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USING BIODIVERSITY DATA TO REVIEW COVERAGE OF UGANDA'S PROTECTED AREAS

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ABSTRACT

This paper seeks to demonstrate the usefulness of the data held at the National Biodiversity Data Bank (NBDB) situated at Makerere University Institute of Environment and Natural Resources (MUIENR). We assess its value as a potential planning tool, based on the growing evidence that Uganda aspires to a robust Protected Area system that encompasses protection of biodiversity at the genetic, species and ecosystem levels. Analyses are presented of the coverage of 21 major vegetation types, and of species of birds and mammals. Several important vegetation types are inadequately conserved, whilst coverage of some categories of birds is also incomplete. The situation seems to be worse for mammals, although this is harder to assess because the distributions of many species are poorly known.

INTRODUCTION

In recent years, the term 'Protected Area' (PA) has come to embrace a wide variety of land use types, from those which are strict Nature Reserves, to others intended to meet broader needs, including those of local communities (McNeely, 1994). Countries such as Uganda, which have signed the Convention on Biological Diversity, are required to develop national conservation strategies. Inevitably, PAs will have a key role in this effort. In Uganda, the major PAs are National Parks, Wildlife Reserves and Forest Reserves (figure 1). The first two are administered by the Uganda Wildlife Authority (UWA), the last by the Forestry Department (FD). Two other categories, in practice largely notional, are Controlled Hunting Areas, and Wildlife Sanctuaries, also managed by the UWA (table 1). During the 1990s, both the FD and the UWA have undertaken detailed reviews of their estates. The FD collected extensive new data (FNCMP, 1999), whereas the UWA relied mainly upon existing data, including a draft of this article (Lamprey *et al.*, 1998). Biodiversity data for the UWA estate remain very incomplete.

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In developing a robust PA system, research (including the sorts of analyses discussed here) has a major part to play. Earlier work on Uganda's PAs had already demonstrated, for

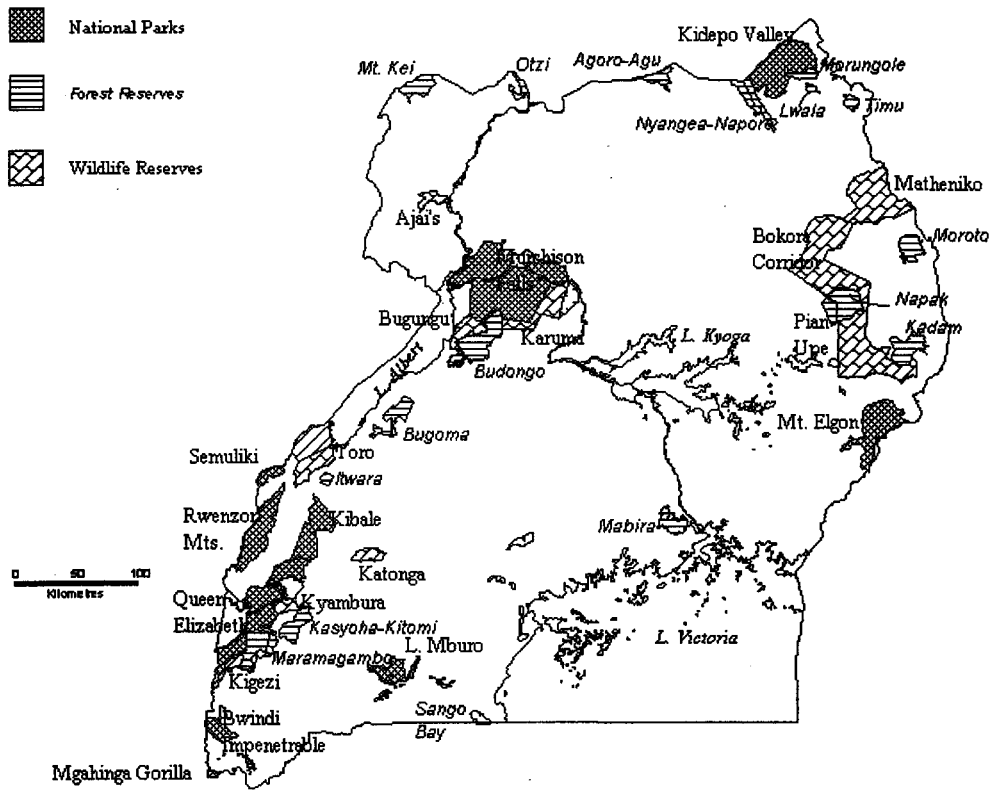

Figure 1. The major Protected Areas of Uganda showing the UWA estate and the Forest Reserves used in the analysis.

example, that species richness in a PA reflects the number of ecosystems that it contains, and the effectiveness of a forest in supporting species of forest-specialist birds depends upon its size (Pomeroy, 1995). Such results are unsurprising, but until recently they were not readily accessible to PA managers, and often lacked clear recommendations (Harmon, 1994; Alexander, 1995). These are amongst the reasons why PA managers worldwide have been slow to adopt research results in conservation planning (Prendergast *et al.*, 1999).

A range of categories of PAs is recognised by IUCN (McNeely, 1994). The highest category is Nature Reserve, which in Uganda is currently found only within some Forest Reserves. At present, Uganda has ten National Parks, ten Wildlife Reserves, and more than seven hundred Forest Reserves, which range in size from a few hectares to over 100,000 hectares (FNCMP, 1999). There are 15 Controlled Hunting Areas (Lamprey *et al.*, 1998). The PA system in Uganda, as in many African countries, originated largely to provide areas for hunting and for timber exploitation. So the fact that a reasonable proportion of Uganda's ecosystems and species are today found in Protected Areas is largely fortuitous. This is why it is now desirable to review the PA system and to plan for coverage to be as complete as

possible for all elements of biodiversity. Such reviews require information that can only come from research.

Some species are widely distributed whereas many others have very limited distributions: for example, there are two species of plant whose total world distribution, so far as is known, is Tororo Rock in eastern Uganda—an unprotected area of less than 10 ha (Okullo, 1997). Although these small distributions are easily missed in countrywide analyses, they must not be forgotten as we look for patterns.

Table 1. Categories of Protected Areas in Uganda, totalling about 60,000 km^2. (Note that a few FRs overlap with UWA areas, for example in the Maramagambo Forest).

Category	Authority[a] responsible	Total area in Uganda (km^2)	Level of protection[b]
National Park (NP)	UWA	11,680	generally good
Forest Reserve (FR)	FD	8,700	variable, generally good in larger reserves
Wildlife Reserve[c] (WR)	UWA	8,630	variable
Controlled Hunting Area[d] (CHA)	UWA	30,700[d]	variable, often slight
Wildlife Sanctuary (WS)	UWA	810	usually negligible

[a] UWA=Uganda Wildlife authority, formed from the Game Department and National Parks in 1995-1996; FD=Forest Department
[b] Obviously there can be different opinions on this: those offered here are widespread
[c] Formerly Game Reserves; both WRs and CHAs are currently undergoing re-evaluation
[d] Lamprey *et al.*, 1998: some overlap with FRs

An ideal Protected Area system would include substantial and representative areas of all the main vegetation types native to the country, and viable populations of all the native plant and animal species. Of course, ideals are hard to achieve, but they can provide guidance as to the directions in which to aim. At a later stage, as more data become available, we plan to examine the coverage of various taxa by Uganda's Protected Area system as a whole. However, at present we restrict ourselves to the following, for which there are adequate data:

- vegetation types in Uganda's PAs, especially National Parks and Forest Reserves; and
- birds and mammals of National Parks.

METHODS

An earlier review of Uganda's PA system (Pomeroy, 1995) had depended on simple manual analyses. The electronic data used for the analyses in this paper are stored in the National Biodiversity Data Bank (NBDB) at the Makerere University Institute Environment and Natural Resources (MUIENR). This is described elsewhere (Reynolds *et al.*, 1999).

It must be stressed that in this analysis, while considerable care and effort have been put in calculating various areas covered by the different PAs, discrepancies, such as with other figures cited elsewhere, still occur. This is mainly because some PA boundaries have been changed and some remain undefined, as well as the scales at which various layers have been digitised. However we feel that this is the first step toward such analyses.

Vegetation

The classification of natural and semi-natural vegetation by Langdale-Brown *et al.* (1964) recognises 22 major categories designated by letters (A, B, C, ...)(appendix 2), and reflects major climatic and physiognomic groups. These are sub-divided into more than 80 types, distinguished mainly by their various dominant plant species. We have used only the major categories, as listed in appendix 2. The Langdale-Brown map includes many mixtures. We have treated these by identifying in each case the dominant type, as indicated on the map by the appropriate colours.

In assessing the extent to which Uganda's present National Parks (NPs) and Forest Reserves (FRs) provide adequate coverage of the major vegetation types, we have taken an arbitrary total area of 300 km^2 in NPs and FRs as a measure of adequacy, comprising at least two separate blocks of 100 km^2 or more each.

Birds and Mammals

Data for birds and mammals were compiled by MUIENR and published in 1995 by the Uganda National Parks (a precursor of the UWA). For birds, a recently-published Red Data List (Bennun & Njoroge, 1996) indicates species at risk in the East African Region, which includes Uganda.

As recommended in the Global Conservation Strategy (1992), we have considered that the PA system supports individual species adequately if they occur in at least two separate parks. This criterion is weaker than stipulating two viable populations, but in Uganda such data are rarely available.

RESULTS

Coverage of Vegetation Types by Protected Areas

The electronically-stored information in the NBDB can be interrogated in many ways. For example, it is possible to calculate the total areas of the 21 major vegetation types recorded by Langdale-Brown *et al.* (1964) and to see how much of each is found within National Parks and other Protected Areas. Appendix 1 shows the total areas of each vegetation category in National Parks (NPs), as well as in the total UWA estate and in Forest Reserves (FRs). The 700 or so Forest Reserves within the Forestry Department's estate used to span an area of 15,950 km^2 (FNCMP, 1999), before some 2,500 km^2 were transferred to the management of the Uganda Wildlife Authority as National Parks. However, a good number of the FRs, most especially the smaller ones and those of little commercial value, exist only on paper, so to consider them as protective of natural vegetation would be unrealistic. In this analysis, we have used 63 of the large Forest Reserves (covering about 8,700 km^2) for which data were available in digital format from Forestry Department by then. In Uganda, a number of Forest Reserves partially overlap or are wholly within National Parks. Our analysis, as shown in appendix 1, takes this into account.

The flora of Controlled Hunting Areas (CHAs) in Uganda are not accorded any legal level of protection, so the natural vegetation in these categories would not be considered as protected. As a result, the percentage figures in columns 11 and 13 of appendix 1 show both percentages of the respective vegetation types protected by UWA as a whole and what is protected excluding the CHAs. Currently, UWA is revising the extents and protection status of this category of PAs, and its hoped that those that protect unique vegetation types will be accorded some higher level of protection.

With the exception of two very widespread vegetation categories (N and W), all PAs containing more than 100 km^2 of a particular vegetation category are listed individually in appendix 2.

In table 2 we summarise the coverage in terms of arbitrary categories of adequacy. Despite the subjective nature of this procedure, it does enable us to identify those vegetation categories which, under present management practices, seem not to be vulnerable. Others, with less than 300 km^2 in NPs and/or FRs (or, if they exceed 300 km^2, with only one block exceeding 100 km^2) are obviously at greater risk.

Table 2. A preliminary assessment of the conservation status of the main vegetation types in Uganda (A to Y) as defined by Langdale-Brown et al. *(1964).*

Area within present National Parks and Forest Reserves[a] (km^2)		Total area of each vegetation type in Uganda[b]	
		<1000 km^2	>1000 km^2
Area in NPs + FRs >300	at least two blocks of >100 each	A	B C D G[c] K N P Q W
		NOT VULNERABLE AT PRESENT	
	only one block >100	-	H L V X F R
			VULNERABLE
Area in NPs + FRs<300	total PA area >300	S	J M T
		SERIOUSLY ENDANGERED	*ENDANGERED*
	total PA area <300	Y	
		CRITICAL	-

[a] *These are assumed to be the two best-protected categories of PA*

[b] *In many cases, the actual areas will be much less, as more land is converted to agriculture and other uses.*

[c] *Although only 83 km^2 in the appendix, part of the area is both National Park and Forest Reserve.*

Of greatest concern from this analysis is swamp forest, category Y, whose only significant block is amongst the group of forests collectively known as the Sango Bay Forest Reserves. They have several unique features (Davenport & Howard, 1996; Katende & Pomeroy, 1997). If, for example, the Kagera River were to be dammed, thus affecting the hydrology of the plains on which the forests lie, their nature could be changed for ever. Further, the contiguous Minziro Forest in Tanzania is being heavily felled (D. Moyer, pers. comm.), which puts more pressure on the Sango Bay forests whilst also increasing their importance.

Although less clear from this analysis, because Langdale-Brown *et al.* (1964) only mapped the major ones, both permanent and seasonal wetlands are also at risk. Many reports have stressed their inadequate representation within Uganda's PA system (see, for example Ministry of Natural Resources, 1995; Omoding *et al.*, 1996).

Coverage of Mammals and Birds by National Parks

Of the 335 species of mammals recorded from Uganda (Gathua & Vanden Berghe, 1993; Davies & Vanden Berghe, 1994), only 58% have so far been recorded within the National Park system (UNP, 1995; figure 2). Whilst many of those missing from the park lists are simply poorly known, a number of larger species are also missing, including two duikers, several squirrels, a jackal and two species of hyrax. Very few species are widespread, only

four occurring in seven parks, and none in eight or more. Using the two-park criterion as a measure of adequacy, only about 40% of Uganda's native mammal species are adequately conserved within National Parks.

Birds are much more widespread, with ten of Uganda's 1010 species known from all 10 parks (figure 3). Nevertheless, there are as many as 70 species (6.9%) that have not been recorded in a single park, and only about 70% of the species are known from two or more parks. The coverage of the more specialised species is of particular concern. The forest specialists are virtually all residents, and nearly a third of them are recorded from less than two parks. Fortunately, almost all of these occur in Forest Reserves. Most waterbirds are more mobile, and some of the larger species, such as flamingos and White Pelicans, *Pelecanus onocrotalus,* are present at times in thousands. Although species such as these do not breed in Uganda, wetlands are important feeding areas for them, and are thus necessary for their survival.

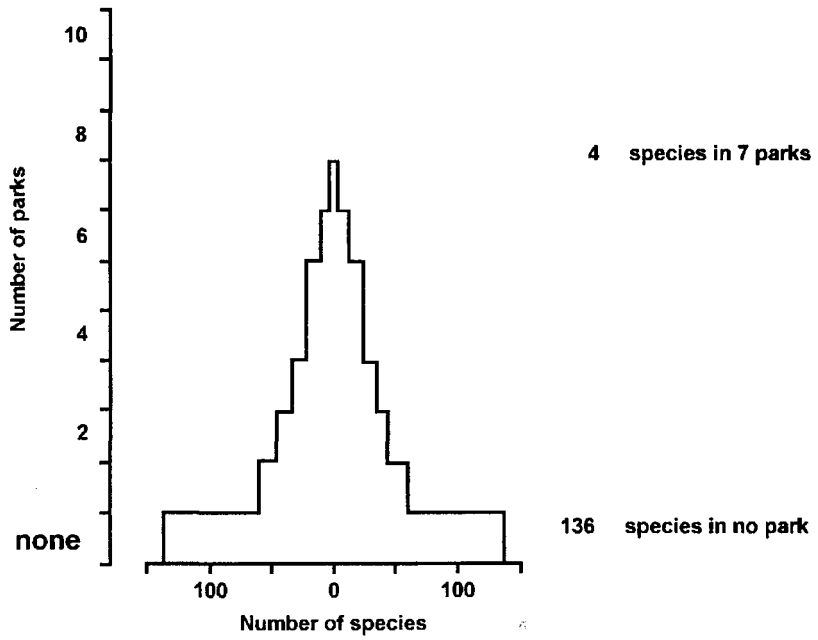

Figure 2. The numbers of mammal species occurring in different numbers of National Parks in Uganda. Based on UNP (1995).

Coverage of Threatened Birds by National Parks

Uganda supports a number of globally threatened species of plants and animals. For birds, the regional Red Data List enables a more detailed analysis to be made (table 3). The global categories of *critical*, *threatened*, and *near-threatened*, have been applied to the region (Bennun and Njoroge, 1996). There is an additional category for species for which the East African region has special responsibility. These are birds that have at least 90% of their global range within the East African region (which for this purpose includes Rwanda and Burundi, as well as Kenya, Uganda and Tanzania). Three East African habitats have a number of species endemic to them. Such species are automatically included, however

Table 3. Numbers of threatened bird species in Uganda, with their representation within the National Parks (from UNP 1995 and Bennun and Njoroge, 1996). See also Table 5.

Category	National parks											
	Mgahinga Gorilla (MG)	Bwindi Impenetrable (BI)	Rwenzori Mountain (RM)	Queen Elizabeth (QE)	Semuliki (Se)	Kibale (Ki)	Lake Mburu (LM)	Murchison Falls (MF)	Kidepo Valley (KV)	Mount Elgon (ME)	Not in any park	Uganda Total[a]
GLOBALLY-LISTED												
Vulnerable	1	4	1	5	0	0	1	1	3	1	3	12
Near-threatened	1	4	1	5	5	1	3	5	2	1	1	12
Restricted range	13	22	13	1	4	4	0	0	0	3	0	28
Globally-listed total[b]	**15**	**30**	**15**	**11**	**9**	**5**	**4**	**6**	**5**	**5**	**4**	**43[c]**
REGIONALLY LISTED												
Critical	0	0	0	0	0	0	0	0	0	0	1	1
Endangered	2	8	2	5	4	2	2	3	4	2	2	11
Vulnerable	1	17	4	25	19	18	12	17	14	13	5	52
Near-threatened	3	19	8	33	17	15	15	25	22	17	6	69
Regional responsibility	17	35	25	19	10	16	16	11	17	24	6	74
Regionally-listed total[b]	**23**	**79**	**39**	**82**	**50**	**51**	**45**	**56**	**57**	**56**	**20**	**187**

[a] This is the total number of species in this category recorded in Uganda; it is not the total across the table, because some species occur in more than one Park.

[b] These are not numbers of species, since one species can occur in two categories, e.g. Near-threatened and Restricted Range.

[c] Includes one Data Deficient species.

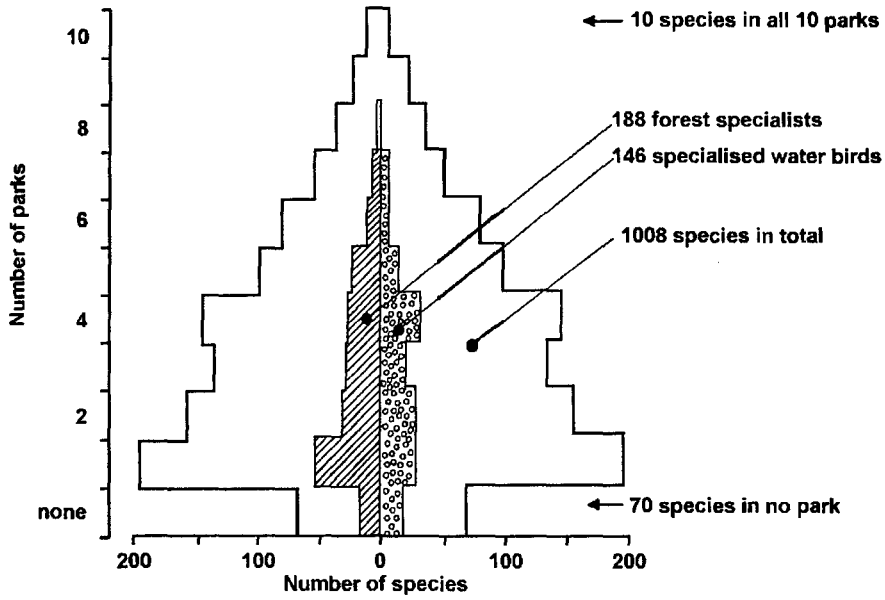

Figure 3. The numbers of bird species occurring in different numbers of National Parks in Uganda. Based on UNP (1995).

common they may be. These habitats are the coastal forests, the Albertine Rift forests and papyrus swamps. Their inclusion is justified because the major representation of each of them is within the region (as is the whole of the Eastern Arc range of forests in Tanzania).

Of all the species of birds listed for Uganda, about 90% are found within at least one park (table 3). The large numbers of Albertine Rift endemics, some of which are very restricted or rare, account for the high totals of globally-listed species in the three forested parks in the south-west of Uganda. Almost all parks hold important numbers of regionally listed species, with Queen Elizabeth National Park heading the list. Forest birds, most of which have restricted distributions (Bennun *et al.*, 1996), are also well-represented in Uganda's PAs.

Broader perspectives

There are many ways of assessing the conservation value of a PA. Using data for both birds and mammals, figure 4 illustrates this for various conservation values. Bwindi Impenetrable is especially important for Albertine Rift endemic birds, Kidepo Valley for birds and mammals found in no other park, Semuliki for forest specialist birds, and so on. Parks with a low 'score' in figure 4 are often important for other groups: Golden Monkeys *Cercopithecus mitis kandti* and Mountain Gorillas *Gorilla g. berengei* in Mgahinga Gorilla National Park, for example.

Thirty-five of the 45 nationally-listed species of threatened woody plants in Uganda occur in at least one National Park or Forest Reserve (Okullo, 1997); some of these species are also globally-listed (Oldfield *et al.*, 1998).

The regional Red Data List for birds (Bennun and Njoroge, 1996) helps to put Uganda's conservation needs into a wider view. There are also, of course, global Red Data lists for many taxonomic groups, but consideration of those is beyond the scope of this paper. However, it is practicable to assess Uganda's importance in terms of global 'ecofloristic

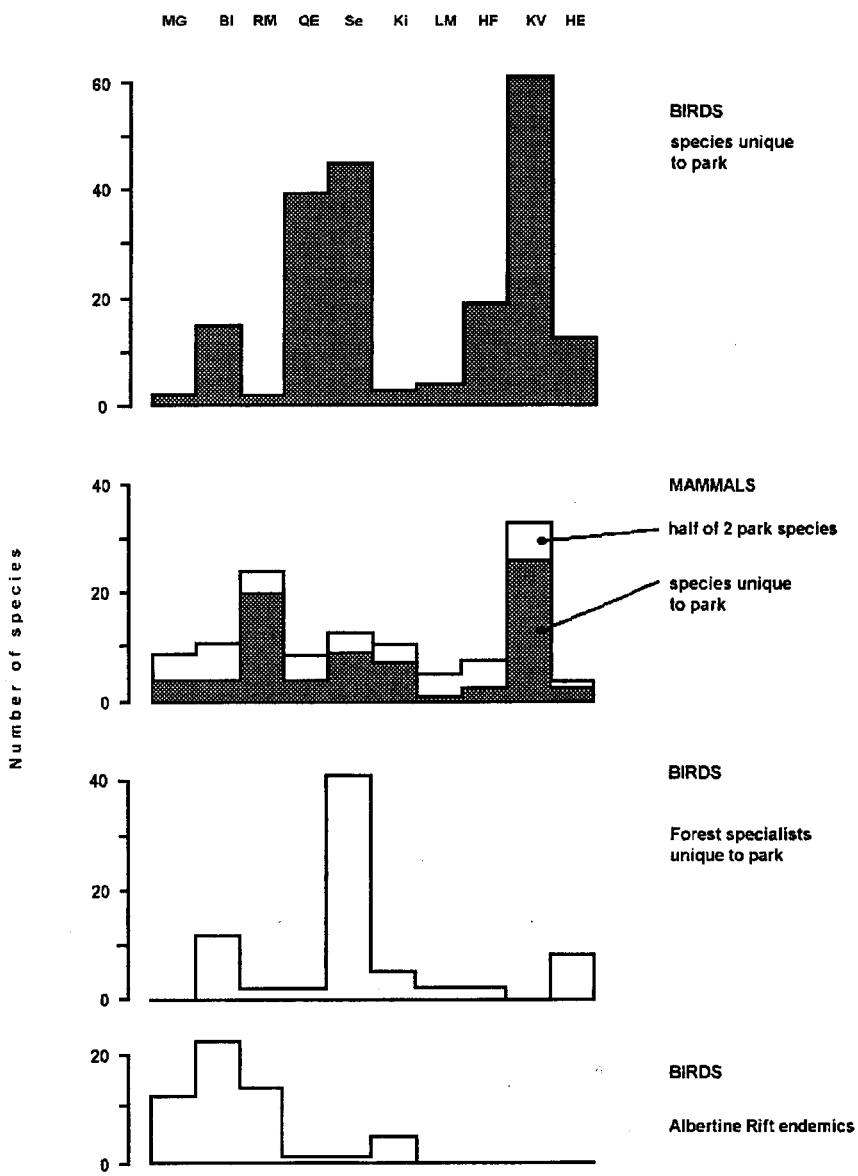

Figure 4. The relative conservation values of Uganda's National Parks, according to four different criteria. Data mainly from UNP (1995); forest birds according to the 'FF' category of Bennun et al., *1996. For mammals, species restricted to either one or two parks are both included, the latter figure being halved to maintain the same scale. Abbreviations of Park names as in Table 3.*

zones'. These are mapped and analysed by Green *et al.* (1996), who show that nine of the zones occur in Uganda. Two can be ignored, as only very small parts of them are found within the country, and three others, mainly in the Rwenzoris and Mt Elgon, are considered to be well-protected already. For the remaining four (table 4), three are rated as of high global priority for conservation and one is placed in the highest category of all. These

assessments are based on the fact that a significant proportion of these four zones occurs within Uganda and, in the case of Transition forest, that the area currently conserved is inadequate globally, so that the PAs in this category in Uganda gain extra significance.

DISCUSSION

Conservation of ecosystems

Based upon the data presented in this paper, Uganda's Protected Area system provides quite good coverage for the various vegetation types, as well as for birds and mammals. However, there are some clear gaps. Further, the data themselves have many more gaps than one would wish; this is likely to affect complementarity analyses of the type used by the FNCMP (1999), which assumes, tacitly, that all species are recorded. In reality, it is probable that only 60-80% are recorded (E. Kabesiime, T. Otim and D. Pomeroy, unpubl. data). Finally, but importantly, some PAs are less well protected than others.

The analyses used by the FD and UWA used the full set of 80 Langdale-Brown categories and they defined minimum areas as 50 km^2 (FNCMP, 1999, page 40) and 100 km^2 (Lamprey *et al.*, 1998, page 22) respectively. But even in the thoroughly-researched UK, 'large-scale habitats' such as woodland, farmland and grass/heath are useful in reaching important conservation conclusions (Gregory and Baillie, 1998). So the discussion here is limited to the use of the letter-grade categories of our analyses.

Table 4. Major African habitats, according to Green et al. *(1996), which are high priorities for conservation action in Uganda.*

Ecofloristic zone[a]	Global priority for conservation action	PAs in Uganda with at least 100 km^2 of the zone
11 Sudanian woodland, dry evergreen forest and savannah	High	Murchison Falls NP
39 Transition forest, 1,000-1,800 m	Highest	Kibale NP, Budongo, Mabira, Sango Bay and Kasyoha-Kitomi FRs
43 Transition woodland and forest, 1,000-2,000 m	High	Kidepo Valley NP, Bokora Corridor and Pian Upe WRs and North Karamoja CHA
51 Scrub forest, semi-evergreen thicket	High	Lake Mburo NP

[a]based upon a global system, as adopted by FAO: details in Green *et al.* (1996)

The vegetation types defined by Langdale-Brown *et al.* (1964) can be broadly equated with ecosystems. Many of the 22 main categories are well-represented within National Parks and Forest Reserves, where they receive a reasonable level of protection (table 2; appendix 1; FNCMP, 1999). Of those whose coverage already appears inadequate, the two of greatest concern are S (Grass steppe) and Y (Swamp forest). Category S could be included in a revised PA system for Karamoja (Pomeroy and Tushabe, 1996; Lamprey *et al.*, 1998), which would also improve the coverage of category T, which is also inadequate at present.

The case for swamp forest, category Y, is more complex. Close collaboration with Tanzania, where a similar type is found in Minziro forest, would appear to be the best policy.

Two other vegetation categories could be considered as threatened (table 2). Moist *Acacia* savannah (J) is remarkably rich for birds (T. Otim and D. Pomeroy, unpubl. data) and possibly other groups. An upgrading of part of the Katonga CHA would seem to be the best prospect here. Type M, palm savannah, occurs in both Murchison Falls and Kidepo Valley National Parks, but in both cases is subject to the depredations of fire (and, in the past, elephants *Loxodonta africana*) and needs careful management.

Global analyses of vegetation conservation (such as that by Green *et al.*, 1996) coincide to some extent with the analyses for Uganda given here. To assess the extent to which Uganda is meeting its global responsibilities detailed reviews are needed. These should become possible in the next few years.

Conservation of species

Analysis for coverage by species is only possible for birds in National Parks, where the data are comparatively complete at a presence-or-absence level, and to a lesser extent for mammals. At least for the more serious threat categories, the few species of birds that are not found within any National Park are unlikely to be helped by additions to the park system (table 5).

Many species of birds and mammals are recorded from only one park or none at all (figures 2, 3). There is no satisfactory way of defining an acceptable minimum number of sites, since the way in which metapopulations function varies between taxa, but in any case is poorly known (Harrison, 1993). In the future, many of these species are likely to be found in other PAs, although not necessarily in viable numbers. But doubts must remain until more information is available. Perhaps wisely, most practical conservationists are wary of putting minimum numbers on ecosystems, or individuals (Groombridge and Jenkins, 1996).

One would of course like to know, not simply that a species is represented in two or more secure reserves, but that it has viable populations in each of them. Similarly, adequate representation of vegetation types depends amongst other things on deciding what is meant by adequate. Our criteria are somewhat different from those of WCMC (Green *et al.*, 1996). There is obviously a need for closer collaboration with other countries, with whom some responsibilities may be shared. For example, the Maccoa Duck and the Cape Grass Owl, rarely recorded in Uganda (table 5) can be better conserved in neighbouring Kenya and Tanzania where they are more common (Britton, 1980).

Uganda's Protected Areas as a system

Uganda has three major groups of PAs, which include a number of National Parks (figure 1):

- East — KidepoValley National Park to Mount Elgon National Park, possibly with some new gazettments;
- South-west — Mgahinga Gorilla National Park via Queen Elizabeth to Rwenzori Mountains, Kibale and Semuliki National Parks. Some of these, such as Mgahinga Gorilla, Rwenzori Mountains and Queen Elizabeth National Parks are contiguous with other large parks in the Democratic Republic of Congo and in Rwanda.
- West — The Murchison group, including the important Budongo Forest Reserve.

Table 5. Bird species in the highest IUCN threat categories which are not represented in any of Uganda's National Parks

		Categories		Distribution and Status		PAs where present in Uganda
		Global	Regional	Global	Regional	
Great Crested Grebe	*Podiceps nigricollis*	-	CR	Widespread	Declining rapidly	None
Maccoa Duck	*Oxyura maccoa*	-	EN	East and South Africa	Kenya, Tanzania, local	[No record since 1930]
Taita Falcon	*Falco fasciinucha*	VU	VU	Local in East and South Africa	Scarce, few localities	None[a]
Corncrake	*Crex crex*	VU	VU	Breeds Palearctic	Widespread, rare	None
Lesser Spotted Crake	*Porzana pusilla*	-	VU	E and S Africa	Local, rare	None
Cape Grass Owl	*Tyto capensis*	-	VU	Local in E and S Africa	Local in highlands	None
Turner's Eremomela	*Eremomela turneri*	VU	EN/RR	East Africa	Very local	Nyondo FR
Heuglin's Masked Weaver	*Ploceus heuglin*	-	VU	Eastern DRC[b] to Kenya	Local in Uganda, very rare in Kenya	None recorded

[a] This species has been recorded breeding near Sipi Falls, some 3 km from Mt. Elgon NP; but there is evidence of a recent decline (K. Otte, pers. comm.).
[b] Democratic Republic of Congo

Long-term planning might aim to consolidate these groups of National Parks with adjacent WRs and FRs; data analysis could be designed to test the effectiveness of such a system. We would then be in a much better position to assess how much of the country's biodiversity is conserved through the Protected Area system. With more data, and an increasing capacity in MUIENR to undertake GIS analyses, it will become possible to employ a more extensive gap analysis (Scott *et al.*, 1992) and further improve the design of the Protected Area system for the country.

CONCLUSIONS

The use of electronic databases

- The examples given in this article and by Reynolds *et al.* (1999) are sufficient to show the potential of electronic databases in planning conservation strategies. Establishment of the databases, coupled with well-planned field work, can go a long way towards providing a ready source of information on the status of a particular resource, whether it is within a Protected Area or not.
- Attempts to produce more sophisticated analyses for Uganda have been hampered by the lack of earlier environmental data. Even where such data are available, they are often in formats unsuited to the objectives of setting up a database for conservation planning.

Nevertheless, we hope to have demonstrated that methods already exist for preliminary assessments of the extent to which biodiversity is being conserved by some of Uganda's Protected Areas.

Conservation of ecosystems and species

- The present coverage of terrestrial ecosystems is inadequate, according to analyses of the classification of both Langdale-Brown *et al.* (1964) and Green *et al.* (1996). However, possible strategies exist to conserve all of the less-well-represented categories.
- Wetlands are seriously under-represented, and plans to address this require vigorous action (Ministry of Natural Resources, 1995; Omoding, 1996).
- Consolidating scattered PAs into groups would provide better insurance and larger areas of key habitats, notably wetlands and forests, would be linked.
- The still extensive gaps in the data can only be filled by well-co-ordinated research.

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Appendix 1: Approximate coverage of vegetation types by Uganda's PA system. Columns 2-10 show the areas of each Langdale-Brown category (in km^2) in Uganda as a whole and in various categories of PA. Where an area is jointly administered, (eg Maramagambo FR, which is partly a Forest Reserve overlapping a National Park), this is indicated by Column 9. Column 6 is the result of the difference between Columns 3 and 5; and Column 7 of 6 and 9. Column 10 includes areas in Column 9.

1	2	3	4	5	6	7	8	9	10	11	12	13
Category[1]	Total	In UWA (all)[2]	In UWA excl. FRs[3]	In CHAs	In UWA excl. CHAs	UWA excl. CHAs & FRs	In NPs	FRs in UWA[4]	Total in FD	% Protected		
										By UWA (excl. CHAs & FRs)	By FD	By UWA (incl. CHAs
A	683	674	662	13	661	655	661	6	6	96	1	99
B	3095	2600	1800	1028	1572	787	1476	785	886	25	29	84
C	3235	469	435	0	469	435	455	34	491	13	15	14
D	5279	831	455	26	805	430	606	375	1903	8	36	16
F	24614	626	573	204	422	369	281	53	418	1	2	3
G	2599	1007	740	588	419	294	113	125	200	11	8	39
H	4189	1558	1558	250	1308	1308	885	0	50	31	1	37
J	6232	677	671	474	203	197	180	7	70	3	1	11
K	15089	1250	1148	515	735	679	566	55	346	5	2	8
L	25874	3073	2431	2606	467	-58	0	525	677	0	3	12
M	2664	647	632	511	136	121	83	15	15	5	1	24
N	38020	11502	9792	8977	2525	243	1308	2282	2275	1	6	30
P	14424	1435	1315	813	622	502	418	120	198	3	1	10
Q	13895	4371	4292	456	3915	3549	2566	365	262	26	2	31
R	1580	1580	1513	1147	433	366	278	68	68	23	4	100
S	801	801	801	332	469	469	0	0	0	59	0	100
T	4277	4239	3986	3548	691	448	181	243	243	10	6	99
V	4615	3398	3537	2392	1006	986	336	20	26	21	1	74
W	18825	7763	7591	5133	2630	2423	160	207	232	13	1	41
X	8626	677	681	229	448	448	374	1	90	5	1	8
Y	260	34	23	0	34	23	32	11	101	9	39	13
Z	6924	334	383	158	176	173	25	2	52	3	1	5
Open Water	*35844*	*200*	*201*	*51*	*149*	*149*	*116*	*0*	*17*	*0*	*0*	*1*
Totals	241645	49747	45221	29451	20296	14998	11102	5298	8625			

[1]See Appendix 2 for details

[2]Includes area of Forest Reserves contained partially or wholly within NP boundaries.

[3]Excludes area of Forest Reserves (FRs) contained partially or wholly within Uganda Wildlife Authority (UWA) boundaries.

[4]Areas of Forest Reserves which overlap with UWA categories.

Appendix 2: The different vegetation categories according to Langdale-Brown et al. *(1964) within Uganda's current PAs.*

Vegetation Category		NPs with >100 km^2	Other UWA designations with >100 km^2	FRs with >100 km^2
A	High altitude heath and moorland	ME, RM	-	-
B	High altitude forest	BI, ME, RM	N.Karamoja, Sebei, S.Karamoja CHAs	Kadam, Moroto, Napak, Timu
C	Medium altitude moist evergreen forest	BI, KF	Katonga CHA	Kalinzu, Kasyoha-Kitomi
D	Medium altitude moist semi-deciduous forest	KF, QE, Se	Kigezi WR	Budongo, Bugoma, Mabira, Maramagambo
F	Forest/savannah mosaic	KF	Karuma WR, Katonga CHA	-
G	Moist thicket	QE	N.Karamoja, S.Karamoja CHAs, Otzi Forest WS	Otzi
H	Woodland	MF	E.Madi CHA, Karuma WR	-
J	Moist *Acacia* savannah	-	Katonga CHA	-
K	Moist *Combretum* savannha	MF	E.Madi, Karuma Falls CHAs, Karuma WR	Budongo
L	*Butryospermum* savannah	-	E.Madi, Lipan, N.Karamoja, N.Teso CHAs, Mt.Kei WS	Mt.Kei
M	Palm savannah	-	Semuliki CHA	-
N	Dry *Combretum* savannah	KV, MF	3 WRs and 8 CHAs	7 FRs
P	Dry *Acacia* savannah	LM, QE	Pian Upe WR, Katonga, Sebei, S.Karamoja CHAs	-
Q	Grassland savannah	LM, MF, QE	Bokora Corridor, Kyambura, Pian Upe WRs, S.Karamoja CHA	Rwoho Plantation Forest
R	Tree and shrub steppe	KV	Matheniko WR, N.Karamoja, S.Karamoja CHAs	-
S	Grass steppe	-	Matheniko WR, N.Karamoja, S.Karamoja CHAs	-
T	Bushland	KV	Matheniko WR, N.Karamoja, S.Karamoja CHAs	Zulia
V	Dry thicket	MF	Bugungu, Matheniko WRs, Kaiso-Tonya, N.Karamoja, S.Karamoja CHAs	-
W	Communities on sites with impeded drainage	KV	2 WRs and 7 CHAs	Napak
X	Swamp	QE	Katonga CHA	-
Y	Swamp forest	-	-	-

UWA - Uganda Wildlife Authority, NP - National Park, WR - Wildlife Reserve, CHA - Controlled Hunting Area, WS - Wildlife Sanctuary
KEY to NPs: BI - Bwindi Impenetrable, KF - Kibale Forest, KV - Kidepo Valley, LM - Lake Mburo, ME - Mt Elgon, MF - Murchison Falls, QE - Queen Elizabeth, RM - Rwenzori Mountains, Se - Semuliki.