy were tested between these taxa. This indicated that, in many cases, one taxon could act as a reasonable surrogate for the other four across the sites surveyed (Plumptre et al., 2003). Numbers of endemic species for one taxon correlated well (Pearson Correlations) with numbers of endemic species in another taxon, for all possible combinations ($P < 0.001$ for all tests). Surrogacy for threatened species was not so good. Numbers of threatened mammals, amphibians and birds correlated well between sites but threatened plants and reptiles did not show any significant correlation with other taxa. However, plants and reptiles have been less completely assessed for threatened species than the other three taxa. Only two reptiles were classified as threatened in this region in the 2002 Red List. 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 mammal and bird fauna because these are popular. Alternatively, it might be better to prioritise sites on species that have economic value and can attract tourists or provide livelihood to local communities, or by their ecological role in the ecosystem. Weightings could be made for certain species or certain taxa to incorporate these ideas. Here we have decided to weight taxa equally so that a high number of mammal species at a site receives the same rank as a high number of plants irrespective of the actual number of species. This effectively gives equal weight to any taxon and ranks biodiversity *per se* rather than social, economic or ecological functions of biodiversity.

Sites were ranked in terms of the number of endemic and number of globally threatened species for each taxon. These ranking scores were standardized for each site by dividing by the maximum rank score to account for the fact that some sites do not have data for all taxa and to account for the varying number of endemic or threatened species between taxa. For example, only two reptile species are currently listed as threatened of the 175 species found in the Albertine Rift sites (primarily because reptiles have not been well assessed). Three sites have threatened reptiles, which means that all sites with no threatened reptiles scored a value of '4' in the rankings. However a rank value of '4' for birds is a high value with many threatened species and therefore ranks cannot be summed across taxa without standardizing them by dividing by the maximum rank (4 in the case of reptiles). A mean rank was then calculated for both endemic and globally threatened species for each site across the five taxa by summing ranks from each taxon and dividing this by the number of taxa for which there were survey data (i.e., for which an initial rank was even possible). These final standardised scores were then ranked (1–38) to rank all the available sites for which we compiled data. Thus, the final rankings allow better comparison of sites with varying levels of knowledge. In presenting the results we grouped sites into categories of high, medium and low rank rather than using actual ranking values for each site. This avoids false precision because the data for many sites are incomplete, some mean ranking scores are based upon just one taxon, and the effort made in sampling sites varies widely. Comparing the rankings for endemic and globally threatened species allows an analysis of the relative importance of these two criteria.

The ranking process described above did not attempt to correct for the area of the sites. We were more interested in which are the priority sites for species conservation in the Albertine Rift rather than which are the richer sites relatively when area is standardised. From a conservation perspective the larger a site is, the easier it is to manage compared to many smaller sites of the same total area; conserving a few large sites will in general be the cheaper option. However, for comparison with other studies we did make this correction. We corrected for area by calculating

$$\text{scored endemic or threatened species} = \ln(\text{number of species} + 1)/\ln(\text{area}).$$

3. Results

The results show that this region contains more than half of continental Africa's bird species and nearly 40% of its mammal species. Reptile and amphibian species do not appear as abundant but this may be a function of the effort that has been made in collecting, identifying and cataloguing them in this region. While invertebrate taxa have been poorly surveyed, this region is known to have a large number of endemic butterflies (probably the best surveyed invertebrate taxon). The results presented here are the current state of knowledge, which will be improved on in due course as more surveys are conducted.

3.1. *Biodiversity values*

3.1.1. *Mammals*

No endemic families occur in the Albertine Rift but two endemic genera occur, *Rwenzorisorex*, and *Delanymys*. A total of 402 mammal species (158 genera and 46 families) have been recorded in the Albertine Rift, of which 35 are endemic (Table 1). Most of the endemic mammals are shrews and rodents. Of the larger endemic mammals, the eastern gorilla is the best known and has two subspecies (mountain, *Gorilla beringei beringei*, and Grauer's, *Gorilla beringei graueri*, gorillas). The Rwenzori duiker, *Cephalophus rubidus*, and the golden monkey, *Cercopithecus kandti*, are two other medium sized endemic mammals. Small mammals have been poorly surveyed throughout much of the Rift, particularly towards the southern end, and it is very likely more species would be added with further effort.

Table 1 – Richness of mammals across sites of the Albertine Rift Mountains, including number of species, number of Albertine Rift (AR) endemic species, and number of globally threatened species (CR = Critically Endangered, EN = Endangered, VU = Vulnerable)

Site	Species no.	AR endemic species	Threatened CR, EN, VU
Budongo FR[a]	95	0	5
Bugoma FR	38	0	4
Bugungu WR	9	0	1
Bururi FR	9	1	1
Bwindi Impenetrable NP[a]	135	20	7
Echuya FR[a]	24	7	1
Forest West of Lake Edward	8	0	1
Gombe NP	19	1	4
Ibambaro FR	2	0	0
Itombwe Massif	72	4	10
Itwara FR	18	0	0
Kagombe FR	14	0	3
Kahuzi Biega NP[a]	136	15	14
Kalinzu–Maramagambo FR[a]	58	1	3
Karuma WR	57	0	4
Kasyoha–Kitomi FR[a]	47	2	3
Kibale NP[a]	115	5	7
Kibira NP[a]	71	8	7
Kitechura FR	17	0	1
Kyambura WR	37	0	3
Mafuga FR	20	3	1
Mahale Mountains NP[a]	52	1	6
Matiri FR	12	1	0
Mbizi FR	23	1	2
Murchison Falls NP[a]	109	0	5
Mweru-Wantipa NP[a]	50	0	7
Nyungwe NP[a]	86	14	3
Queen Elizabeth NP[a]	97	0	6
Rwenzori Mountains NP[a]	102	18	10
Semliki NP[a]	86	1	5
Semliki WR	69	0	4
Sumbu NP[a]	61	0	6
Virunga NP[a]	196	21	13
Total	402	35	36

a Reasonably surveyed for all mammals.

Virunga National Park in eastern DRC has the highest number of endemic mammal species (21). Bwindi Impenetrable National Park (20) and Rwenzori Mountains (18) rank next highest.

Thirty-four mammal species are globally threatened (Critically Endangered, Endangered or Vulnerable) according to the 2002 IUCN Red List (Hilton-Taylor, 2000; www.iucnredlist.org), of which 12 are Albertine Rift endemics. These include eastern gorilla (*Gorilla beringei*), golden monkey and Rwenzori otter shrew *Micropotamogale ruwenzorii*. Kahuzi Biega National Park had the highest number of globally threatened mammals (14) followed by Virunga National Park (13).

3.1.2. *Birds*

Three genera are endemic to this region, *Pseudocalyptomena*, *Graueria*, and *Hemitesia* but no families are endemic. At least 1061 bird species (in 368 genera and 80 families) occur in the Albertine Rift (Table 2) of which 4.5% are migratory species that overwinter in the region but do not breed, or which pass through on migrations within the African continent. Although this is the most thoroughly surveyed group of animals, new species for the Rift continue to be added as migrant species and new range extensions are recorded. Within our definition of the Albertine Rift there are two contiguous Endemic Bird Areas (EBAs) defined by BirdLife International: Albertine Rift and Eastern Zairean Lowlands (Table 2) (Stattersfield et al., 1998). We have combined these areas because old museum collections of Albertine Rift endemic species show they occur at lower altitudes in eastern DRC and that they overlap in altitudinal range with the Eastern Zairean lowland species (Bober et al., 2001; Herremans et al., 2002). The total number of endemic birds in the Albertine Rift as defined here is 41 species, which includes the endemics of these two EBAs.

The Itombwe Massif, an unprotected area west of the northern end of Lake Tanganyika, contains more endemic species than any other site in the Albertine Rift (34). It is closely followed by Kahuzi Biega National Park (30) and Virunga National Park (27).

Twenty-five Albertine Rift species are globally threatened, 13 of which are endemics. These include congo bay owl (*Phodilus prigoginei*), itombwe nightjar (*Caprimulgus prigoginei*),

Table 2 – Richness of birds across sites of the Albertine Rift Mountains, including number of species, number of Albertine Rift (AR) endemic species as defined by BirdLife International (with number of eastern Zairean lowland endemic species in parentheses that were included in the definition of Albertine Rift Endemic species here – see text) and number of globally threatened species (CR = Critically Endangered, EN = Endangered, VU = Vulnerable)

Site	Species no.	AR endemic species	Threatened CR, EN, VU
Budongo FR	362	0	1
Bugoma FR	221	0	1
Bururi FR	155	13	3
Bwindi Impenetrable NP	381	24(1)	6
Echuya FR	136	14	2
Forests West of Lake Edward	420	25	11
Gombe NP	267	0	2
Idjwi	150	2	1
Itombwe Massif	583	34(4)	15
Itwara FR	183	0	0
Kagombe FR	121	0	0
Kahuzi Biega NP	335	32(3)	11
Kalinzu–Maramagambo FR	393	4	1
Kasyoha–Kitomi FR	308	2	1
Kibale NP	327	3	3
Kibira NP	211	21	7
Kitechura FR	90	0	0
Kyambura WR	450	0	6
Lendu Plateau	317	6	4
Mafuga FR	130	10	0
Mahale Mountains NP	250	2	1
Marungu	282	1	0
Matiri FR	119	0	0
Mbizi FR	116	0	0
Mt Kabobo	231	18	3
Murchison Falls NP	476	0	7
Nyungwe NP	280	26	7
Queen Elizabeth	594	0	7
Rusizi NR	182	1	3
Rwenzori Mountains NP	241	21	4
Semliki NP	441	7(5)	9
Semliki WR	435	0	3
Virunga NP	706	27(2)	11
Total	1061	41(6)	25

In the analyses presented in this paper Albertine Rift and Eastern Zairean Lowland endemic species were combined because of the extensive overlap in distributions of the two groups as can be seen here.

kungwe apalis (*Apalis argentea*), grauer's rush warbler (*Bradypterus graueri*) and golden-naped weaver (*Ploceus aureonucha*). Itombwe had the highest number of globally threatened species (15) followed by Virunga National Park (11), Kahuzi Biega National Park (11) and the mountains west of Lake Edward (11).

3.1.3. *Reptiles*

No endemic genera or families of reptiles are known from the Albertine Rift. A total of 175 reptiles, from 69 genera and 20 families (about 14% of Africa's reptiles) have been recorded for the Albertine Rift (Table 3). Far fewer sites have been surveyed for reptiles to the same extent as for mammals and birds, although some records existed for at least 33 sites. Itombwe Massif and Kahuzi Biega National Park in eastern DRC may contain many species but to date have been poorly surveyed. Other areas that need work include the Marungu Massif in eastern DRC at the southern end of Lake Tanganyika and the Mahale Mountains National Park and its surrounding natural vegetation.

Sixteen endemic reptile species occur in the Rift, of which Virunga National Park contains the highest number (11), followed by Rwenzori Mountains National Park (9) and Nyungwe National Park (8). Endemic species include five chameleons such as the strange-horned chameleon (*Bradypodion xenorhinum*), and Johnston's chameleon (*Chamaeleo johnstoni*), two colubrid snakes, one viper, six skinks, one worm snake (*Leptotyphlops*) and one lacertid lizard.

Only two globally threatened reptiles are currently listed for the Albertine Rift (*Trionyx triunguis* and *Osteolaemus tetraspis*). However, this is because the region has few data and reptiles as a whole have not been assessed completely for their threatened status. The IUCN Global Reptile Assessment is underway and it is likely many more species will be added to the Red List. As a result no site has more than one globally threatened reptile (Table 3).

3.1.4. *Amphibians*

Three amphibian genera are endemic to the Albertine Rift; *Laurentophryne*, *Chrysobatrachus* and *Callixalus*. There are 119

Table 3 – Richness of reptiles across sites of the Albertine Rift Mountains, including number of species, number of Albertine Rift (AR) endemic species, and number of globally threatened species (CR = Critically Endangered, EN = Endangered, VU = Vulnerable)

Site	Species no.	AR endemic species	Threatened CR, EN, VU
Budongo FR	48	1	0
Bugoma FR	9	0	0
Bugungu WR	9	0	0
Bururi FR	1	1	0
Bwindi Impenetrable NP	34	6	0
Echuya FR	4	0	0
Forests West of Lake Edward	6	3	0
Gombe NP	1	0	0
Itombwe Massif	35	5	0
Itwara FR	10	0	0
Kahuzi Biega NP	69	7	0
Kalinzu–Maramagambo FR	9	0	0
Karuma WR	15	0	0
Kasyoha–Kitomi FR	9	0	1
Kibale NP	56	3	0
Kibira NP	3	2	0
Kyambura WR	12	0	0
L. Rukwa	7	0	0
L. Tanganyika	13	0	0
Lendu Plateau	6	0	0
Mafuga FR	17	2	0
Mahale Mountains NP	4	0	0
Marungu Massif	6	0	0
Mbizi FR	3	0	0
Mt Kabobo	6	2	0
Murchison Falls NP	32	0	1
Nyungwe NP	43	8	0
Queen Elizabeth	34	0	0
Rusizi NR	3	0	0
Rwenzori Mountains NP	34	9	0
Semliki NP	49	0	0
Semliki WR	33	0	1
Virunga NP	109	11	0
Total	175	16	2

species of amphibians in the Albertine Rift, including 29 genera and 11 families, (about 19% of Africa's amphibians).

Thirty-six endemic species have been identified. It is likely that more survey effort would uncover further endemic species. Virunga National Park had the highest number of endemic species (16) with Itombwe Massif (16) and Nyungwe Park (14). Four endemic species (*Hyperolius pustulifer*, *Schoutedenella loveridge*, *Schoutedenella mossoensis*, *Schoutedenella vercammeni*), have only been recorded outside the 40 sites described here and are thus not found in any of the protected areas in the Albertine Rift.

Sixteen Albertine Rift amphibians are globally threatened, of which 14 are endemic. 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 4).

3.1.5. *Fish*

While no attempt was made to put together species lists of fish for the rivers and lakes in the Albertine Rift, the literature was searched for data on the major lakes (Albert, George, Edward, Kivu and Tanganyika). Lake Tanganyika alone has 289 endemic species that make up 89% of fish diversity of the lake (Snoeks, 2000). Only Lake Malawi has more endemic fish in Africa. Fifty-six fish species are endemic to lakes George and Edward, while Kivu and Albert have 15 and six endemic fish respectively. Only 10% of Lake Tanganyika's shore has been explored and a total of over 1200 faunal species (vertebrates and invertebrates) have been recorded, making it the second highest recorded diversity for any lake on earth (Patterson and Makin, 1998).

3.1.6. *Butterflies*

The total number of butterfly species found in the Albertine Rift is unknown, as this information cannot be compiled until many more areas have been surveyed, particularly in eastern DRC. In Uganda, inventories of the forests in the Albertine Rift have shown that at least 581 species of butterfly, 16% of the estimated 3630 species in Africa, occur in this part of the Albertine Rift alone (Howard and Davenport, 1996). It is possible that, given the numbers from Uganda and Tanzania, up to 1300 butterfly species might occur in the Rift, about 35% of Africa's total. There are no known endemic families, but the genus *Kumothales* is restricted to the Albertine Rift. It is known that 117 endemic species from 49 genera exist in the Albertine Rift (Plumptre et al., 2003). The

Table 4 – Richness of amphibians across sites of the Albertine Rift Mountains, including number of species, number of Albertine Rift (AR) endemic species, and number of globally threatened species (CR = Critically Endangered, EN = Endangered, VU = Vulnerable)

Site	Species no.	AR endemic species	Threatened CR,EN, VU
Budongo FR	32	1	1
Bugoma FR	20	1	0
Bururi FR	4	4	1
Bwindi Impenetrable NP	29	6	6
Echuya FR	19	5	1
Forests West of Lake Edward	6	6	3
Itombwe Massif	23	16	11
Itwara FR	19	0	0
Kahuzi Biega NP	25	7	4
Kalinzu–Maramagambo FR	25	2	2
Karuma WR	16	0	0
Kasyoha–Kitomi FR	16	3	2
Kibale NP	33	5	3
Kibira NP	1	0	0
Kitechura FR	15	0	0
Kyambura WR	14	0	0
Mafuga FR	1	1	0
Marungu	19	1	0
Matiri FR	15	0	0
Mt Kabobo	8	7	5
Murchison Falls NP	14	0	0
Nyungwe NP	33	14	5
Queen Elizabeth NP	10	1	1
Rwenzori Mountains NP	25	7	1
Semliki NP	24	1	0
Semliki WR	13	0	0
Virunga NP	65	16	10
Total	119	36	16

total number of endemics (of which 85% are forest dependent) is considerably larger than the 78 endemic species found in the Eastern Arc Mountains and coastal forests of Tanzania and Kenya, and could increase with further survey effort. Whether or not butterflies are indicative of other invertebrate species is unclear but these numbers do demonstrate unequivocally that this region is not only important for vertebrate conservation.

3.1.7. *Plants*

Higher plants have been relatively well surveyed in the forests of Uganda and Rwanda but elsewhere in the Albertine Rift surveys have been patchy. Currently 5793 plant species (from 1537 genera and 233 families) have been recorded within the Rift but this will change as surveys are discovering new species regularly even within Uganda (Table 5). These data include ferns and higher taxa but do not include the bryophytes and lichens, which are very poorly surveyed. The number of plant species is high compared with many regions of similar size and forms 14% of all mainland Africa's estimated plant species. A preliminary estimate of the numbers of endemic plant species has been compiled by the WCS's Albertine Rift Programme and this now numbers 551 species. These lists are based on published flora descriptions of plant families, but many families have not been described for DRC or East Africa. Some input was made by herbaria experts, but the list is still incomplete. As a result this list should be considered to be very preliminary and could increase greatly when lower plants and little studied growth forms such as climbers, epiphytes, lichens and bryophytes are included. Western Tanzania, especially around Mahale Mountains National Park, appears to be particularly rich in plant species and yet has still not been surveyed intensively. As such it deserves more attention. Virunga National Park in eastern DRC and Bwindi Impenetrable National Park in Uganda had the highest numbers of plant species recorded but both sites have been relatively intensively surveyed. The Marungu Massif and Itombwe Massif in eastern DRC have few records but also could be relatively rich and require surveys.

3.2. *Site priority rankings*

Rankings were made for numbers of both endemic and globally threatened species for all taxa (mammals, birds, reptiles amphibians and plants), for each site as explained in Section 2.2 (Table 6). We then grouped the sites into high (rank scores 1–12), 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 for endemic and globally threatened species (Table 7). Given the gaps in the data and differences in sampling effort between sites we believe that grouping the sites into the three broad ranking categories provides a more conservative approach by alleviating these biases.

Those six sites that scored highest are considered to be the most important because they rank highly for number of both

Table 5 – Richness of plants across sites of the Albertine Rift Mountains, including number of species, number of tree species only, number of Albertine Rift (AR) endemic species, and number of globally threatened species (CR = Critically Endangered, EN = Endangered, VU = Vulnerable)

Site	Species no.	No. tree species	AR endemic species	Threatened CR, EN, VU
Budongo FR[a]	1064	449	29	18
Bugoma FR	256	245	7	12
Bwindi Impenetrable NP[a]	1405	393	74	18
Echuya FR[a]	423	131	32	1
Gombe NP[a]	510	112	12	0
Itwara FR	258	248	7	10
Kagombe FR	211	201	3	5
Kahuzi Biega NP[a]	1171	218	145	9
Kalinzu–Maramagambo FR[a]	787	442	34	12
Kasyoha–Kitomi FR[a]	901	419	41	17
Kibale NP[a]	532	330	16	12
Kitechura FR	113	108	2	0
Mafuga FR	115	100	7	2
Mahale Mountains NP[a]	1174	220	39	9
Matiri FR	113	105	2	2
Mbizi FR[a]	385	94	18	8
Murchison Falls NP	149	145	1	5
Nyungwe Forest[a]	1105	230	137	7
Queen Elizabeth[a]	950	288	22	5
Rwenzori Mountains NP[a]	696	199	55	5
Semliki NP	333	318	7	14
Virunga NP[a]	2077	264	230	10
Total	5793	821	551	40

a Reasonably surveyed for all plant groups (ferns, herbs, climbers and shrubs).

endemic and globally threatened species. Virunga National Park consistently ranks high for all taxa because it contains a very diverse suite of habitats ranging from glaciers to lowland forest and savannas. Itombwe Massif is a critical area for conservation as it is currently unprotected and yet ranks in the top five for endemic and globally threatened species. Kahuzi Biega National Park in eastern DRC is just to the north of Itombwe and ranks highly despite being poorly surveyed. Two sites in Uganda rank highly: Bwindi Impenetrable National Park and Kibale National Park. These two sites include forest at high and medium altitude respectively. Nyungwe National Park ranks highly although the contiguous Kibira National Park does not rank so highly, probably because it has been less surveyed. The next important sites are those three that rank highly for globally threatened species and medium for endemic species richness, as globally threatened species are in more urgent need of conservation. On the whole this classification seems to make sense intuitively and from what is known about these sites.

These rankings are affected by area. Those sites that are large tend to have more endemic species and a higher species richness. In some studies a correction is made for the area of the site to calculate those sites that have the highest numbers of species per unit area. We do not believe this is as useful for conservation purposes because we are ideally trying to conserve the largest sites with most endemic and globally threatened species. However, it is useful for comparisons with other studies to calculate those sites that have high numbers of endemic and globally threatened species per unit area. The results show that many of the key sites previously identified still rank highly (Table 8). Large sites such as Virunga and Kahuzi Biega National Parks and the Itombwe Massif contain large numbers of endemic and globally threatened species per unit area as well as in total.

4. Discussion

The Albertine Rift contains many high global conservation priority sites. This region contains more vertebrate and more endemic vertebrate species than anywhere else on the African continent (Burgess et al., 2004). Although for many taxa and sites, species lists are still incomplete and will increase as more research is undertaken, the data presented here do show the large number of species known from this region. The data are used to prioritise sites for conservation but we also caution how this ranking is interpreted and used. Most surveys have focused on the protected areas listed here and yet very little is known about the surrounding landscapes in which these sites sit. Given this low level of knowledge outside protected areas it makes sense to also conserve at a larger landscape scale until we have a better knowledge of what occurs elsewhere. Managing at the landscape scale in the Rift is a necessary long-term conservation strategy, even though it will require more resources than focusing on single protected areas. Management at a landscape scale will also ensure that certain species, landscape species (Sanderson et al., 2002), may stand a better chance of survival over the longer term (Plumptre et al., 2007). For example, large predators such as leopards *Panthera pardus*, lions *Panthera leo*, some of the larger primates (chimpanzees *Pan troglodytes*, gorillas *Gorilla*

Table 6 – Rankings for each taxon at each site for endemic (End) and globally threatened (Th) species

Site	Mamm End	Mamm Th	Bird End	Bird Th	Rep End	Rep Th	Amph End	Amph Th	Plant End	Plant Th
Budongo FR	19	12	21	20	12	4	14	11	10	1
Bugoma FR	19	15	21	20	14	4	14	16	15	5
Bugungu WR	19	25			14	4				
Bururi FR	12	25	11	14	14	4	11	11		
Bwindi Impenetrable NP	2	5	6	10	5	4	7	3	4	1
Echuya FR	7	25	10	18	14	4	9	11	9	20
Forest West of Lake Edward	19	25	5	2	7	4	7	7		
Gombe NP	12	15	21	18	14	4			14	21
Ibambaro FR	19	31								
Idjwi	0		17	20	9	4				
Itombwe Massif	9	3	1	1	14	4	1	1		
Itwara FR	19	31	21	26	14	4	20	16	15	8
Kagombe FR	19	19	21	26					19	13
Kahuzi Biega NP	4	1	2	2	4	4	4	6	2	10
Kalinzu–Maramagambo FR	12	19	15	20	14	4	13	9	8	5
Karuma WR	19	15			14	4	20	16		
Kasyoha–Kitomi FR	11	19	17	20	14	1	12	9	6	3
Kibale NP	8	5	16	14	7	4	9	7	13	5
Kibira NP	6	5	7	6	12	4	20	16		
Kitechura FR	19	25	21	26			20	16	20	21
Kyambura WR	19	19	21	10	14	4	20	16		
Lendu Plateau			14	12	14	4				
Mafuga FR	10	25	12	26	9	4	14	16	15	18
Mahale Mountains NP	12	9	17	20	9	4			7	10
Marungu			20	26	14	4	14	16		13
Matiri FR	12	31	21	26			20	16	20	18
Mbizi FR	12	24	21	26	14	4			12	13
Mt Kabobo			9	14	14	4	4	4		
Murchison Falls NP	19	12	21	6	14	1	20	16	22	13
Mweru-Wantipa	19	5								
Nyungwe NP	5	19	4	6	3	4	3	4	3	12
Queen Elizabeth NP	19	9	21	6	14	4	14	11	11	13
Rusizi NR					6	4				
Rwenzori Mountains NP	3	3	7	12	2	4	4	11	5	13
Semliki NP	12	12	13	5	14	4	14	16	15	4
Semliki WR	19	15	21	14	14	1	20	16		
Sumbu	19	9								
Virunga NP	1	2	3	2	1	4	1	2	1	8

The lowest numbers are the sites with most species. These ranks were then standardized by dividing each rank value by the highest number in each column. Mamm – mammal; Rep – Reptile; Amph – amphibian.

beringei), and large ungulates (elephants *Loxodonta africana*, hippopotamuses *Hippopotamus amphibious*) are species that need large areas to maintain viable populations. As such some of the 'less rich' sites and as yet unsurveyed ones may have important connectivity roles and should not be ignored.

4.1. *Contiguous sites and conservation*

Many of the protected areas or conservation sites in the Albertine Rift are contiguous with other protected areas/sites or are still connected by relatively natural habitat. Where these connections are truncated existing biota can be seriously jeopardised (e.g., Kibale-QENP Corridor, Kahuzi Biega lowland–highland sectors, Kibira (Teza sector in the south) and its connection to Nyungwe National Park). These natural habitats serve as corridors for wildlife, and their conservation status is in most cases unclear because they have been little surveyed. As such they form larger 'landscapes' whose species richness will be larger than for single sites. Larger conservation areas have higher chances of long-term persistence of their species and habitats (Groves, 2003). Many of these landscapes cross international boundaries or connect sites that are managed by different institutions, such as the forest reserves and national parks in Uganda. If protected areas are to persist it is important that they are managed as one contiguous unit rather than independent sites in order to maintain connectivity. Transboundary conservation and inter-institutional management of larger landscapes is complex and requires regular coordination if it is to work (see Plumptre et al., 2007). However for an area such as the Albertine Rift, with heavy human population pressure, many conservation sites are becoming islands and maintaining connectivity is a priority.

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

Table 7 – Relative rankings of sites for Albertine Rift (AR) endemic and globally threatened species

AR endemic species	Globally threatened species		
	High	Medium	Low
High	Virunga NP Itombwe Massif Kahuzi Biega NP Kibale NP Bwindi Impenetrable NP Nyungwe NP	Rwenzori Mts NP Mt Kabobo Forest W. of Lake Edward Mahale Mts NP	Echuya FR Rusizi NR
Medium	Kasyoha–Kitomi FR Queen Elizabeth NP Semuliki NP	Budongo FR Kalinzu–Maramagambo Lendu Plateau Kibira NP	Mafuga FR Bururi FR Gombe NP Mbizi FR Idjwi Island
Low	Mweru-Wantipa NP Murchison Falls NP Sumbu NP	Bugoma FR Semliki WR Kagombe FR Kyambura WR	Bugungu WR Kitechura FR Matiri FR Itwara FR Ibambaro FR Marungu Massif Karuma WR

Table 8 – Relative rankings for numbers of endemic and globally threatened species when area is standardised

AR endemic species	Globally threatened species		
	High	Medium	Low
High	Bwindi NP Nyungwe NP Virunga NP Itombwe Massif Kahuzi Biega NP Mt Kabobo Rwenzori NP Forest W. of L. Edward	Bururi FR	Echuya FR Mafuga FR Rusizi NR
Medium	Kasyoha–Kitomi FR Kibira NP Kibale NP Semuliki NP	Budongo FR Kalinzu–Maramagambo FR Lendu Plateau Queen Elizabeth NP Mahale NP Mbizi FR	Idjwi Gombe NP
Low		Kagombe FR Semliki WR Kyambura WR Bugoma FR Murchison Falls NP	Marungu Massif Bugungu WR Ibambaro FR Karuma WR Matiri FR Kitechura FR Itwara FR

Semliki, Rwenzori, Bwindi Impenetrable, Queen Elizabeth, and Kibale National Parks and Kasyoha–Kitomi and Kalinzu–Maramagambo Forest Reserves and Kigezi and Kyambura Wildlife Reserves in Uganda. This 'Greater Virunga landscape' covers about 13,190 km^2 and includes a wide variety of habitats and altitudes, ranging from 600 to 5100 m above sea level. It is also incredibly rich in total species as well as endemic and globally threatened species (Table 9, Plumptre et al., 2007) and is one of the most biodiverse sites in the world. There is nowhere else in Africa that can claim vertebrate species numbers close to those found here and detailed studies of sites in the neotropics certainly have fewer numbers than these (Gentry, 1990). Despite the large size of this landscape, there are species that still occur at low density so there is a need to manage it as a whole (Plumptre et al., 2007). However as all these protected areas are already linked, there is only a need to generate the political will to manage this landscape as one protected area across the international boundaries. The Lendu Plateau (Blue Mtns) to the north may also be an important addition to this landscape. It is the peripheral forests that may contain biological and genetic outliers due to their relatively longer term isolation.

Table 9 – Species richness and numbers of Albertine Rift (AR) endemic and globally threatened species for the Greater Virunga landscape

Taxon	Species richness	AR endemic species	Threatened species
Mammals	278	30	22
Birds	876	33	17
Reptiles	134	12	1
Amphibians	87	21	10
Fish	81	56	?
Plants	3552	262	46

Threatened status for freshwater fish species has not been assessed.

Other than this outstanding landscape the following five areas could be managed on a landscape scale:

1. Nyungwe–Kibira forests: these two existing protected areas are contiguous across the Rwanda–Burundi border and it is therefore relatively easy to think about management at the landscape scale. Species that may benefit from management at this scale include chimpanzees, leopards and golden cats *Felis aurata*.
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 gene flow in chimpanzee communities because few forests in this landscape contain more than 500 individuals. It will require developing corridors that would link some of the forest reserves, potentially by creating incentives for private landowners to manage forest instead of converting it to cultivation.
3. Maiko National Park highlands – Tayna Community Reserve – Kahuzi Biega National Park – 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 tenuous linkage between the upland and lowland sectors of Kahuzi Biega National Park. Species that would benefit from management at this landscape scale would be elephants and eastern gorillas. There is currently a programme attempting to create community reserves that would create the corridors to link these sites.
4. Mahale Mountains – Katavi–Ugalla: much wild land still exists to the east of Mahale Mountains National Park and down towards Katavi National Park. It may be possible to protect parts of this region to enlarge the park and link Mahale to other protected areas. Species that would benefit include elephants, chimpanzees, sable *Hippotragus niger*, roan *Hippotragus equinus* and African wild dogs *Lycaon pictus*.
5. Marungu Massif and up the western coast of Lake Tanganyika to Mount Kabobo. Neither of these sites are protected and little is known about them. These two sites probably cannot be linked in a larger landscape but the area around Marungu still appears to be relatively intact from satellite imagery (A. Plumptre pers. obs.). A recently (2005) acquired high resolution satellite image of Mt Kabobo by WWF shows that significant tracts of montane forest still exist. Both regions require surveys to assess the need for protected status and possible conservation of larger landscapes.

These six landscapes have been identified as core areas by the regional strategic framework plan that was developed for the Albertine Rift by conservation NGOs and government protected area institutions. These landscapes cover most of the natural habitat in the Albertine Rift and should be thought of more as political units to help plan for their management, rather than priorities per se. The priority sites in the Albertine Rift are those identified in Table 7.

Most assessments of this region have not considered the lakes within the Albertine Rift. Whether or not they are considered part of the Albertine Rift, together with Lake Malawi, they should have greater support from the conservation community because of their enormous wealth of biodiversity. Many of the African lakes are poorly known for their fish fauna and some studies in the early 20th century did not recognise the diversity of the cichlids at the time they were surveyed (Kaufman et al., 1996; Snoeks, 2000). It is likely many more species would be identified in Lakes George, Edward and Albert with further survey work. The number of endemic species for the Albertine Rift lakes is likely to be more than the sum of the species endemic to each lake, which already numbers 366 species.

This analysis focused on species and used species presence/absence to identify conservation priorities. It is possible that a focus on subspecies would generate a different result. We focused on species because there is better agreement on the taxonomy of species than subspecies and the results are likely to be more stable. Subspecies tend to be better described for mammals and birds than reptiles, amphibians and plants and it would be complex trying to do a cross taxa analysis at the subspecies level.

4.2. *Conclusions*

These results have highlighted the importance of the Albertine Rift within Africa and globally. They have been used to support the raising of the profile of the Albertine Rift within African conservation. Our data was used to support Conservation International's recent incorporation of the Albertine Rift within the Eastern Afromontane Hotspot in their re-assessment of global hotspots (Brooks et al., 2004; Plumptre, 2004). Natural habitat in this region is highly threatened because of the high density of people (up to 500–600 km^{-2}) living here

(Plumptre and Williamson, 2001). There is a need to focus more attention on the Albertine Rift to ensure that all the endemic and globally threatened species survive. Much of the Albertine Rift has still been poorly surveyed despite the wealth of data presented here, and it is probable that many more species will be discovered if we have the time and resources to invest in biodiversity surveys. Outside protected areas, natural habitat is being lost at a fairly rapid rate in the Albertine Rift (Plumptre et al., 2003) and unless we increase the speed and scale of conservation it is likely we will lose species before they are even discovered.

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REFERENCES

Ackery, P.A., Smith, C.R., 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. p. 803.

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.

Beadle, L.C., 1974. The Inland Waters of Tropical Africa. Longman, London.

BirdLife International, 2000. Threatened Birds of the World. Lynx Edicions and BirdLife International, Barcelona/Cambridge, UK.

Bober, S.O., Herremans, M., Louette, M., Kerbis Peterhans, J.C., Bates, J.M., 2001. Geographical and altitudinal distribution of birds endemic to the Albertine Rift. In: Proc. Pan-African Ornithological Congress, vol. 10. Ostrich 72, Supplement 1, pp. 189–196.

Brooks, T., Balmford, A., Burgess, N., Fjeldsa, J., Hansen, L.A., Moore, J., Rahbek, C., Williams, P., 2001. Towards a blueprint for conservation in Africa. BioScience 51, 613–624.

Brooks, T., Hoffmann, M., Burgess, N., Plumptre, A., Williams, S., Gereau, R.E., Mittermeier, R.A., Stuart, S., 2004. Eastern afromontane. In: Mittermeier, R.A., Robles-Gil, P., Hoffmann, M., Pilgrim, J.D., Brooks, T.M., Mittermeier, C.G., Lamoreux, J.L., Fonseca, G. (Eds.), Hotspots Revisited: Earth's Biologically Richest and Most Endangered Ecoregions, second ed., Cemex, Mexico, pp. 241–242.

Burgess, N., D'Amico Hales, J., Underwood, E., Dinerstein, E., Olson, D., Itoua, I., Schipper, J., Ricketts, T., Newman, K., 2004. Terrestrial Ecoregions of Africa and Madagascar: a continental assessment. Island Press, Washington DC. p. 550.

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). Journal of the East African Natural History Society (Special Supplement No. 8).

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

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

Congdon, T.C.E., Gardiner, A., Bampton, I., 2001. Some endemic butterflies of Kenya, Tanzania and Malawi, ABRI, Nairobi, p. 19.

Cornet d'Elzius, C., 1996. Ecologie, Structure et evolution des Populations des Grands Mammiferes du Secteur Central du Parc National des Virunga (Parc National Albert) Zaire (Congo Belge). 231 pp. Fondation pour Favoriser les Recherches Scientifiques en Afrique, Belgium.

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

d'Abrera, B., 1997. Butterflies of the Afrotropical Region. Part 1, revised edition. Lansdowne Press, Melbourne.

Davenport, T.R.B., 1996. The Butterflies of Uganda – An Annotated Checklist. Uganda Forest Department, Kampala, Uganda. p. 48.

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

Delvingt, W., 1978. Ecologie de l'hippopotame au Parc National des Virunga. Ph.D. Thesis, Fac. Sc. Agr. Gembloux, Belgium.

Demey, R., Herroelen, P., Pedersen, T., 2000. Additions and annotations to the avifauna of Congo-Kinshasa (ex Zaire). Bulletin of the British Ornithological Club 120, 154–172.

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. Tervuren, Belgium, 200 pp.
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., van de Weghe, J.P., undated. Les oiseaux de la foret de Nyungwe. Checklist published by the Project Conservation de la foret de Nyungwe.
Drewes, R.C., Vindum, J.V., 1994. Amphibians of the Impenetrable Forest, southwest Uganda. Journal of African Zoology 108, 55–70.
Drewes, R.C., 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., Vindum, J.V., O'Brien, J.P., 1992. Amphibians of the impenetrable forest, Uganda. Unpublished Report, California Academy of Sciences, San Francisco.
Eltringham, S.K., 1999. The Hippos. T & D Poyser, Academic Press, London.
Evans, M., 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. Ph.D. thesis, Franz Steiner Verlag, Stuttgart, 240 pp.
Friedmann, H., 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.
Gaugris, Y., Prigogine, A., 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., 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.
Groves, C.R., 2003. Drafting a Conservation Blueprint. Island Press, Washington.
Henning, S.F., 1988. The Charaxinae Butterflies of Africa. Aloe Books, Johannesburg, South Africa.
Herremans, M., Louette, M., Meirte, D., 2002. The importance of historical collections for in-situ conservation in Africa. Abstracts 23° International Ornithological Congress, Beijing.
Hilton-Taylor, C. (compiler), 2000. 2000 IUCN Red List of Threatened Species. IUCN, Gland, Switzerland. 61 pp.
Hinkel, H., Fischer, E., 1988. Reptiles et amphibians du Rwanda et leurs environnement. Johannes Gutenberg Universitat, Mainz, Germany.
Howard, P.C., Davenport, T.R.B., 1996. Biodiversity Reports: vols. 1–33. Uganda Forest Department, Kampala.
Hutterer, R., van der Straeten, E., Verheyen, W.N., 1987. A checklist of the shrews of Rwanda and biogeographical considerations of African soricidae. Bonn Zoologishe Beitrage 38, 155–172.
INECN, undated. Les oiseaux du Parc National de la Kibira. INECN, Bujumbura.
Kalina, J., 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., Chapman, C.A., 1996. The great lakes. In: McClanahan, T.R., Young, T.P. (Eds.), East African Ecosystems and their Conservation. Oxford University Press, Oxford, pp. 191–215.
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., 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., Austin, P.K., 1996. Small mammals along an elevational gradient in Rwenzori Mountains National Park, Uganda. In: Osmaston, H., Tukahirwa, J., Basalirwa, C., Nyakaana, J. (Eds.), The Rwenzori Mountains National Park, Uganda: Exploration, Environment and Biology. Proceedings of the Rwenzori Conference, Department of Geography, Makerere University, Uganda.
Kielland, J., 1990. Butterflies of Tanzania. Hill House, Melbourne/London.
Kingdon, J., 1971–1983. Mammals of East Africa. University of Chicago Press, Chicago.
Kunkel, I., Kunkel, P., 1969. Contribution à la connaissance de l'avifaune de la forêt du Rugege (Rwanda). Revue de Zoologie et de Botanique Africaines 79, 327–351.
Larsen, T.B., 1991. The Butterflies of Kenya. Oxford University Press, Oxford.
Laurent, R.F., 1964. Adaptive modifications in frogs of an isolated highland fauna in central Africa. Evolution 18, 458–467.
Laurent, R.F., 1972. Exploration du Parc National Albert: amphibians. Institut des Parcs Nationaux du Congo Belge, Bruxelles. 125 pp.
Lebrun, J.-P., 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.
Lock, J.M., 1977. The vegetation of Rwenzori National Park, Uganda. Botanische Jahrbücher für Systematik. Pflanzengeschichte und Pflanzengeographie 98, 372–448.
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., 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.
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 M.Sc. Thesis, Makerere University Institute for Environment and Natural Resources.
Olson, D.M., 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., 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., Makin, J., 1998. The state of biodiversity in Lake Tanganyika – A literature review. Natural Resources Institute, Chatham, UK.
Peace Corps and INECN, undated. The mammals of the Kibira National Park, Burundi. Checklist of species produced for ICCN.
Pitman, C., 1938. A Guide to the Snakes of Uganda. Wheldon & Wesley, Codicote.
Pitman, C.R.S., 1974. A Guide to the Snakes of Uganda, Revised Ed. Wheldon & Wesley, London. 290 pp.
Plumptre, A.J., 2004. Priority Sites for Conservation in the Albertine Rift and the Importance of Transboundary Collaboration to Preserve Landscapes. In: Harmon, D., Worboys, G.L. (Eds.), Managing Mountain Protected Areas:

Challenges and Responses for the 21st Century. Andromeda Editrice, Italy, pp. 233–238.
Plumptre, A.J., Williamson, E.A., 2001. Conservation-oriented research in the Virunga Region. In: Robbins, M.M., Sicotte, P., Stewart, K.J. (Eds.), Mountain Gorillas: Three Decades of Research at Karisoke. Cambridge University Press, Cambridge, pp. 361–389.
Plumptre, A.J., Masozera, M., Fashing, P.J., McNeilage, A., Ewango, C., Kaplin, B.A., Liengola, I., 2002. Biodiversity surveys of the Nyungwe forest Reserve in SW Rwanda. WCS Working Paper No. 19, 95 pp.
Plumptre, A.J., Behangana, M., Davenport, T.R.B., Kahindo, C., Kityo, R., Ndomba, E., Nkuutu, D., Owiunji, I., Ssegawa, P., Eilu, G., 2003. The Biodiversity of the Albertine Rift. Albertine Rift Technical Reports No. 3, p. 105. Available from: <www.albertinerift.org\arift-publications>.
Plumptre, A.J., Kujirakwinja, D., Treves, A., Owiunji, I., Rainer, H., 2007. Transboundary Conservation in the Greater Virunga Landscape: its importance for Landscape Species. Biological Conservation 134, 279–287.
Poulsen, A.D., 1997. Plant diversity in forests of western Uganda and eastern Zaire (preliminary results). AArhus University reports No. 36. University of Copenhagen, 76 pp.
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. Tervuren, Belgium, 117 pp.
Prigogine, A., 1960. La faune ornithologique du Massif du Mont Kabobo. Annales du Musee Royal de l'Afrique Centrale. Sciences Zoologiques No. 85. Tervuren, Belgium, 46 pp.
Prigogine, A., 1967. La faune ornithologique de l'île Idjwi. Revue de Zoologie et de Botanique Africaines 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. BirdLife International, Cambridge, pp. 277–295.
Robyns, W., 1948–1955. Flore des Spermatophytes du Parc National Albert: vols. 1–3. Institut des Parcs Nationaux du Congo Belge, Bruxelles.
Sanderson, E.W., Redford, K.H., Vedder, A., Coppolillo, P.B., Ward, S.E., 2002. A conceptual model for conservation planning based on landscape species requirements. Landscape and Urban Planning 58, 41–56.
Schiøtz, 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). Review Zoology and Botany Africa 62, 158–174. and 322–371.
Schouteden, H., 1966. La faune ornithologique du Burundi. Musee Royal de l'Afrique Centrale. Documentation zoologique No. 11. Tervuren, Belgium, 81 pp.
Snoeks, J., 2000. How well known is the icthyodiversity of the large East African Lakes. In: Rossiter, A., Kawanabe, H. (Eds.), Ancient lakes: Biodiversity Ecology and Evolution, Advances in Ecological Research, 31. Academic Press, New York, pp. 17–38.
Spawls, S., Howell, K., Drewes, R., Ashe, J., 2002. A field guide to the reptiles of East Africa. Academic Press, London.
Stanford, C., Msuya, P., 1995. An annotated list of the birds of Gombe National Park, Tanzania. Scopus 19, 38–46.
Stattersfield, A.J., Crosby, M.J., Long, A.J., Wege, D.C., 1998. Endemic Bird Areas of the World: priorities for biodiversity conservationBirdLife International Conservation series No. 7. BirdLife International, Cambridge.
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.
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., 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.
van der Straeten, E., Kerbis Peterhans, J.C., 1999. *Praomys degraaffi*, a new species of Muridae (Mammalia) from central Africa. South African Journal of Zoology 34, 80–90.
van de Weghe, J.P., Loiselle, B.A., 1987. The bird fauna of Bururi Forest, Burundi. Le Gerfaut 77, 147–164.
Verheyen, R., 1947. Exploration du Parc National Albert: oiseaux. Institut des Parcs Nationaux du Congo Belge, Bruxelles. 87 pp.
Vollesen, K., Bidgood, S., 1996. Kew expedition to Tanzania: January–May 1994. Unpublished report, 45 pp.
Vollesen, K., Bidgood, S., 1999. Kew expedition to Tanzani: April–May 1997. Unpublished report, 57 pp.
Vonesh, J.R., 1998. The amphibians and reptiles of Kibale Forest, Uganda: herpetofaunal survey and ecological study of the forest floor litter community. Unpublished M.Sc. thesis, University of Florida.
Weber, W., 1989. Conservation and Development on Zaire–Nile Divide. An analysis of value conflicts and convergence in the management of afromontane forests in Rwanda. Ph.D. Thesis, University of Wisconsin, Madison.
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., 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.