UGANDA ECOSYSTEM AND PROTECTED AREA CHARACTERISATION

Derek Pomeroy
Herbert Tushabe
Polycarp Mwima
Panta Kasoma

A Contribution to the Strategic Criteria for Rural Investments in Productivity (SCRIP) Program of the USAID Uganda Mission

Makerere University Institute of Environment and Natural Resources (MUIENR)
P. O. Box 7298, Kampala. Uganda

The International Food Policy Research Institute (IFPRI)
2033 K Street, N.W. Washington, D.C. 20006

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Strategic Criteria for Rural Investments in Productivity (SCRIP) is a USAID-funded program in Uganda implemented by the International Food Policy Research Institute (IFPRI) in collaboration with Makerere University Faculty of Agriculture and Institute for Environment and Natural Resources. The key objective is to provide spatially-explicit strategic assessments of sustainable rural livelihood and land use options for Uganda, taking account of geographical and household factors such as asset endowments, human capacity, institutions, infrastructure, technology, markets & trade, and natural resources (ecosystem goods and services). It is the hope that this information will help improve the quality of policies and investment programs for the sustainable development of rural areas in Uganda. SCRIP builds in part on the IFPRI project *Policies for Improved Land Management in Uganda (1999-2002)*. SCRIP started in March 2001 and is scheduled to run until 2006.

The origin of SCRIP lies in a challenge that the USAID Uganda Mission set itself in designing a new strategic objective (SO) targeted at increasing rural incomes. The *Expanded Sustainable Economic Opportunities for Rural Sector Growth* strategic objective will be implemented over the period 2002-2007. This new SO is a combination of previously separate strategies and country programs on enhancing agricultural productivity, market and trade development, and improved environmental management.

Contact in Kampala
Simon Bolwig and Ephraim Nkonya
IFPRI, 18 K.A.R. Drive, Lower Kololo
P.O. Box 28565, Kampala
Phone: 041-234-613 or 077-591-508
Email: E.Nkonya@cgiar.org
S.Bolwig@cgiar.org

Contact in Washington, D.C.
Stanley Wood, Project Leader
IFPRI, 2033 K Street, NW,
Washington, D.C. 20006-1002, USA
Phone: 1-202-862-5600
Email: S.Wood@cgiar.org

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SUMMARY

Uganda deserves its reputation as a country with good rainfall, fertile soils and – largely as a result of these – high biodiversity. Inevitably this leads to conflicts in land use policy: both farmers and conservationists would like the best places. Fortunately, the two interests do not entirely coincide, so there is scope for both, although inevitably areas set aside for conservation will be much the smaller of the two. Other opportunities for conservation occur in almost all pastoral areas, and those agricultural ones where fragments of natural vegetation survives.

Uganda has been well-mapped and we find that for the purposes of this report we can usefully base our analyses on the standard vegetation map of Landgale-Brown *et al* (LB) and use the maps from the National Biomass Study (NBS) to identify areas which are now cultivated (Figure 1). We can relate biodiversity values to the various vegetation types, but this is more difficult in the case of other variables, such as water quality, carbon and economic values, largely because of inadequate data.

From our own data (held in the National Biodiversity Data Bank) and other sources, we assessed the main vegetation types supporting critical species, critical sites and useful plant resources. The latter are those determined by Baldascini (2002). Critical species are taken as those on the international Red Data lists, whilst critical sites include National Parks, key forests and other places identified as having particular value. The sites are ranked highest if they have many threatened species but are also poorly protected (Table 4). The overall result shows the very great importance to everybody of Uganda's forests, and also of the wetlands and drier savannas (Table 11).

Obvious areas to encourage better - and more sustainable - use of natural resources are those with lower conservation values but higher availability of useful plants. These are mainly in the moist savanna areas (LB types G to M: Table 11). The most suitable areas for these activities are in the north, with smaller ones in the southwest and south-east (these are shown green on the cover map – see also Figure 6).

Uganda is losing its biodiversity rapidly – one estimate is 10% per decade. Fixed carbon is also being lost in all but a very few places. These losses can be reduced by making better use of Uganda's natural resources, for example as recommended in this report : more use in some areas so long as it is sustainable, and improved conservation in others. At the same time we need considerably better information on biodiversity and – especially – environmental economics to be sure of having the best policies.

This report is in two parts : this printed copy, and an electronic GIS database with a set of linked tables on an accompanying CD. Section 3 explains the connection.

ABBREVIATIONS

DRC	Democratic Republic of Congo
FACE	(merely an acronym, like CARE)
FD	Forestry Department (formerly Forest Department and scheduled to be replaced by a Forest Authority)
FR	Forest Reserve
IBA	Important Bird Area
IUCN	The World Conservation Union
L-B	Langdale-Brown *et al* 1964
NBDB	National Biodiversity Data Bank
NBS	National Biomass Study
NP	National Park
PA	Protected Area
RD	Red Data (species lists)
UTM	Universal Transverse Metcator
UWA	Uganda Wildlife Authority
WR	Wildlife Reserve

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1 INTRODUCTION

1.1 Background

It is a truism to say that Uganda is changing faster than at any time in its past, and also faster than most of its neighbours. This is enabling it to catch up for the lost years of the 1970s and 1980s. A less desirable result is rapid environmental degradation (NEMA 2002) involving, amongst many other things, unsustainable use of natural resources and considerable loss of biodiversity (Arinaitwe *et al* 2000).

As a contribution towards more sustainable development, USAID/Uganda has developed a six-year integrated strategic plan (ISP 2002-2207) for Uganda (USAID 2001). A key ingredient in the ISP 2002-2007 is the merging of the economic growth and environment Strategic Objectives (SOs) in a new SO7, *Expanded Sustainable Economic Opportunities for Rural Sector Growth*. The SO7 will "assist Uganda to reduce rural-based poverty and sustain economic growth by expanding economic opportunities and increasing employment, income, and the viability of enterprises" while halting environmental degradation and biodiversity loss (Ibid: 36-39). The key strategy to achieve this objective is the integration of economic growth, agriculture, and environment and natural resources interventions (Ibid). The three core investment programs under the SO7 are: Productive Resource Investments for Managing the Environment/Western Region (PRIME/WEST); Agricultural Production Enhancement Program (APEP); and Uganda Trade Revitalization and Diversification of Exports (U-TRADE).

Developing sustainable and productive land use systems is essential for poverty eradication and sustained economic growth in rural Uganda where the vast majority of people depends on natural resources for their livelihood and is expected to do so in the foreseeable future. In recognition of this, USAID/Uganda asked the International Food Policy Research Institute (IFPRI) to prepare a strategic planning framework for rural land use development in Uganda, which successfully integrates the country's agricultural growth and rural livelihood needs with responsible environmental management (IFPRI, 2001). The "IFPRI approach" and associated analyses make up the "Strategic Criteria for Rural Investments in Productivity" (SCRIPT) – the first of SO7's two policy-related analytical frameworks, the other being "Competitiveness". A crucial question is the extent to which increased productivity of the land can be achieved whilst also reducing the rate of biodiversity loss (Chemonics 2001).

A large part of Uganda is blessed with a warm, moist climate. This supports a very diverse set of land use activities, with the potential to feed very adequately a much larger population than the present 23 million or so. Warm, moist climates also support high levels of biodiversity, both terrestrial and aquatic. An altitudinal range from below 700 m in the far north-west to 5109 m at the summit of the Rwenzoris further enhances diversity, although most of the country lies between 900 and 1500 m. Uganda may well have a quarter of a million species of living things, or even more; and is known to have about 1010 species of birds and 330 of mammals (NBDB, unpubl. Data). These are supported by forest, savanna and montane habitats, as well as extensive aquatic habitats: for its size, Uganda has a large amount of open water (more than 35,000 km^2) and nearly 10,000 km^2 of permanent swamps.

Rapid population increase, estimated to reach 25 millions by 2005 (UBOS 2000), is one reason why Uganda is losing biodiversity almost as fast as the population is growing. Whilst agricultural outputs clearly need to rise at least as fast as the human population, this has mainly been happening through expansion of the areas devoted to crops, rather than by intensification and increasing productivity, which in general is very low (IFPRI 2001). Almost all farmers are smallholders, growing mixtures of low-producing varieties in plots of very small size. It may well be that 50 million people can be comfortably supported by intensification of agriculture from a smaller area than the 84,000 km^2 estimated as being under cultivation in the mid-1990s (National Biomass Study, 1996). With better terms of trade and an increasing proportion of the population employed in other ways there could be room for a larger system of Protected Areas (PAs) than the current 33,000 km^2 or so of National Parks, Forest Reserves and Wildlife Reserves (FNCMP 1999). But the pressure on these areas seems certain to intensify in the shorter term – perhaps the text 2 to 3 generations – after which it may relax.

All ecosystems are losing biodiversity, but preliminary analyses suggest that losses from natural and semi-natural ecosystems are the most serious (Nachuha & Pomeroy, in prep.). Will the government be able to maintain its present policy of conserving all existing PAs more-or-less intact? Until recently, this seemed unlikely. Now, however, there are schemes such as the Poverty Eradication Action Plan (PEAP) and the Plan for the Modernisation of Agriculture (PMA) whose aim is to boost production. If they are successful soon, it may be possible for the line to be held. Meanwhile, the Ugandan people are also showing an increasing awareness of environmental issues. Recent government decisions to degazette two small Forest Reserves (Namanve and Butamira), and the experimental trading in Uganda’s wildlife, have met heated and vocal opposition (despite which, each of these schemes is going ahead). However, if the rate of habitat loss is to be reduced – let alone reversed - many non-agricultural jobs need to be created. Possibly even more important for conservation – and even harder to measure than habitat loss – is the degradation of the remaining areas of natural vegetation. At present, for example, remote sensing yields very little information on ‘ecosystem health’ (R. Fuller, pers. comm.).

Land use changes such as clearance for agriculture and swamp drainage drive the process of habitat loss, but there are many other factors leading to biodiversity loss, amongst them –

- loss of tree cover to meet rapidly–increasing demands for timber, fuelwood and charcoal;
- ever-increasing pollution which, most noticeably, has affected the whole ecology of Lake Victoria and most other waters; and
- introductions of exotic species, most notoriously the Nile Perch into many lakes, including Victoria.

Nevertheless, many people maintain old traditions of using native plants and animals as resources. Other land uses practices which are thought likely to lead to biodiversity change – and probably mostly loss – are frequent burning and overgrazing. A UNEP-funded project – LUCID – is currently investigating the question in East Africa. Meanwhile, Uganda's livestock areas, which cover about half the country (some 100,000 km^2) still retain much of their original natural vegetation. Planted pastures, on the other hand, are rare.

Baldascini (2002), in a sister report to this one, has documented some of the major uses of plants – including some exotics – with a particular concern for those which show promise for furthering income-generation. Wildlife resources (using 'wildlife' in the classical sense of 'game') are becoming scarce, and options for their sustainable use are largely restricted to non-consumptive uses. Small-scale trials of licencing hunters on a ranch near Lake Mburo NP, and allowing exports of wildlife, both under licence from the Uganda Wildlife Authority (UWA), are seen by many to be unwise. A common view is that UWA should try harder to conserve what is left, rather than encouraging uses which, by their own admission, they cannot monitor adequately.

Until recently – indeed until now in most places – rural land use has usually been unplanned except by the actual users. It has of course been influenced to varying degrees by government policies and regulations; but many policies – such as those relating to fire and soil management – are rarely, if ever, implemented unless the local person decides to do so for his or her own reasons. Similarly, the government, including the president, have several times told people not to cut trees and other vegetation along the banks of rivers and lakes, but that advice has also been ignored by most people. Introductions of exotic species are usually unplanned too, although that of the Nile Perch and other fish species to Lake Victoria and elsewhere was intentional. But, as is pointed out by WRI (2000: p. 7) it is very unlikely that the consequences of those actions were even vaguely foreseen.

Now, with increasing need to use land wisely, both for the long-term good, and to raise living standards, planning is not merely necessary, it is desirable. However, it may take more than a ministerial statement and a couple of radio shows to persuade the Baganda, for example, that bananas are not necessarily the best crop if one wishes to maximize sustainable production of carbohydrates!

1.2 Objectives and plan of the report

We attempt in this study to characterise the major remaining natural and semi-natural ecosystems of Uganda, together with the species that they support, with a view to –

- identifying in some detail those which are most threatened, and where they are located, and
- considering how, despite these threats, people can receive greater benefits from the remaining natural resources.

We review these against a background of some of the goods and services provided by natural ecosystems. Many of the data in this report have come from our own database in the National Biodiversity Data Bank. We have used some information held by the Wetlands Inspectorate Division of the Ministry of Lands, Water and Environment, and the Biomass Section of the Forestry Department, but both are continuing to collect data, the more recent of which are not yet generally available. There is also an increasing number of District Environment Profiles. Currently there are about 20, available in both printed and electronic formats from NEMA (Betty Gowa, pers. comm.).

Much of the information in this report is new, particularly the analyses represented as maps and tables. They are supported by an extensive electronic database on the accompanying CD. This is in Access and Arcview, allowing many options for the user (see below).

Section 2 considers Uganda's ecosystems in some detail and assesses two major approaches to their classification. Our preference for one of them − Langdale-Brown *et al* (1964; L-B for short) − is because they used a biological rather than the physiognomic approach of the National Biomass Study (NBS 1996). Analyses using L-B form the central theme of the remaining sections. L-B was originally published nearly 40 years ago but there is no evidence of significant changes to those natural ecosystems which remain undegraded (as in National Parks and Forest Nature Reserves), or relatively so in the uncultivated rangelands.

The files on the accompanying CD, and their various linkages, allow you to manipulate the data in many ways, as explained in **Section 3**.

Uganda's major Protected Areas (PAs) are the responsibility of the Forestry Department (for Forest Reserves: FRs) and the Uganda Wildlife Authority (National Parks (NPs) and Wildlife Reserves (WRs)). Both of these organisations have undertaken extensive and detailed reviews of the conservation values of their respective estates, largely based upon L-B. To add to these, MUIENR, and in particular the National Biodiversity Data Bank (NBDB) has collected data and carried out analyses on biodiversity outside PAs. Our data on the threats to critical ecosystems and species are complemented by the sister report of Baldascini (2002) since we have also related her species to the vegetation types where they are mainly found. Combining all of this information, in **Section 4**, gives us a broad view of which natural resources are to be expected where, and whether they are likely to be sufficiently common or extensive to justify any recommendation for further use.

Section 5 takes a closer look at the south-west of Uganda, where several districts retain only small areas of natural vegetation outside PAs. Multiple use *within* PAs is another way of sustainable resource use.

Section 5 does not go into the detail necessary for planning major new initiatives, but we believe that the report as a whole provides pointers, which will speed their planning processes in this field.

2 UGANDA'S NATURAL ECOSYSTEMS

2.1 Classifying ecosystems

Uganda has been inhabited by people for a very long time: certainly tens of thousands of years, although forest clearance, presumably for agriculture, did not begin until about 2,300 years ago (Jolly *et al* 1997). Consequently, one could argue that no ecosystem in the country is completely 'natural', if by that we mean 'unaffected by human activities'. The degree to which ecosystems have been affected, however, varies considerably. And not all effects originate in Uganda; the upper reaches of the Rwenzori mountains are already showing marked changes which probably result from global warming, with considerable and well-documented glacial retreat on the Rwenzoris (Osmaston & Kaser 2001) being the most striking.

There have been numerous attempts at classifying ecosystems, but those based upon vegetation are the most practical, since vegetation is easily observed, and most other organisms – notably animals – depend upon it. Vegetation in Uganda has been classified in various ways, of which the most important for this study are those of Langdale-Brown *et al* (1964) and the National Biomass Study (1996):

- Langdale-Brown *et al* (1964) mapped the vegetation of the whole country at a scale of 1:500,000, using aerial photography of the mid-1950s as a basis but with considerable work on the ground too. The major Forest Reserves were actually mapped at 1:50,000 and these maps formed the basis for the ones at 1:500,000 (H. Osmaston, pers. comm.). However, the larger-scale maps have not been digitized. Landgale-Brown *et al* recognized *22 plant communities*, identified by letters between A and Z (which we refer to as 'letter-grade' categories). Most of these were subdivided into *mapping units* (designated A1, A2 etc), of which there are 86. Their plant communities can be considered as being more-or-less the same as ecosystems, but for simplicity we shall just refer to them as vegetation *types* (ecosystems comprise animals as well as plants).
- The National Biomass Study used SPOT and LANDSAT satellite imagery obtained between 1989 and 1995, supported by aerial photographs and extensive fieldwork from 1993 to 1995. From all of this work they mapped vegetation at a scale of 1:50,000. As would be expected, their categories reflect the amount of plant material – its biomass – rather than the species composition. They recognized only five types of natural vegetation – forest, woodland, bushland, grassland and wetland. These categories are closer in concept to biomes than ecosystems (Begon *et al* (1990) define biomes as 'communities characteristic of broad climate regions').

There are several other vegetation classifications of note, including two which are global: the 'ecofloristic zones' of Green *et al* (1996), who rank the zones in the tropics in terms of conservation importance; they recognize 65 such zones for Africa, with nine in Uganda. There are 119 of WWF's terrestrial 'ecoregions' in Africa, with seven occurring in Uganda (Olson & Dinerstein 1998). There are two more classifications for Africa. Firstly White (1983), whose map covers the whole of Africa, and is based primarily upon a system of 18 phytochoria – extensive areas of vegetation which are differentiated from each of the others by at least a thousand plant species endemic to them; and secondly Pratt & Gwynne (1977), who were primarily concerned with East African rangelands.

Initially we had planned to use the National Biomass data because they are comparatively recent compared to L-B (as we shall call Langdale-Brown for short). However, since the emphasis of this study is Uganda's biodiversity we also considered L-B. There are three main advantages of using the L-B map here. Firstly, it has a biological basis, namely plant communities. Secondly, although much of Uganda's vegetation has been extensively altered during the past few centuries, and especially the last few decades, the L-B maps can still be considered to represent the *potential* vegetation over much of the country. Finally, even at the 'letter-grade' scale of vegetation communities, there are 22 to describe the terrestrial vegetation (Table 1), compared to only four for the uncultivated land cover types in the Biomass system (tropical high forest (THF) and degraded THF being essentially the same vegetation type).

The main advantages of the Biomass maps are that they are based upon much more recent surveys, whereas the fieldwork for the L-B maps was completed more than 40 years ago; and that they are mapped at a finer resolution (1:50,000) than the L-B maps. Neither system is very effective for wetlands, L-B recognizing only three communities (W, X and Y, the first being seasonal), whilst Biomass has only permanent swamps and a system of indicating areas of other units which are subject to seasonal flooding. The extent to which the two approaches correspond is shown in Table 2. This table reveals some interesting patterns which we discuss in Section 2.2.

After considerable discussion we opted for the following arrangement. The L-B classification was used as the main basis because it does distinguish, for example, between the wooded savannas of the north and those of the south (both are woodlands in the Biomass study). Yet to a bird, and probably a butterfly, *Terminalia* woodlands of the Murchison Falls area are quite different from the *Acacia* woodlands of Lake Mburo National Park. But the considerable changes that took place between the late 1950s (L-B) and early 1990s (Biomass) are reflected in large part by the extensive areas shown on the Biomass maps as having small-scale farmland (there is very little large-scale cultivation in Uganda). These cultivated areas were 'subtracted', from the L-B map, using a GIS procedure, as will be seen, for example, in Figure 1.

Table 1. The 22 'letter' grades of the Langdale-Brown *et al* vegetation types and open water. On the left are the corresponding biomes. The approximate extent of each type is given in Table 2.

Biome[a]		L-B Communities	Characteristics
HIGH ALT.	A:	High altitude moorland and heath	Mainly above 3000 m, and including the giant species of *Senecio* and *Lobelia*, as well as ice and rock
FORESTED	B:	High altitude forests	Montane forests, above 1500 m, and including bamboo zones in some places
	C:	Medium altitude moist evergreen forests	Widespread below 1500 m
	D:	Medium altitude moist semi-deciduous forests	Also widespread, typically in areas of lower rainfall
	F:	Forest/savanna mosaics	These can extend as high as 3000 m, with forest in the valleys and savanna on ridges, maintained by fire
MOIST SAVANNAS	G:	Moist thickets	Thickets can occur as climax vegetation, but also as post-cultivation precursors of forest
	H:	Woodlands	"… have neither the many-layers structure of the forests nor the dense, dominant grass layer of the savannas" (L-B)
	J:	Moist *Acacia* savannas	Probably derived from forest by "long continued cutting, cultivation and burning" (L-B)
	K:	Moist *Combretum* savannas	Dominated by *Combretum* trees and *Hyparrhenia* grasses
	L:	*Butyrospermum* savannas	Typical of monomodal rainfall zones in areas of former cultivation
DRYLANDS	M:	Palm savannas	Dominated by *Borassus* palms, the grasslands are maintained by fire
	N:	Dry *Combretum* savannas	Fire influences this type again; *Acacia* is often present too
	P:	Dry *Acacia* savannas	These are long-grass areas, typically with *A. gerrardii* trees
	Q:	Grass savannas	Extensive tall grasslands, dominated by *Themeda triandra* or species of *Hyparrhenia*
	R:	Tree and shrub steppes	Typical of areas with 6-700 mm a year of rain, with many small trees and shrubs
	S:	Grass steppes	Areas of short grass and bare ground, mainly in Karamoja
	T:	Bushlands	These are characteristic of over-grazed areas which would otherwise be more open savannas
	V:	Dry thickets	Dense spiny trees and shrubs which can become almost impenetrable
WETLANDS	W:	Communities on sites with impeded drainage	Most extensive in valley bottoms, and often with large termite mounds covered by thickets
	ww:	Open water	Not an L-B category, but obviously important. Standing water <6 m deep is classified as a wetland under the Ramsar convention.
	X:	Swamps	Permanent swamps, often dominated by *Papyrus* and other macrophytes
	Y:	Swamp forests	Seasonally or in some cases permanently flooded forests occur most notably in the Sango Bay area
POST-CULTIVATION	Z:	Post-cultivation communities	In the days of shifting cultivation, post-cultivation communities were widespread: but many are now cultivated more-or-less permanently.

Note: a our own assessment

Table 2. Correspondence between Langdale-Brown vegetation types (rows) and National Biomass categories (columns). Figures are in sq km; shaded cells represent the highest correspondence values of NBS to L-B.

		Broadleaved Tree Plantations or Woodlots	Coniferous Plantations	Tropical High Forest – Fully stocked	Tropical High Forest – Degraded	Woodland	Bushland	Grassland	Wetland	Farmland - Small Scale	Farmland - Large-Scale	Built-up Area	Open Water	TOTAL
A	High altitude moorland and heath	0	0	135[a]	0	339[a]	14[a]	189[a]	0	0	0	0	0	**677**
B	High altitude forests	0	30	1,023	295	784	478	187	0	279	0	0	0	**3,078**
C	Medium altitude moist evergreen forests	0	5	1,369	212	42	5	145	24	1,125	13	5	270	**3,215**
D	Medium altitude moist semi-deciduous forests	19	4	2,486	428	489	27	135	27	1,544	6	0	89	**5,254**
F	Forest/savanna mosaics	13	31	1,054	823	1,354	12	757	109	20,007	103	158	75	**24,495**
G	Moist thickets	0	0	126	4	819	232	471	24	850	0	2	60	**2,587**
H	Woodlands	0	3	0	0	1,674	16	457	20	1,968	0	0	29	**4,167**
J	Moist *Acacia* savannas	0	0	61	51	802	74	712	23	4,430	0	1	51	**6,205**
K	Moist *Combretum* savannas	0	2	137	38	2,594	86	1,630	86	10,384	16	11	28	**15,013**
L	*Butyrospermum* savannas	0	0	0	0	8,479	417	3,589	7	13,211	0	2	0	**25,705**
M	Palm savannas	0	0	1	1	318	39	776	130	1,367	1	9	10	**2,652**
N	Dry *Combretum* savannas	0	37	198	81	13,222	2,581	9,634	116	11,895	6	8	51	**37,830**
P	Dry *Acacia* savannas	0	0	17	9	755	2,543	6,831	56	4,105	9	2	26	**14,353**
Q	Grass savannas	0	25	118	67	2,012	580	6,395	35	4,432	21	19	133	**13,837**
R	Tree and shrub steppes	0	0	0	0	16	457	837	0	262	0	1	0	**1,573**
S	Grass steppes	0	0	0	0	1	106	691	0	0	0	0	0	**798**
T	Bushlands	0	0	0	0	302	1,503	2,035	0	408	0	0	1	**4,249**
V	Dry thickets	0	0	0	1	572	1,800	1,559	71	496	0	0	93	**4,592**
W	Communities on sites with impeded drainage	1	0	0	13	2,614	1,138	9,601	513	4,685	24	3	138	**18,731**
ww	Open water[b]	0	0	64	30	64	17	202	234	174	0	4	34,861	**35,649**
X	Swamps	0	1	255	172	675	152	1,671	2,299	2,173	6	11	1,164	**8,579**
Y	Swamp forests	0	0	147[c]	1	42	0	46	7	14	0	0	1	**259**
Z	Post-cultivation communities	2	9	65	9	335	134	666	67	5,477	18	26	83	**6,892**
	TOTAL	**35**	**149**	**7,257**	**2,236**	**38,305**	**12,408**	**49,217**	**3,847**	**89,287**	**223**	**263**	**37,162**	**240,388**

Notes:
a the NBS was not really concerned with high altitude non-forest types, hence the curious set of categories corresponding to L-B's type A
b not an L-B category
c mostly seasonally-flooded forest of the Sango Bay area

The result seems to be a reasonable compromise, and relates fairly well to our combined field experience. But the following must be borne in mind. The approach remains 'broad brush' in the sense that many vegetation types are, in reality, intermediates of one sort or another; and considerable agricultural expansion into areas of natural vegetation has occurred since the Biomass database was created.

The Biomass maps are without detailed definitions (so we cannot say that their mapping unit 'farmland' means that 50, 90 or 100% of the mapped area was actually under cultivation). A likely figure will be less than 90%, perhaps as low as 50%, because there is always fallow land, swamps may be left alone, and some natural vegetation often survives along streams and roads or around rocky outcrops.

Many of the L-B vegetation types were recognized at that time as being secondary (as opposed to 'primary' or 'completely natural'). Interestingly, one of the most species-rich vegetation types – the moist *Acacia* savannas, type J of Langdale-Brown *et al* (1964) - is thought to be 'the result of long continued cutting, cultivation and burning in areas that once supported forest or evergreen thicket' (p.56). Of the other 'moist' non-forest types (G to L, Table 1), K and L, and perhaps H, are also secondary.

Within Uganda's many Protected Areas (PAs, see Section 4), a wide range of vegetation types occurs. We know approximately how big an area of each L-B vegetation type occurs within Uganda's PAs. Apart from MUIENR's own analyses (Arinaitwe *et al*, 2000, Table 19), both the Forestry Department (FNCMP 1999) and Uganda Wildlife Authority (UWA 2000) used the L-B system in their own planning documents. By subtracting areas of cultivation from the total representation of each type in the country as a whole, we can also estimate the amount of each type still 'available' outside the PAs (see Section 2.2). These are the places to which rural people have the greatest access; but more of them have been lost to cultivation since the time of the Biomass study, and most are degraded to a much greater extent than their counterparts within the PAs.

2.2 Changing land use and its effects on agriculture

IFPRI (2001) calculated the extent of land conversion to agriculture between 1964 and 1992, i.e., from L-B to NBS. More detailed analyses (Table 2) reveal some interesting aspects concerning the extent to which the L-B and NBS categories correspond. Most striking is the fact that more than three-quarters of the area mapped by L-B as forest/savanna mosaics (type F) was found by the NBS to have been converted to agriculture. The proportion of land which L-B designated as 'post cultivation' (Z), but which is now regularly cultivated, is even higher – apparently long fallows are no longer possible in most places. All of the L-B moist savanna areas (G to L) – together with F and M – have large proportions cultivated, whereas most dryland types (P to T) remain 'grasslands'. The natural forest types, B to D, remain predominately forested, being mainly within FRs, but roughly a third of each type has been cleared for cultivation.

The Wetlands Inspection Division reports that only 7% of Uganda's wetlands have been converted into agriculture (Arinaitwe *et al*, 2000, p. 20), whereas Table 2 seems to imply that the proportion is more than a quarter of permanent swamps (X) and also of areas of impeded drainage (W – much of which is seasonal swamp). This discrepancy is probably only partly explained by differences in how wetlands are classified.

2.3 Charaterisation of ecosystem types

An overview of the major ecosystems on a large-scale or landscape level is provided in Table 3 (and taking ecosystems types as equivalent to vegetation types). This indicates the connections to look-up tables, as explained in Section 3. There are several potentially useful ways of characterizing ecosystems, as in the sections which follow (see also Section 4).

2.31 Conservation importance

In a positive sense, ecosystems are important if they support lots of species, especially the more important ones. But their importance in terms of needing conservation action is greater if they are under threat, and particularly if they are small in area and inadequately represented within the major PAs (NPs and FRs) : see Section 4.

2.32 Important wildlife

A further aspect of an ecosystem's overall conservation importance is the particular species of wildlife that it supports. Species of global conservation concern are obvious examples – gorillas and chimpanzees, for instance. Others may have national significance (such as Uganda's national bird, the Grey Crowned Crane *Balearica pavonina*) or more locally (as with the totem species of various tribes).

2.33 Goods and services (see Section 2.4)

All ecosystems provide environmental goods and services, including water and carbon. The nature of the vegetation – which largely defines ecosystems – reflects water availability in the ground. At the same time, a range of vegetation types (F, and J to P) are indicated by L-B to have well-drained soils. Vegetation cover is crucial in the regulation of the water supply deriving from hills and mountains.

When the vegetation cover is massive, as in forests, the speed at which rain falls is reduced, minimizing soil erosion. Much of the rain is held by the soil's organic matter and the overlying litter, and only slowly reaches streams and rivers, by gravity. Of course, evapotranspiration from forests is also high, and the total annual flow in rivers downstream from a forest is less than from open ground. But floods are less likely and erosion is much lower, as is easily seen from the clear water in forest streams. Forests, especially growing forests, contribute to carbon sequestration. However, as biomass is being lost almost everywhere in Uganda, the key issue is carbon management at a landscape level.

Table 3: Summarising the characterisation and assessment of ecosystems

Biome	Ecosystem type (L-B)	Matching NBS (and Langdale-Brown) land cover classes[a]	Level of importance and threat to ecosystem[b]	Ecosystem goods and services (relative and absolute values)[c]							Dominant plant & animal species (link to look-up table)	Threatened plant & animal species (link to look-up table)	Location of particular sites and habitats for threatened species	Non-ag livelihood plant & animal species (link to look-up table)
				Marketable products	Biodiversity value	Carbon sequestration			Water availability	Water quality etc				
						Retained carbon	Carbon balance[d]	Carbon values[f]						
HIGH ALT	A	-	(M)	L	H	L	N	?	H	H	Refer to electronic database	Refer to electronic database	Refer to electronic database	See Table 8 and electronic database
FORESTED	B	THF	(L)	H	H	H	L (G[e])	359	H	M-H				
	C	THF	(H)					432						
	D	THF	(M)											
	F	FSS	H					?						
MOIST SAVANNA	G	FSS	H	H	M-H	M	L		M	L-M				
	H	FSS	L					205						
	J	FSS	H					?						
	K	FSS	H											
	L	FSS	M											
DRYLANDS	M	Wo	H	M	M-H	L	L		L	L				
	N	G	M					205						
	P	G	L											
	Q	G	H					4						
	R	G	M											
	S	G	(L)											
	T	G	M											
	V	B	L					28						
WETLANDS	W	(G)	H	H	H	M	L	?	H	M-H				
	X	We	(H)											
	Y	THF	(H)											
POST-CULT	Z	FSS	-	M	L	-	-	?32						

NOTES:
- a See Table 2; B = bushland, FSS = small scale farmland, G = grassland, THF = tropical high forest, We = wetland, Wo = woodland
- b From Arinaitwe *et al* 2000 (p. 41), where more details are given. Parentheses indicate small samples
- c H = High, M = Medium, L = Low
- d Retained = current biomass, Currently gaining = G, neutral = N, Loss = L. See also Section 2.42
- e In Kibale, where FACE is operating, there may be a net gain
- f Based upon Clausen 2001.

2.34 Resource-based options

The results of the sister study by Baldascini (2002) are related to this one through tables 10 and 11, showing likely occurrence of the plant resources in each ecosystem type. Of course, availability does not necessarily mean that wise use is an option: the resource may be limited in amount or found only in areas of high conservation concern. On the other hand, the types identified for particular plant species also indicate places where they might be cultivated.

2.35 Identifying gaps

The majority of Ugandan species of conservation concern have been so little studied that the necessary data for viability analysis do not exist. Amongst mammals, information exists for gorillas (McNeilage *et al,* 1998), is being collected for chimpanzees (A Plumptre pers comm.) and could be deduced fairly easily for a few others (e.g, elephant, lion). For almost all other species of concern, even guessing is difficult. Hence it will be some years before the Conservation Action Plans, as required of countries which have ratified to the Convention on Biological Diversity, can be prepared for the many endangered species that occur in Uganda (see Tables 5 to 8).

2.4 Valuing goods and services

It is clear that Ugandans continue to derive many benefits from their environment, whilst the wider community benefits too from climatic amelioration, tourism potential and suchlike things. Numerous wild plants, and a few animals, provide an amazing variety of foods and medicines (Baldascini 2002, Katende *et al* 1995 & 1999, Nakibuuka 1998). Then there are the plants on which livestock browse and graze, timber from forests and plantations, fuels of many kinds but especially wood and charcoal. And the swamps, rivers and lakes and all that they provide: water, fish, building materials and so on.

However, many uses of natural resources are currently unsustainable – peoples' current needs exceed the supply. Although many resources are potentially renewable, little effort is made to replace what is lost, despite the numerous local tree-planting schemes. A good example of this widespread situation comes from a recent study around Kibale National Park in Western Uganda, where Naughton-Treves and Chapman (2002) have shown that removal of trees from fallow land considerably exceeds natural replacement (partly because trees regenerate very slowly).

The general principles of valuing natural resources are well-known (Winpenny 1996). Emerton & Muramira (1999) applied them to Uganda's major biomes. Two other studies have been made of the costs and benefits of maintaining Uganda's system of PAs (Howard 1995, Mason 1995). None of these can, however, be readily related to the L-B vegetation categories, although the 'fit' with NBS data is better, and we generally use their results at that level.

2.41 Economic valuation of natural resources in Uganda

The main potential cost of conserving natural resources to a nation such as Uganda, which has both a disproportionate share of conservation treasures and highly fertile well-watered land, is the farmland foregone by setting aside land for conservation. Looking ahead 25 years to a largely rural population more than twice that of today, these empty tracts of land will appear to be a massive under-utilised resource.

It is likely that tourism will go some way towards offsetting the opportunity costs of agriculture foregone, but it is unlikely to be anywhere near valuable enough. The problem is compounded by the fact that the highest value assets for tourism are the open, relatively less fertile plains and their mega fauna, whereas the areas of greatest conservation interest are the fertile mountain forests and wetlands which, it has been said, offer tourists little but bugs, rain and difficult access. Others however take a kinder view and the real position at present is not as dismal as it may appear, certainly for the next 20 or so years.

Considering Uganda as a whole, Emerton and Muramira (1999) estimated the total economic benefits of natural resources at about US $ 700 million annually, and the costs as about US $ 315 millions annually (mainly production foregone) (taking the UGS/USD as about 1600 at that time). These figures were derived from district–by-district assessments of forests, woodlands, bushlands and grasslands, using the NBS (1996) data as a basis, and adding assessments of aquatic ecosystems.

On a finer scale, social-cost-benefit analysis was used by Howard (1995) to examine the Total Economic Value (TEV) of Uganda's protected areas, including the country's National Parks, Wildlife Reserves, and Forest Reserves. He estimated that the benefits were worth US $ 123 million annually. Benefits that were valued included revenues derived from tourism, timber and game utilisation; non-market produce such as firewood, building poles, game meat and thatching grass used by local people; environmental services such as provision of clean water, maintenance of downstream fisheries, pollution control, and climate regulation; and the maintenance of biodiversity and other attributes which provide options for future development, and are valued for cultural, moral or religious reasons.

Howard estimated the 1995 costs at US $ 200 million annually, more than half of which was attributed to the opportunity costs of land. However, although it appeared then to be in Uganda's short-term financial interest to maintain the country's protected areas (largely on account of US $ 11 million contributed annually by donors), Howard considered that the outlook was less certain. This uncertainty has been confirmed, for example, by Archabald and Naughton-Treves (2001) who found that no tourism revenues were disbursed by the UWA between 1998 and the time that they were writing (2001), due to administrative complications that are finally being resolved in 2002 (D. Aleper, pers. comm.).

According to Mason, also writing in 1995, land availability was not yet a severe constraint. He pointed out that there may even be benefits to be gained from excluding people from National Parks, thus limiting extensification of agriculture and promoting intensification (cf IFPRI 2001). The weight of evidence suggests that better land management is induced by concentration of people into smaller areas which have good access to markets, infrastructure, extension services and ample labour. Nonetheless, even with excellent management of land, if populations continue to grow at current rates, land must eventually become the limiting resource. Mason estimated that by the time that happens, perhaps by the 2020s, the opportunity cost of conservation of Uganda's National Parks and Wildlife Reserves will (in the terms of 1995) be between US $ 450 and $ 1,100 million per year, whereas the revenue flowing to Uganda from tourism is likely to be only around US $ 200 million per year.

2.42 Carbon management

Background

Increasing atmospheric CO_2 is almost universally accepted as one of the major contributors to global warming (Clausen & Gholz 2001). Many ways are being considered for mitigating this; one of the most important being the sequestration of carbon by growing vegetation. However, a natural ecosystem is more-or-less 'in balance' with regard to carbon. Over a year or more, carbon fixed roughly equals carbon lost, the latter being mainly through the respiration of plants and, to a lesser extent, animals.

There is abundant evidence that the standing biomass of most ecosystems in Uganda is declining; the main exceptions being the larger protected forests, which are almost entirely confined to Forest Reserves and National Parks. These are probably somewhere near to being in a steady state with respect to carbon, having little or no net loss.

Evidence for net biomass loss includes the reduction of total forest area (see, for example, Arinaitwe *et al*, 2000, NEMA 2002), although the rate of loss is probably lower now than in the mid-20th century, partly because most of the unprotected forest has now gone (Arinaitwe *et al* 2000). But active deforestation is conspicuous in for example, Mpigi, Mubende and Masindi Districts. Furthermore, many of the remaining forests are still being degraded, woodlands cut for charcoal and fuelwood, and swamps converted to cultivation. There are, here and there, places where cultivation has been abandoned, and natural regeneration leads to increased biomass. Eviction of encroachers from several large areas (Mabira, Elgon, Kibale) has also allowed some forest regeneration. In Kibale and Mt Elgon NPs the FACE programme has actively planted millions of tree seedlings (see below), and the Forest Dapartment has planted considerable numbers in Mabira Forest. All over Uganda, tree lots have appeared, although almost entirely of species of *Eucalyptus*, and there will be few areas (say at the level of districts) where these plantations exceed, in terms of biomass, the amounts lost from cutting other trees. If there is an exception, it is probably Bushenyi, where trees have become well-established as a crop.

Since biomass is being lost almost everywhere, Uganda is contributing to the net increase in global CO_2 emissions. Hence the emphasis in Clausen's 2001 report on *carbon management*: sometimes the best one can hope for is reduced rates of loss. The opportunities for the latter are considerable, but they are not being realized.

Improving carbon management

Clausen (2001) used various data sources to estimate the relative amounts of fixed carbon for ten districts six of which are in the south-west, and produced these 'Final Carbon Values'. (Clausen gives no units, but we assume they are US $).

Kasese	113	Kotido	42
Bushenyi	117	Luwero	117
Rukungiri	100	Kumi	36
Kabale	58	Gulu	88
Kisoro	84		
Mbarara	18		

(Ntungamo was not assessed, but is likely to be similar to Rukungiri; Kanungu District has recently been created from part of Rukungiri)

We have also used Clausen's (2001) data to allocate approximate carbon values to some of the main L-B vegetation types (Table 3). This again emphasizes the very high significance of forests (and therefore the seriousness of deforestation).

Various forms of land use affect the rate at which there are net losses (or gains) of biomass and, therefore, carbon. Vegetation destruction – as when land is cleared for agriculture – almost invariably results in a net loss (most planted crops have a relatively low biomass); on the other hand, establishing tree plantations, or increasing the forestry component of agroforestry, can yield an increase in biomass. There is some evidence that bird numbers increase with biomass, especially woody biomass, and this may well be true of biodiversity in general, although there will certainly be exceptions.

Uganda's Forestry Department has plans to promote major plantations of fast-growing trees to reduce the current deficit in timber production. These will contribute substantially to carbon sequestration for so long as there is net growth (and so long as the timber produced is not burnt!)

FACE in Uganda

Tree-growing in Uganda has not, as yet, been seen as a major way of fixing carbon, with the exception of the FACE project. The FACE Foundation is a Dutch-based organization dedicated to carbon sequestration by means of reaforestation programmes in the tropics. The major objective of FACE in Uganda is to plant tree in 25,000 ha in Mt Elgon National Park and 10,000 ha in Kibale National Park, all of native tree species. Over a period of 70 years, this is expected to sequester over 20 million tons of CO_2, at a cost of US $0.30 per ton of carbon (Okonya 1999). However, the extent of their success has been limited (H. Osmaston, unpubl. Report to the Forestry Department, 2000).

2.43 Some conclusions on values

A significant gap in our assessment of the importance of Uganda's major ecosystems is our limited ability to assign monetary values to their many goods and services. Undoubtedly more data exist than we have been able to find in this short survey; and there are also general values in publications of organizations such as WRI and IUCN. In particular, it is hard to ascribe values to particular ecosystems. The main exception is forest: L-B types B, C and D. Emerton and Muramira (1999) considered that they contributed 18% to Uganda's total biodiversity value, despite covering less than 4% of the land (Arinaitwe *et al* 2000). This translates into about US $ 200 per ha per year. Forest has by far the highest 'carbon value' (Table 3). Uganda's wetlands and lakes have an estimated relative value to the economy about half that of forests, some US $100 per ha per year, but a small carbon value.

The total economic benefits of Uganda's biodiversity have already been mentioned in relation to the study by Emerton and Muramira (1999): at 2002 values, they are about US $ 750 million. Using a very different approach, based upon Howard's (1995) assessment (Section 2.41) of the net benefits from major PAs of some US $120 millions annually, we make the reasonable assumption that this by now will be US $150 millions and the much more questionable assumption that the value per km^2 is the same outside PAs as within them. On that basis, we can make the very rough guess of a billion dollars a year for the whole of Uganda, for terrestrial ecosystems. This compares well with Emerton and Muramira, although they also included lakes and other waters, without which their figures would have been less than US $500 million. Nevertheless, the two estimates are within sight of each other, which encourages the belief that a figure of the order of US $ 500-700 millions a year is realistic.

We defer to Section 6 a consideration as to what the implications of these data are when it comes to deciding on the best land use option for any particular ecosystem or site.

2.5 Exotic and invasive species

Exotic species – those which do not occur naturally in Uganda – can, if they are invasive, be harmful to natural ecosystems. Some of these are briefly reviewed by NEMA (2002, p. 68, where they are referred to as alien species).

The success of Uganda and its neighbours in greatly reducing the impact of the water hyacinth *Eichornia crassipes* has been notable, whilst the negative environmental impacts of the introductions of the Nile Perch *Lates niloticus* and other fish species are very well-known (see e.g. Arinaitwe *et al* 2000). One of the most seriously invasive plants, the paper mulberry *Broussonetia papyrifera*, has been studied in detail (Mbogga 2001), but most have not.

Some species, which have caused major problems in other parts of the world (such as the prickly pear cactus *Opuntia* sp) are only occasionally a problem in Uganda, perhaps because the high levels of native biodiversity provide some resistance to intruders! For instance, there are only two non-native species of birds in Uganda, the Feral Pigeon *Columba livia* and the House Sparrow *Passer domesticus* (which arrived last year); that is far fewer than for in most countries. And it's also notable that the paper mulberry does not spread into closed-canopy forest (Mbogga 2001).

But although Uganda may have fared better than others, one cannot be complacent. Thus, Witte *et al* (1999, p. 199) have this to say: 'The decline of fish species in Lake Victoria is the largest documented loss of biodiversity ever inflicted by man on an ecosystem'. Amongst prospective threats are the recent widespread plantings, as hedges, of the Mauritius thorn (*Caesalpinia decapetala*), which comes from tropical Asia.

3 THE ELECTRONIC DATA BASES

3.1 The Access Database

The IFPRI electronic database uses a relational database management system (RDBMS) written in Microsoft Access 2000 software. Like all RDBMS − based applications, the database comprises several data tables related to each other by various common link fields. Data entry is simple through customized entry forms with several error-check measures aimed at minimizing typographical errors.

Installing the Database

The database consists of the main database file, *ifpri.mdb* and the *Images* sub-folder, which contains some of the images used on the *Switchboard* form and the database icon, *ifpri.ico*. The *ifpri* folder should be copied to *c:*. Optionally, the database icon and shortcut could be placed on the desktop by following the normal shortcut creation procedures under the various *MS Windows* platforms.

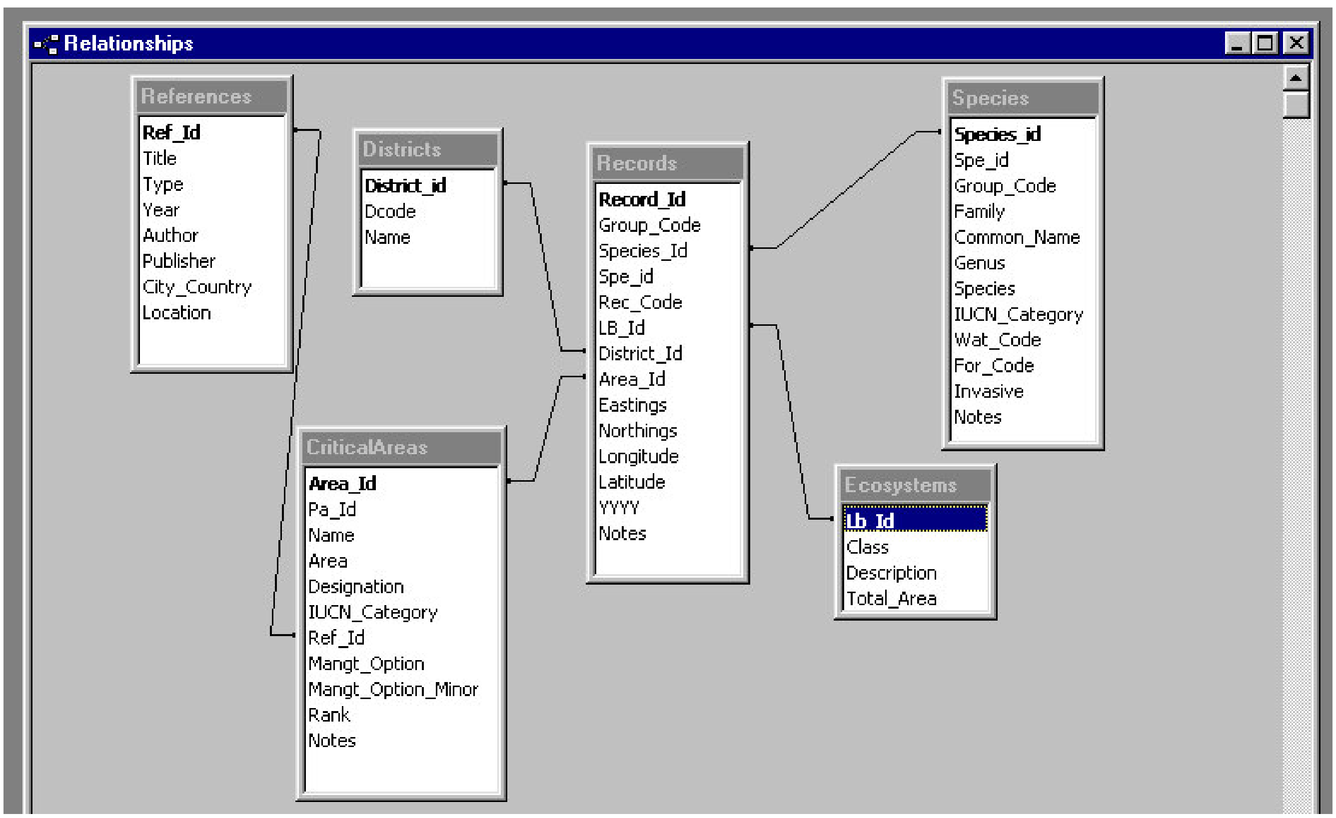
Database Structure

The main tables in the database are: **Critical Areas** – with information on the critical areas such as names, location, levels of protection/designation, area, management options, threat rank and reference material with useful information on these areas; **Districts** – with names and number codes of the districts of Uganda; **Species** – with taxonomic information, threat categories, forest/water specialism and whether the species are invasive or not; **Records** – geo-referenced records of species of conservation concern, ecosystems where the species have been recorded, districts, year of recording and a link field to the National Biodiversity Data Bank (NBDB) electronic database; **Ecosystems** – the L-B vegetation categories; and **References** – reference material regarding the critical areas

The data entry forms are: **Critical Areas**; **Species**; **Records**; and **References,** all corresponding with the tables.

As mentioned above, the tables are interlinked. Figure 2 illustrates the links among the various tables.

Figure 2. Relationships amongst the look-up tables



Using the Database

This section briefly describes the basic steps of using the database. It should not be taken as a database manual, and it is assumed that the user has fair knowledge of using MS Access.

a. Accessing the data

1. Either from the database icon on the desktop or from MS Access, open the **IFPRI Database**.
2. This will open the database ***Welcome*** screen. Click on the *Enter Database* button to enter the database, or on *Exit* to quit Access.
3. On entering the database, this action will open the **Main Switchboard**, from which the basic forms can be accessed. Four buttons on this screen will help in accessing the four basic forms. Note that the database loads a customised menu applicable to this database. The basic forms can also be accessed through the **File** menu. [Use *Ctrl+F11* to toggle between MS Access full menus and this customised menu].
4. In addition to the *File* menu, there is a *Customise List* menu, from which the **Districts** and **Ecosystems** tables can be accessed and edited.

b. Entering the Data

Data can be entered through the respective data entry forms. Note that each form has a number of buttons in the left panel that help the user to navigate through the records, enter new records, delete existing records, copying the current record onto a new one and to undo some of the previous actions on the data.

Also where relevant, there are buttons below this panel that can be used in accessing other associated forms. You can always access the **Switchboard** by clicking on *Main Switchboard* in the menu. Data that should be entered into each form are as indicated in the beginning of this section under "Database Structure".

c. Querying the data

Data in MS Access can be retrieved in many ways (for example on forms by navigation or by browsing the tables). However, MS Access queries are more useful and powerful in retrieving specific data, depending on the user's requirements. Note again that it is assumed the user knows how to create queries in MS Access. What is useful here is Figure 2, which shows the relationships among the tables. (The relationships will come automatically in Access queries, so the relationships do not have to be recreated). Queries can then be saved as separate data subsets or exported into other applications.

Links with GIS

A good number of records in the database are geo-referenced with UTM co-ordinates; and also have latitude/longitude coordinates in decimal degrees. This therefore makes it easy to link the records with GIS. Those that are not well geo-referenced have districts and critical areas linked with them. The field *district_id* in the **Districts** table links the *ug_districts_utm.shp* shapefile in the GIS database; and *area_id* in the **CriticalAreas** table links with the *area_id* field in *ug_critical_utm.shp* shapefile in the GIS database.

Sources of Data

The main sources of data are:

Data held at the NBDB collected over the years by various researchers;

IUCN Red Data Lists;

Makerere University Herbarium

Makerere University Zoology Department Museum

The Flora of Tropical East Africa series; and

Various publications as indicated in the references

3.2 The GIS Database

The GIS database comprises several thematic layers in ArcView GIS 3.1 format. The data layers are shapefiles that are geo-referenced in a UTM coordinate system. The layers are linked to the database through the gazetteer file (**Records**) that contains the coordinates for each of the Red Data species records. The *area_id* field in the **Critical Areas** table also links the database to the Critical Areas map (*ug_critical_utm.shp*) with the shapefile polygons having the same Id.

The maps should be saved on *c:\ifpri\maps* as the projects information files refer to this path (refer to the accompanying CD). The shapefiles are:

Layer Description	**File**
1. An NBS map for Uganda at a 1:900,000 scale.	*ug_bio_utm.shp;*
2. A map of L-B at a 1:500,000 scale.	*ug_lb_utm.shp;*
3. A map of L-B showing natural vegetation remaining (i.e. L-B take away the NBS categories 9 & 10 that show farmlands) at a 1:500,000 scale.	*ug_natural_utm.shp*
4. A map of Uganda's critical areas.	*ug_critical_utm.shp;*
5. A map of Uganda's districts.	*ug_districts_utm.shp;*
6. A map of the boundary of Uganda.	*ug_bnd_utm.shp;*
7. Major water bodies.	*ug_water_utm.shp*
8. Thematic maps showing conservation values, plant resources and resource use potential. Modified map of L-B with the values respectively in the last three columns.	*ug_values_utm.shp*
9. A map of the districts of the southwestern part of Uganda showing the natural vegetation.	*sw_nat_utm.shp*
10. A map of the natural vegetation of SW Uganda.	*sw_nat_utm.shp*
11. A map of the critical areas of the SW	*sw_critical_utm.shp*
12. A map of the natural vegetation of Kasese district created using NBS maps at 1:50,000 scale.	*kasese_nat_utm.shp*
13. A map of the boundary of Kasese District.	*kasese_utm.shp*

ArcView Projects

The GIS database contains the projects from which Figures 1 and 3-10 are based. The projects are well labeled and are in the *d:\ifpri\maps* subfolder on the CD. They are:

Project	**Figure**
1. *ug_natural.apr*	Figure 1
2. *ug_critical.apr*	Figure 3
3. *ug_values.apr*	Figures 4-6
4. *sw_critical.apr*	Figure 7
5. *kasese.apr*	Figure 8

4 CRITICAL SITES FOR CONSERVATION

Many important areas in Uganda are conserved under existing laws, as Protected Areas (PAs). These fall under the Forestry Department, which is responsible for major national Forest Reserves (FRs) (many smaller ones are administered locally), and the Uganda Wildlife Authority. UWA is responsible for the management of Animal Sanctuaries, Community Wildlife Areas, Wildlife Reserves (WRs) and National Parks (NPs) and for all wildlife throughout the country.

The three major categories – NPs, FRs, WRs – vary in the extent to which protection is effective. No one is allowed to live in them unless they can show that they, or their ancestors, were living there at the time they were created – as happened in the case of Queen Elizabeth NP and Mabira FR. As Management Plans are developed or revised for the various PAs, they designate zones for various uses, including, in many cases, Nature Reserves in which almost no human activities are allowed. However, some important sites are, at present, unprotected.

In Table 4, we document a series of critical sites, defined as belonging to one or more of the following categories.

1. National Parks, as established by the Parliament of Uganda, from 1952 onwards (and most recently revised in 2002).
2. Forest Reserves classified as ‘Prime’ or ‘Core’ by the Forestry Department (FNCMP 1999).
3. Important Bird Areas (Byaruhanga *et al* 2001).

Table 4. Assessment of critical sites. The criteria for starring values are given at the head of the table. Sites included for consideration were: all National Parks; all forests rated as "Prime" or "Core" by the FD (FNCMP 1998); all IBAs. Several sites come into all three categories. The ranks in the final column are high (H), where there are 3 starred citeria (4 for Mt Moroto); M (medium) for 2 criteria, and L (low) for one.

Name	PA status[e]	Area km^2	Nos of RD species[a]	Level of protection	FNCMP category	IBA level of threat	Dangerous or sensitive spp[b]	Rank
*Criteria for high rank (stars *)*		*<100km^2*	*>5 spp*	*Levels 3 and 4*	*Prime*	*Levels 3 and 4*		
Mgahinga Gorilla	NP	34*	*9	1	Prime*	2	G	H
Bwindi Impenetrable	NP	321	14*	1	Prime*	1	G,C	M
Queen Elizabeth Conservation Area	NP/WR	1978	19*	1	Prime*	2	L,E,B,C,Cr	M
Rwenzori Mountains	NP	996	7*	1	Prime*	1		M
Kibale	NP		11*	1	Prime*	1	E,B,C	M
Semliki	NP	219	24*	1	Prime*	1	B,C	M
Murchison Falls Conservation Area	NP/WR	3900	(19)*	1	Prime*	1	L,E,B,C,Cr	M
Lake Mburo	NP	370	5	1	Prime*	1	B,Cr	L
Mt Elgon	NP	1192	5	1	Prime*	3*		M
Kidepo Valley	NP		7*	1	Prime*	1	L,E,B	M
Budongo	FR	825	13*	1	Prime*	2	C	M
Otzi	FR	188	9*	3*	Prime*	1		H
Mt Moroto	FR	483	6*	3*	Prime*	3*		H
Mt Kei	FR	384	10*	3*	Core	1		M
Ssese Is	FR	2*	3	3*	Core	3*		H
Kalinzu-Maramagambo	FR	584	16*	1	Core	-	E,B,C	L
Sango Bay	FR	151	8*	1	Core	2	B	L
Era	FR	74*	9*	3*	Core	-		H

Name	PA status[e]	Area km²	Nos of RD species[a]	Level of protection	FNCMP category	IBA level of threat	Dangerous or sensitive spp[b]	Rank
*Criteria for high rank (stars *)*		*<100km²*	*>5 spp*	*Levels 3 and 4*	*Prime*	*Levels 3 and 4*		
Kasyoha-Kitomi	FR	390	16*	1	Core	-	C	L
Labwor Hills	FR	437	3	3*	Core	-		L
Nyangea-Napore	FR	417	4	3*	Core	-		L
Echuya	FR	40*	3	3*	Core	3*		H
Bugoma	FR	401	16*	3*	Core	-		M
Mabira	FR	300	16*	1	Core	1		L
Lake Nabugabo	R[d]	225	7*	4*	-	3*		H
Tororo R	N	<1*	1	4*	-	-		M
Lake Bisina	N	61*	3	4*	-	3*		H
Getom	N	<5*	(1)	4*	-	-		M
Nyamiriro	N	51*	3	4*	-	4*		H
Doho Rice	N	32*	2	4*	-	4*		H
Lutembe Bay	N	8*	2	4*	-	3*		H
Semliki	WR	1150	7*	2	-	3*		M
Ajai	WR	158	(2)	2	-	3*		L
Lake Opeta	N	566	6*	4*	-	3*		H
Musambwa Is	N	0.08*	0	4*	-	3*		H
Mabamba Bay	N	165	4	4*	-	2		L
Lake Nakuwa	N	165	6*	4*	-	2		M

Notes

a Flowering plants, insects, birds and mammals

b L – lion, E- elephant, B- buffalo, G – gorilla, C – chimpanzee, Cr – crocodile

c only a small part of the FR is included in the IBA

d awaiting confirmation as a Ramsar site

e FR – Forest Reserve, N – unprotected, NP – National Park, WR – Wildlife Reserve

( ) need confirmation – current data incomplete

Sources of information: FNCMP 1989, BLI 2001, Byaruhanga *et al*, 2001, Hilton-Taylor 2000, NBDB data

Those in categories 2 and 3 were selected by the FD and NatureUganda, respectively, on the basis of very detailed and objective criteria, as described : Sections 4.14 and 4.15.

We have used several criteria for ranking areas for conservation. They are listed here and described in more detail in the sections which follow.

1. Size: small areas are assumed to be under greater threat than large ones.
2. The numbers of globally-threatened species, and their degree of threat. Uganda, like all signatories to the Convention on Biological Diversity, has particular responsibilities for these.
3. The level of protection of the area. For this purpose, the less the protection, the more critical is the area, in the sense that it is subject to unregulated use.
4. The FD ranking of forests as 'Prime' or 'Core' conservation areas (FNCMP 1999).
5. Ranking by NatureUganda in its assessment of the degree of threat to each of the Important Bird Areas (IBAs).

In Table 4, sites that are considered the most critical (high conservation value and/or considerable threat) are starred. The actual criteria are explained in Section 4.1. As will be seen, these criteria are not completely independent of each other, and should therefore be thought of as a set.

4.1 Criteria for selecting and ranking critical areas

4.11 Size

The approximate area of each site is given in the table. Nine sites are smaller than 100 km^2, considerably increasing their risks of degradation or even of complete loss. Use of resources at these sites requires special care.

4.12 Globally-threatened species

Globally-threatened species are defined as those occurring on IUCN Red Data lists. For some taxa, notably the higher vertebrates, every living or recently-extinct species has been assessed, whereas for such groups as insects and flowering plants, only a proportion are well-enough known for this to have been done.

The current threat categories are described by Mace & Stuart (1994); subsequent updates by IUCN General Assemblies are comparatively minor. The major categories are Critical (CR), Endangered (EN) and Vulnerable (VU). Each is defined by specific criteria: for example, if a species' global population is less than 250 mature individuals, or if the population occupies an area of less than 10 km^2, then that species is considered to be critically threatened with extinction. In Uganda, several plants come into that category (see, for example, Lye & Namaganda, in press).

Current global listings of Red Data species are maintained by IUCN (ww.redlist.org) (Hilton-Taylor 2000). These have been used to identify species which occur in Uganda and which are thought to be threatened with extinction. Data are adequate or better for four taxonomic groups: flowering plants, butterflies, birds and mammals; these are listed in Tables 5 to 8. There are lists for some other groups, notably fish, amphibians and reptiles; but too little is known about their distributions in Uganda for them to be included, although the demise of many cichlid fish species in Lake Victoria is well-known (see, for example, Arinaitwe *et al*, 2000, WRI 2000). Further, with the exception of birds and the larger mammals, the lists of threatened species are far from complete, again because not enough is known about the distributions of the majority of plants, invertebrates and lower vertebrates. A good example is butterflies, for which Uganda has 30 endemic species (Table 6). However, none of them has yet been assessed to see whether they qualify for Red Data listing, although it is likely that many of them will.

4.13 Level of protection

Not all critical ecosystems are protected; and of those which are, the degree of *de facto* protection is usually less – sometimes much less – than it should be. In assessing the individual sites (Table 4) we have used the following scores, in which a high number indicates high priority for conservation under the present conditions:

- 4 for unprotected sites, of which there are eleven (one, Lake Nabugabo, is expected soon to become a Ramsar site);
- 3 for those Forest Reserves which we consider to be less protected (compared to Budongo, Kalinzu-Maragambo, Sango Bay, Kasyoha-Kitomi and Mabira); there are nine in this category;
- 2 for Wildlife Reserves, of which only two qualify; and
- 1 for the five major Forest Reserves and all ten National Parks.

4.14 Forestry Department ratings

The FD carried out a very thorough assessment of 65 forests in the early 1990s. Five of these are now National Parks (Bwindi Impenetrable, Kibale, Semliki, Rwenzori Mountains, Mt Elgon) and others are not forests in the traditional sense (especially some in the north), despite being FRs. All were assessed in detail for their biodiversity values, the results being published in a series of 33 reports (Howard and Davenport 1996). This information was taken into consideration when proposing management plans of the Forest Reserves, together with such criteria as slope, presence of valuable timber trees and access.

Table 5. Occurrence by vegetation types of IUCN-listed species of flowering plants in Uganda, listed alphabetically by family. See Section 4.12 for IUCN categories.

SPECIES NAME	FAMILY	THREAT CATEGORY	LANGDALE-BROWN VEGETATION CATEGORIES																						
			A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	NOTES
Aloe tororoana	Aloaceae	CR									■														Tororo Rock, found on rock faces and hill summit
Antrocaryon micraster	Anacardiaceae	VU			■	■																			
Pistacia aethiopica	Anacardiaceae	LR/nt		■										■											
Isolona congolana	Annonaceae	LR/nt																				■			
Rhynchostigma racemosum	Asclepiadaceae	VU		■																					
Tylophora cameroonica	Asclepiadaceae	LR/nt								■															
Afrothismia winkleri	Burmanniaceae	CR				■																			Only known to be in Budongo in dense shade on forest floor
Brachylaena huillensis	Compositae	LR/nt																						■	East Bank Victoria Nile Common near river bank
Juniperus procera	Cupressaceae	LR/nt		■																					
Dracaena ombet	Dracaenaceae	EN																							
Diospyros katendei	Ebenaceae	CR														■					■				
Euphorbia bwambensis	Euphobiaceae	VU					■																		
Irvingia gabonensis	Irvingiaceae	LR/nt			■	■																			
Beilschmiedia ugandensis	Lauraceae	VU																					■		
Ocotea kenyensis	Lauraceae	VU		■																					Found on ridge tops in Bwindi Forest
Afzelia africana	Leguminosae	VU						■				■													Mt. Kei & Otze Forests in NW region
Afzelia bipindensis	Leguminosae	VU				■																			Very local in Bwamba Forest
Albizia ferruginea	Leguminosae	VU			■	■																			
Cordyla richardii	Leguminosae	VU						■																	
Dalbergia melanoxylon	Leguminosae	LR/nt												■		■			■	■	■				
Dialium excelsum	Leguminosae	EN				■					■														Only recorded from Budongo and Bwamba
Millettia lacus-alberti	Leguminosae	VU				■	■																		Recorded only in Bwamba
Memecylon bequaertii	Melastomataceae	VU		■	■	■																			
Entandrophragma angolense	Meliaceae	VU		■	■	■																			
Entandrophragma cylindricum	Meliaceae	VU			■	■																			
Entandrophragma utile	Meliaceae	VU				■																			
Guarea cedrata	Meliaceae	VU			■	■																			
Guarea mayombensis	Meliaceae	VU		■	■																				
Khaya anthotheca	Meliaceae	VU				■	■				■														

SPECIES NAME	FAMILY	THREAT CATEGORY	LANGDALE-BROWN VEGETATION CATEGORIES																						NOTES
			A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	
Khaya grandifoliola	Meliaceae	VU			■			■						■											
Khaya senegalensis	Meliaceae	VU												■											
Lovoa swynnertonii	Meliaceae	EN			■																				
Lovoa trichilioides	Meliaceae	VU			■	■																			
Turraeanthus africanus	Meliaceae	VU			■																				
Milicia excelsa	Moraceae	LR/nt			■	■	■	■	■		■														
Lophira alata	Ochnaceae	VU										■	■	■											Northern Uganda. Source of timber and is now rare
Prunus africana	Rosaceae	VU		■	■	■																			
Hallea stipulosa	Rubiaceae	VU																					■		
Nauclea diderrichii	Rubiaceae	VU				■	■																		Only recorded from Bwamba
Pavetta intermedia	Rubiaceae	VU			■																				
Pouteria altissima	Sapotaceae	LR/cd																							
Vitellaria paradoxa	Sapotaceae	VU										■		■											Commonly in NE, N, & NW Uganda.
Brazzeia longipedicellata	Scytopetalaceae	EN														■					■				Only recorded from Ishasha Gorge
Cola bracteata	Sterculiaceae	VU					■								■	■								■	
Number of threatened species in each vegetation type			0	8	15	17	9	4	1	1	4	4	1	6	1	4	0	0	1	1	3	1	2	2	

Table 6. Occurrence by vegetation type of Uganda's two Red Data listed species of butterflies. In addition we list the 30 species endemic to Uganda: all such species are candidates for Red Data List status. Those only known from Semliki NP are highly likely to occur in the DRC, as are most of those recorded from Bwindi Impenentrable NP.

Species name	Family	Threat	A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	Recorded distributions
Papilio antimachus	Papilionidae	VU		■	■	■																			Budongo, Kalinzu, Kibale,Semliki, Bwindi
Papilio leucotaenia	Papilionidae	VU		■	■																				Bwindi
Telipna kayonza	Lycaenidae	Uganda endemic		■	■																				Bwindi
Telipna sheffieldi	Lycaenidae	Uganda endemic			■																				Kibale
Ornipholidotos jacksoni	Lycaenidae	Uganda endemic																					■		Sango Bay
Toxochitona ankole	Lycaenidae	Uganda endemic			■																				Kalinzu, Kibale
Toxochitona vansomereni	Lycaenidae	Uganda endemic		■	■																				Bwindi
Iridana bwamba	Lycaenidae	Uganda endemic				■																			Semliki
Iridana obscura	Lycaenidae	Uganda endemic				■																			Semliki
Iridana tororo	Lycaenidae	Uganda endemic				■																			West Bugwe
Epitola bwamba	Lycaenidae	Uganda endemic				■																			Semliki
Epitola carilla	Lycaenidae	Uganda endemic			■		■																		Entebbe
Epitola cyanea	Lycaenidae	Uganda endemic				■																			Semliki
Epitola mittoni	Lycaenidae	Uganda endemic				■																			Semliki
Lachnocnema busoga	Lycaenidae	Uganda endemic				■	■																		Busoga
Aphnaeus nyanzae	Lycaenidae	Uganda endemic																					■		Sango Bay
Epamera mongiro	Lycaenidae	Uganda endemic				■																			Semliki
Epamera pseudofrater	Lycaenidae	Uganda endemic			■	■																			Bwindi
Iolaphilus henryi	Lycaenidae	Uganda endemic			■	■																			Bwindi
Argiolaus kayonza	Lycaenidae	Uganda endemic			■	■																			Bwindi
Argiolaus vansomereni	Lycaenidae	Uganda endemic						■																	Otzi
Pilodeudorix ankoleensis	Lycaenidae	Uganda endemic			■																				Kalinzu
Lepidochrysops labwor	Lycaenidae	Uganda endemic										■		■											Labwor Hills
Thermoniphas albocaerula	Lycaenidae	Uganda endemic		■	■																				Bwindi
Thermoniphas caerula	Lycaenidae	Uganda endemic		■	■																				Bwindi
Thermoniphas kigezi	Lycaenidae	Uganda endemic		■	■																				Bwindi, Echuya

Species name	Family	Threat	A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	Recorded distributions
Chilades alberta	Lycaenidae	Uganda endemic																							Acholi
Acraea bergeri	Acraeidae	Uganda endemic																							Karamoja
Acraea simulata	Acraeidae	Uganda endemic																							Sesse Islands
Osmodes minchini	Hesperiidae	Uganda endemic																							Entebbe
Parosmodes onza	Hesperiidae	Uganda endemic																							Bwindi
Gretna bugoma	Hesperiidae	Uganda endemic																							Bugoma
Number of threatened species in each vegetation type			**0**	**8**	**17**	**13**	**3**	**1**	**0**	**0**	**0**	**2**	**0**	**3**	**1**	**1**	**1**	**1**	**1**	**0**	**0**	**0**	**2**	**0**	

Source of data: Mainly from T Davenport (pers comm.)

Table 7. Occurrence by vegetation type of IUCN-listed Red Data species of birds in Uganda. Species are listed alphabetically by family. Scientific names can be found in Carswell *et al*, in press.

SPECIES COMMON NAME	FAMILY	THREAT CATEGORY	LANGDALE-BROWN VEGETATION CATEGORIES																						NOTES
			A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	
Lappet-faced Vulture	Accipitridae	VU										▒	▒	■	■	■	▒	▒							
Pallid Harrier	Accipitridae	LR/nt														■									
Hartlaub's Duck	Anatidae	LR/nt																							Semliki river
Madagascar Pond-heron	Ardeidae	VU																				■			Rare vagrant in Uganda
Shoebill	Balaenicipitidae	LR/nt																				■			Mainly in areas with extensive papyrus
Red-faced Barbet	Capitonidae	LR/nt													■	▒									
White-naped Pigeon	Columbidae	LR/nt			▒	■																			Mainly Semliki & Kibale National Parks
Shelley's Crimson-wing	Estrildidae	VU		■																					
African Green Broadbill	Eurylaimidae	VU		■																					
Lesser Kestrel	Falconidae	VU								▒	▒	▒	▒	■	■	■	▒	▒							
Taita Falcon	Falconidae	LR/nt		■																					Thought to be extinct in Uganda
Black-winged Pratincole	Glareolidae	DD																							Mainly on large, rocky rivers
Black-crowned Crane	Gruidae	LR/nt																			■			▒	Only in far Northwest
Blue Swallow	Hirundinidae	VU														■									
Dwarf Honeyguide	Indicatoridae	LR/nt		■																					
Lagden's Bush-shrike	Laniidae	LR/nt		■																					
Papyrus Gonolek	Laniidae	LR/nt																				■			
Chapin's Flycatcher	Muscicapidae	VU		■																					
Forest Ground-thrush	Muscicapidae	LR/nt				■																			Predominantly Semliki National Park
Grauer's Rush Warbler	Muscicapidae	EN																				■			Exclusively highland swamps
Karamoja Apalis	Muscicapidae	VU															▒		■	■					
Kivu Ground-thrush	Muscicapidae	LR/nt		■																					

SPECIES COMMON NAME	FAMILY	THREAT CATEGORY	LANGDALE-BROWN VEGETATION CATEGORIES																						
			A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	NOTES
Papyrus Yellow Warbler	Muscicapidae	VU																				■			
Denham's Bustard	Otididae	LR/nt												▒	▒	■									
Nahan's Francolin	Phasianidae	EN				■																			Only Budongo, Bugoma & Mabira forests
Lesser Flamingo	Phoenicopteridae	LR/nt																							Only on alkaline lakes of QENP & Kyambura WR
Entebbe Weaver	Ploceidae	DD																							Species has not been generally accepted.
Sassi's Greenbul	Pycnonotidae	LR/nt				■																			Only Semliki forests
Corncrake	Rallidae	VU														■									
Great Snipe	Scolopacidae	LR/nt																			■	▒			
Turner's Eremomela	Sylviidae	EN		■																					Only one record for Uganda
Number of threatened species in each vegetation type			0	8	1	4	0	0	0	1	1	2	2	3	4	7	3	2	1	1	2	6	0	1	

■ Key Habitat

▒ Occurs

Table 8. Occurrence by vegetation type of IUCN-listed Red Data species of mammals in Uganda, listed alphabetically by family

SPECIES NAME	FAMILY	THREAT CATEGORY	LANGDALE-BROWN VEGETATION CATEGORIES																						NOTES
			A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	
Idiurus zenkeri	Anomaluridae	LR/nt			■	■																			
Aepyceros melampus	Bovidae	LR/cd													■	■									
Alcelaphus buselaphus	Bovidae	LR/cd												■	■										
Cephalophus nigrifrons	Bovidae	LR/nt		■	■																				
Cephalophus nigrifrons ssp. rubidus	Bovidae	EN		■																					
Cephalophus rufilatus	Bovidae	LR/cd											■	■	■										
Cephalophus silvicultor	Bovidae	LR/nt		■	■																				
Cephalophus weynsi	Bovidae	LR/nt			■	■	■																		
Damaliscus lunatus	Bovidae	LR/cd												■	■		■								
Gazella granti	Bovidae	LR/cd																■							
Hippotragus equinus	Bovidae	LR/cd													■	■									No recent sightings
Kobus ellipsiprymnus	Bovidae	LR/cd						■								■			■						
Kobus ellipsiprymnus ssp. defassa	Bovidae	LR/cd														■			■						
Kobus kob	Bovidae	LR/cd														■		■							
Kobus kob ssp. Leucotis	Bovidae	LR/nt																■							
Kobus kob ssp. Thomasi	Bovidae	LR/cd														■		■							
Neotragus batesi	Bovidae	LR/nt				■																			No recent sightings
Oreotragus oreotragus	Bovidae	LR/cd													■	■									
Oryx gazella ssp. beisa	Bovidae	LR/cd															■	■	■						No recent sightings
Ourebia ourebi	Bovidae	LR/cd														■									
Redunca fulvorufula (LR/cd)	Bovidae	LR/cd		■																					
Redunca redunca	Bovidae	LR/cd															■			■		■			
Syncerus caffer	Bovidae	LR/cd			■	■	■								■	■									
Taurotragus derbianus[a]	Bovidae	LR/nt																							
Tragelaphus derbianus ssp. gigas	Bovidae	LR/nt						■				■									■				
Tragelaphus eurycerus[b]	Bovidae	LR/nt						■				■									■				

SPECIES NAME	FAMILY	THREAT CATEGORY	LANGDALE-BROWN VEGETATION CATEGORIES																						NOTES
			A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	
Tragelaphus eurycerus ssp. isaaci	Bovidae	EN																							
Tragelaphus imberbis	Bovidae	LR/cd															■	■	■						
Tragelaphus oryx	Bovidae	LR/cd		■															■						
Tragelaphus spekii	Bovidae	LR/nt				■																■	■		
Tragelaphus strepsiceros	Bovidae	LR/cd		■										■	■	■									
Lycaon pictus	Canidae	EN													■		■	■	■						No recent sightings
Cercopithecus lhoesti	Cercopithecidae	LR/nt		■	■																				
Cercopithecus mitis ssp. kandti	Cercopithecidae	EN		■																					Only known in Mgahinga
Colobus angolensis ssp. ruwenzorii	Cercopithecidae	VU		■	■																				
Procolobus badius ssp. ellioti	Cercopithecidae	DD			■																				
Loxodonta africana	Elephantidae	EN			■	■	■	■															■		
Saccolaimus peli	Emballonuridae	LR/nt		■	■	■	■																	■	
Acinonyx jubatus	Felidae	VU												■	■	■									
Panthera leo	Felidae	VU												■	■	■									
Galago matschiei	Galagonidae	LR/nt			■	■	■								■										
Giraffa camelopardalis	Giraffidae	LR/cd													■										
Okapia johnstoni	Giraffidae	LR/nt				■																			Possibly extinct in Uganda
Bdeogale jacksoni	Herpeestidae	VU		■	■																				
Gorilla beringei	Hominidae	EN		■	■																				
Pan troglodytes	Hominidae	EN																							
Pan troglodytes ssp. schweinfurthii	Hominidae	EN			■	■	■																		
Crocuta crocuta	Hyaenidae	LR/cd											■	■		■									
Hystrix cristata	Hystricidae	LR/nt				■	■							■		■									
Manis temminckii	Manidae	LR/nt																							
Cardioderma cor	Megadermatidae	LR/nt													■		■			■					
Chaerephon chapini	Molossidae	LR/nt																							Distribution uncertain
Mops congicus	Molossidae	LR/nt			■	■																			
Mops demonstrator	Molossidae	LR/nt				■	■																		
Mops trevori	Molossidae	LR/nt				■	■																		

SPECIES NAME	FAMILY	THREAT CATEGORY	A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	NOTES
Otomops martiensseni	Molossidae	VU			X																			X	
Dasymys incomtus	Muridae	DD						X													X	X			
Dasymys montanus	Muridae	VU		X	X																				
Oenomys hypoxanthus	Muridae	DD			X	X	X	X																	
Otomys denti	Muridae	LR/nt			X	X																			
Otomys typus	Muridae	LR/nt		X	X																				
Pelomys hopkinsi	Muridae	VU																			X	X			
Pelomys isseli	Muridae	VU														X					X			X	
Rhabdomys pumilio	Muridae	DD		X	X																				
Tachyoryctes ankoliae	Muridae	VU																						X	
Aonyx congica	Mustelidae	DD		X	X	X																			
Rhinolophus alcyone	Rhinolophidae	LR/nt			X	X	X																		
Rhinolophus maclaudi	Rhinolophidae	LR/nt		X																					
Funisciurus carruthersi	Sciuridae	VU		X	X																				
Paraxerus alexandri	Sciuridae	LR/nt			X	X	X																X		
Crocidura selina	Soricidae	EN				X																			
Micropotamogale ruwenzorii	Tenrecidae	EN		X	X																				No recent sightings
Praomys jacksoni	Tenrecidae	LR/nt			X	X	X	X																	
Hyemoschus aquaticus	Tragulidae	DD				X																			No recent sightings
Chalinolobus egeria	Vespertilionidae	LR/nt			X																				
Chalinolobus gleni	Vespertilionidae	LR/nt			X																				
Miniopterus schreibersi	Vespertilionidae	LR/nt					X	X																	
Number of threatened species in each vegetation type			0	19	29	22	14	8	0	0	0	2	2	7	13	15	6	7	6	2	5	4	3	4	

The columns A–Z are headed: LANGDALE-BROWN VEGETATION CATEGORIES

NOTES

a Giant Eland reported in literature to have occurred in W Nile and Pian Upe

b Bongo reported to have occurred in Acholi on Sudan border occupying dense mountain & forests Bamboo forest. Not sure it still exists

Forests were ranked through an 11-step procedure, described in detail in the FNCMP (1999). The overall result was the selection of eight forests as 'prime' (including the five that are now NPs); 11 more were ranked 'core' and a further 25 as 'secondary'. The thirty-nine which are FRs are scheduled to have Nature Reserves within them: the total area of these will amount to 20% of the national forest estate. In a further 30% of the estate, limited use will be allowed, with commercial selective logging in the remaining 50%. (Implementation has so far been slow, however, largely due to delays in the establishment of a new Forest Authority).

4.15 Important Bird Areas

Important Bird Areas or IBAs are a series of sites whose selection has been co-ordinated globally by BirdLife International. For Africa alone, more than 1200 have been identified (Fishpool & Evans 2000). Together, they form a network which, if adequately protected, will help to conserve all bird species for which site-based conservation is appropriate. All IBAs have to meet internationally-agreed criteria, such as regular occurrence of threatened species, biome-restricted species and large congregations of birds. There is evidence that, taken as a set, IBAs are effective for the conservation of all taxa, not just birds (MUIENR, unpubl. Data).

`Thirty IBAs have so far been identified for Uganda (Byaruhanga *et al* 2001). A workshop reviewed each of them in detail (BLI 2001) with respect to such characteristics as conservation importance, integrity of the area (itself related to human population levels, levels of encroachment and similar criteria). These various measures were combined to give a threat score from 1 (low) to 4 (high).

4.2 Special species

There is also a column in Table 4 showing the presence of dangerous species or those which are particularly sensitive to human presence. Species included here are:

- Dangerous species: lion, elephant, buffalo, crocodile, wherever they are known to be reasonably common.
- Sensitive species: gorilla and common chimpanzee, mainly because of the risks of disease transmission, particularly from man to apes.

Nowadays, none of these species occurs in significant populations outside PAs, and their relevance here is therefore in determining acceptable multiple-use zones within those PAs where they occur. Clearly one should not encourage bee-keeping, collection of thatch materials and so on if people would be exposed to high levels of risk, or where they themselves might be a danger to great apes.

4.3 Ranking of sites

The final column in Table 4.3 ranks the sites according to the criteria described in Section 4.1. The geographical distribution of all 37 sites is shown in Figure 3. Thirteen sites are rated 'high', 14 as 'medium' and 10 as 'low'. Whilst the whole process contains elements of subjectivity, the second two categories should not be considered unimportant, as they all qualify as 'critical sites' under the definition in the introduction to Section 4.

The highest-ranked sites are the ones which are least suitable for consumptive resource use. They are small, already being exploited, or unprotected, despite having high conservation importance. Where dangerous or sentistive species occur in appreciable numbers, extra care needs to be exercised when considering resource use – for example in demarcating multiple-use zones.

4.4 Distribution of Red Data species by vegetation type

In Tables 5 to 8, we indicate those vegetation types where Red Data species (Section 4.12) occur, for flowering plants, butterflies, birds and mammals. Of these, only birds are really well-known, whilst flowering plants and butterflies are both poorly-known in terms both of distribution and of threat assessment. The vegetation types (L-B) are as in Table 1.

These tables form part of the Database, but they also yield interesting features for our general survey, although the vegetation types shown for each species should only be regarded as an indication. Some highly-specialised species (such as papyrus in permanent swamps) are restricted to one vegetation type, but others are much more widespread. Migratory birds and butterflies, cultivated plants and some other species can occur almost anywhere, the latter being largely dependent upon peoples' wishes and the success or otherwise of their efforts. The tables are thus limited to showing the more important vegetation types for each species.

In due course, as the NBDB acquires sufficient data, species distributions will be mapped. For Uganda, the first such group will be birds (Carswell *et al*, in press), but that atlas has yet to be published. Even then, information on scarce species, particularly those of nondescript appearance such as the Karamoja Apalis *Apalis karamojae*, is certainly inadequate for useful conservation measures to be contemplated. The situation is worse for most other Red Data species.

The number of species listed for each vegetation type is given at the bottom of Tables 5 to 8, and summarized in Table 11, and the distributions of the various L-B vegetation types with respect to the combined numbers of Red Data species is shown in Figure 4.

Plants considered as prospectively useful resources (Baldascini 2002) are treated similarly to flowering plants (Table 5); they are listed in Table 9 and the totals again included in Table 11. Figure 5 shows the distribution of L-B vegetation types according to the number of plant resource species likely to occur in each type.

For the Red Data species, forested ecosystems (vegetation types B to D) are particularly important, followed by drylands (M to V) (Table 11). On the other hand, the least important vegetation types are amongst the moist savannas, H to K (Table 1). To an extent which is at first surprising, the situation for Baldascini's plant resources is the converse, with H to K being nearly as important as forests, and drier savannas and wetlands relatively unimportant (Table 9). As mentioned in Section 2.1, most of the moist savannas show signs of being derived from forested types by many years of cutting and burning. They are not, therefore, a completely 'natural habitat'. Most Red Data species are rare, and adapted to specialized habitats; consequently relatively few are found in these vegetation types. The large species numbers consist mainly of non-specialists, few of which are Red Data-listed.

The main vegetation types of the critical sites (Table 4) are indicated in Table 10. Again, forested ecosystems score highly, together with two dryland types.

Geographically, when we combine the Red Data species from the four taxa included in Table 5-8 and 10, a parallel to the Critical Sites is apparent (compare Figures 3 and 4). This could be taken as a confirmation that a mixture of chance, good fortune and effective planning have ensured that the major PAs are all in the right places. Even the sites which are not yet PAs fall in the same general areas, with the notable exception of three sites in the north-west. However, it could also be that the conservation community has concentrated its efforts in the PAs, producing more data for them, including Red Data. Further, lists of Red Data species are only one contribution to our assessment of conservation value; others commonly included are species richness and various measures of rarity. The FNCMP (1999) assesses a number of measures in some detail.

Ideally, resource use should be most encouraged in places where high demand coincides with low conservation importance. A suggestion as to how this might work out in practice is given in the final row of Table 11, which as it were, shows Baldascini's (2002) resources *minus* Red Data species and critical sites. This argues quite strongly for efforts to encourage greater resource use to be concentrated on moist savannas whilst avoiding, so far as possible, the other major biomes: forest, drylands and wetlands. Geographically, as can be seen from Figure 6, the green areas – where increased use of natural resources is of least conservation concern – are predominantly in the north of Uganda.

Table 9. Plant species characteristic of various vegetation types, as determined from the study by Baldascini (2002). They are arranged alphabetically by family.

SPECIES NAME	FAMILY	LANGDALE-BROWN VEGETATION CATEGORIES																						NOTES ON STATUS IN UGANDA
		A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	
Agave sisalana	Agavaceae					■																	■	Exotic species, planted widely
Mangifera indica	Anacardiaceae				■	■	■	■	■	■	■	■	■	■	■	■								Exotic species, planted widely
Rhus vulgaris	Anacardiaceae							■	■	■														
Annona muricata	Annonaceae																							Exotic species
Annona senegalensis	Annonaceae							■					■	■										
Annona squamosa	Annonaceae																						■	Exotic species
Carissa edulis	Apocynaceae						■																	
Funtumia elastica	Apocynaceae			■	■	■																		
Polyscias fulva	Araliaceae		■	■	■	■	■	■																
Balanites aegyptica	Balanitaceae												■	■				■	■					
Markhamia lutea	Bignoniaceae			■	■	■	■																	
Spathodea campanulata	Bignoniaceae			■	■	■	■																	
Kigelia africana	Bignoniaceae								■	■														
Canarium schweinfurthii	Burseraceae			■	■	■																		
Tamarindus indica	Caesalpiniaceae								■	■	■	■	■	■										Planted widely
Warburgia ugandensis	Canellaceae			■	■	■																		
Cleome gynandra	Capparaceae																						■	Preserved in gardens
Catha edulis	Celastraceae		■																					
Combretum collinum	Combretaceae							■		■	■				■									
Vernonia amygdalina	Compositae					■	■																■	Cultivated areas also
Tagetes minuta	Compositae																						■	
Cannabis sativa	Connabidaceae																							Often planted
Cupressus lusitanica	Cupressaceae																							Widespread hedgerow species; exotic
Cyperus papyrus	Cyperaceae																				■			
Dracaena fragans	Dracaenaceae				■	■	■	■	■	■														Often planted
Diospyros mespiliformis	Ebenaceae											■	■											
Alchornia cordifolia	Euphorbiaceae			■	■	■																■		
Aleurites moluccana	Euphorbiaceae																							Exotic species, increasingly planted, mainly ornamental
Euphorbia hirta	Euphorbiaceae																						■	
Dovyalis abyssinica	Flacourfiaceae		■	■		■																		
Dovyalis caffra	Flacourfiaceae			■	■	■	■	■	■	■	■	■	■	■										Exotic species, planted widely

SPECIES NAME	FAMILY	LANGDALE-BROWN VEGETATION CATEGORIES																						NOTES ON STATUS IN UGANDA
		A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	
Dovyalis macrocalyx	Flacourfiaceae			■	■	■	■	■	■	■	■	■	■	■										
Arundinaria alpina	Gramineae		■																					
Oxytenanthera abyssinica	Gramineae						■																	
Harungana madagascariensis	Gultiferae				■	■	■	■	■	■												■		Pioneer species
Lentinus prolifer	Hydnaceae																						■	
Cinnamomum zeylanicum	Lauraceae																						■	Exotic species, planted widely
Azadirachta indica	Malvaceae									■	■		▒		▒									Exotic species
Sida cuneiflora	Malvaceae																						■	
Carapa procera	Meliaceae			▒	■																			
Entandrophragma angolense	Meliaceae			■	■																			
Entandrophragma cylindricum	Meliaceae			■	■																			
Entandrophragma excelsum	Meliaceae		■	■																				
Entandrophragma utile	Meliaceae			■	■																			
Khaya anthotheca	Meliaceae			■	■																			
Khaya grandifoliola	Meliaceae			■	■																			
Khaya senegalensis	Meliaceae										■	■	■											
Acacia senegal	Mimosaceae									■	■	■	■	■										
Albizia coriaria	Mimosaceae				■	■	■			■	■													Pioneer species
Acacia gerrardii	Mimosaceae						■	■	■															
Acacia hockii	Mimosaceae								■	■								■						
Ficus dicranostyla	Moraceae									■	■		■											
Ficus natalensis	Moraceae			■	■	■	■	■	■	■	■	■	■	■									■	Planted widely
Ficus vasta	Moraceae															■	■	■						
Milicia excelsa	Moraceae				■	■	■	■	■	■					■									Planted widely
Moringa oleifera	Moringaceae																		■					Exotic species
Syzygium cuminnii	Myrtaceae				■	■	■	■	■															Exotic species
Syzygium guineense	Myrtaceae						■	■																
*Eucalyptus saligna (= grandis)**	Myrtaceae																							An exotic planted widely in Central Uganda
Eugenia (capensis) bukobensis	Myrtaceae			■	■	■																		
Lophira alata	Ochnaceae							■	■	■														
Ximenia americana	Olacaceae						■	■			■	■												
Averrhoa carambola	Oxalidaceae																						■	Exotic species; often in banana and coffee plantations
Borassus ethiopum	Palmae									■														

SPECIES NAME	FAMILY	LANGDALE-BROWN VEGETATION CATEGORIES																						NOTES ON STATUS IN UGANDA
		A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	
Calamus deeratus	Palmae																					■		
Elaeis guineensis	Palmae			■	■	■																■		Increasingly planted commercially
Phoenix reclinata	Palmae			■	■																	■		
Raphia farinifera	Palmae			■	■																	■		
Erythrina abyssinica	Papilionaceae					■	■	■	■	■	■	■	■	■	■	■								
Sesbania sesban	Papilionaceae																					■	■	Widely planted species
Pinus caribaea (E)	Pinaceae																							Planted widely as ornamental and in plantation
Pinus patula (E)	Pinaceae																							Planted widely as ornamental and in plantation
Podocarpus latifolius	Podocarpaceae			■	■																			
Securidaca longepedunculata	Polygalaceae								■	■														
Ziziphus mauritiana	Rhamnaceae						■					■	■	■										
Maesopsis eminii	Rhamnaceae			■	■	■																		
Prunus africana	Rosaceae		■	■	■																			
Cordia Africana	Boraginaceae			■	■	■	■	■																Mpigi and Wakiso District: Buvuma, Namunyoro, Entebbe
Zanthoxylum microphyllum	Rutaceae		■	■	■																			
Butyrospermum paradoxum	Sapotaceae										■													
Cyphomandra betacea	Solanaceae		■	■	■	■	■																	Exotic species, often planted
Solanum incanum	Solanaceae																						■	Also preserved in gardens, although a weed
Armillaria mellea	Tricholomataceae																						■	
Termitomyces aurantiacus	Tricholomataceae					■	■		■	■					■								■	Fungus species from termite mounds
Termitomyces eurrhizus	Tricholomataceae					■	■		■	■					■								■	Fungus species from termite mounds
Typha spp.	Typhaceae																				■			
Steganotaenia araliacea	Umbelliferae							■																
Tectona grandis	Verbenaceae																							Mainly in plantations
Aframomum angustifolium	Zingiberaceae		■	■	■																			
Number of species in each vegetation category		**0**	**10**	**30**	**33**	**28**	**24**	**19**	**19**	**23**	**14**	**11**	**14**	**10**	**7**	**3**	**1**	**3**	**2**	**0**	**2**	**7**	**16**	

* this species is much more important than *E. citriodora* of Baldascini's list

Sources: plant list from Baldascini (2002); distribution data from the Makerere University Herbarium (P Ssegawa, pers comm.), Agnew & Agnew 1994, Beentje 1994, Eggeling & Dale (nd), Hamilton 1991, Katende *et al* 1995, Katende *et al* 1999

Table 10. Vegetation types found in critical sites, listed alphabetically.

CRITICAL AREAS	LANGDALE-BROWN VEGETATION CATEGORIES																							NOTES
	A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	ww	
Ajai												■							■			■		
Budongo Forest Reserve				■	■				■			■												
Bugoma Forest Reserve				■	■																			
Bwindi Impenetreble National Park		■	■																					
Doho Rice Scheme																					■			
Echuya Forest Reserve		■																						
Era Forest Reserve						■				■														
Getom swamp																			■					
Kalinzu-Maramagambo FR			■	■		■																		
Kasyoha-Kitomi Forest Reserve			■	■	■	■																		
Kibale National Park			■	■	■																			
Kidepo Valley National Park												■			■		■		■					
Kigezi Wildlife Reserve				■										■										
Kyambura Wildlife Reserve														■					■	■				And saline lakes
Labwor Hills Forest Reserve										■		■												
Lake Bisina														■					■				■	
Lake Mburo National Park													■	■									■	
Lake Nabugabo														■						■			■	
Lake Nakuwa																				■			■	
Lake Opeta																				■			■	
Lutembe Bay																							■	
Mababa Bay																				■			■	

CRITICAL AREAS	LANGDALE-BROWN VEGETATION CATEGORIES																							NOTES
	A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	ww	
Mabira Forest Reserve				■	■							■												
Malamagambo Forest Reserve			■	■				■				■		■								■		
Mgahinga Gorilla National Park	■	■			■																			
Moroto Forest Reserve		■			■																			
Mount Elgon National Park	■	■																						
Mt Kei Forest Reserve										■		■												
Murchison Falls Conservation area							■		■			■		■				■						
Musambwa Islands																								Mainly bare rock
Nyamiriro swamp																					■			
Nyangea-Napore Forest Reserve					■							■												
Otzi Forest Reserve						■				■														
Queen Elizabeth Conservation area				■		■							■	■						■			■	And saline lakes
Rwenzori Mountains National Park	■	■																						
Sango Bay forests																				■	■			
Semliki National Park				■																				
Semliki Wildlife Reserve					■						■	■		■										
Ssese Islands			■																				■	
Tororo Rock									■													■		And bare rock
Total Number of Habitats	**3**	**6**	**6**	**10**	**9**	**5**	**1**	**1**	**3**	**4**	**1**	**10**	**2**	**9**	**1**	**1**	**1**	**1**	**5**	**9**	**1**	**3**	**9**	

Table 11. Summary of plant resources and critical sites by vegetation categories

		A	B	C	D	F	G	H	J	K	L	M	N	P	Q	R	S	T	V	W	X	Y	Z	ww
Biodiversity resources		0	10	30	33	28	24	19	19	23	14	11	14	10	7	3	1	3	2	0	2	7	16	0
Biodiversity conservation: *Critical sites*		3	6	6	10	9	5	1	1	3	4	1	10	2	9	1	1	1	1	5	9	1	3	9
Red Data Species :	Flowering plants	0	8	15	17	9	4	1	1	4	4	1	6	1	4	0	0	1	1	3	1	2	2	0
	Butterflies	0	8	17	13	3	1	0	0	0	2	2	3	4	7	3	2	1	1	2	6	0	1	0
	Birds	0	8	1	4	0	0	0	1	1	2	2	3	4	7	3	2	1	1	2	6	0	1	0
	Mammals	0	19	29	22	14	8	0	0	0	2	2	7	13	15	6	7	6	2	5	4	3	4	0
Conservation totals		3	49	68	66	35	18	2	3	8	14	8	29	24	42	13	12	10	6	17	26	6	11	9
Natural resource use potential[a]		-3	-39	-38	-33	-7	6	17	16	15	0	3	-15	-14	-35	-10	-11	-7	-4	-17	-24	1	5	-9

Note a: this is simply the values in the top row (Biodiversity resources) minus the penultimate row (Conservation totals); see also Figure 6.

5 SOUTH-WESTERN UGANDA

South-western Uganda for this study consists of the following eight districts: Kisoro, Kabale, Ntungamo, Mbarara, Rukungiri, Kanungu, Kasese and Bushenyi. Mbarara was added to those currently considered under various USAID-funded projects because it contains less cultivation than the others, and thus makes the region rather more representative of Uganda as a whole. Further, it has much more extensive savanna habitats than the other seven districts, with pastoralism as the major land use.

Figure 7, which was prepared in the same way as Figure 1, shows the Districts of the south-west in greater detail. It is immediately apparent that in Kisoro, Kabale, Rukungiri (which here includes the recently-created Kanungu), Bushenyi and Kasese, no extensive areas of natural vegetation remain outside the main PAs. Mbarara, and to a lesser extent Ntungamo, retain considerable uncultivated grazing areas, although that too is changing.

There are, however, pockets of natural vegetation in many places, as is clear from comparing Figure 8 with Figure 7. Figure 8 is based on the NBS's 1:50,000 databases, and reveals many small areas of natural vegetation. Others, too small to map even at this scale, will be found along roads and rivers, near rocky outcrops and suchlike places. Altogether, therefore, there are likely to be some natural plant resources available for uses such as preparing medicines, but not often will there be sufficient of them to support much collection of firewood or poles.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Ugandans have inherited a very rich flora and fauna, but the country is rapidly losing its biodiversity: a preliminary estimate (Arinaitwe *et al* 2000) suggests an overall rate of loss of about 1% per year. Planned agricultural developments, urgently needed to improve peoples' lives, will further reduce the habitats of many species, whilst a wide range of human activities continues to degrade non-farmland areas, especially (but by no means only) outside PAs.

If we compare Figure 6 of this report (showing areas most suitable for greater use of natural resources) with Figures 5 and 11 of IFPRI 2001 (land use options for agriculture), there are some areas of agreement. However, almost all parts of Uganda considered suitable for agricultural expansion are in the south or west, and consequently conflict with areas where we have proposed more limited activity. Exceptions include parts of Rukungiri, Bushenyi and Kanungu Districts in the SW; Nebbi, Arua and Moyo in the NW; and Tororo, Pallisa and Kumi in the SE.

On the other hand, areas where cultivation is thought likely to expand compare quite well to areas where Baldascini (2002) found good numbers of prospectively useful plant species. Although the total area which we consider suitable for encouraging more use of natural resources amounts to less than half of Uganda (Figure 6) there is another alternative. Many of the plants on Baldascani's list (Table 9) can be cultivated – indeed, a number already are, including all of the exotics. Table 9 provides an indication as to where planting programmes are most likely to succeed.

Agricultural expansion tends to 'just happen', mainly through population pressure. In this it often differs from intensification, which is much more susceptible to policy inputs. However, in this case there could be a happy coincidence! As peace spreads through northern Uganda, people will be able to return to their land and spread into new areas. This process of extensification will be encouraged by the government's overall policy of assisting the north to catch up with the south, and at the same time, increased use of natural resources will be least harmful in these areas. This is the most obvious win-win outcome of our analyses.

Whilst there are indications that forests are the most important vegetation types, data for other types are much more limited. Forests are of relatively high value from all points of view – including economic. Our study thus supports many others that favour much greater protection for forests, which is often compatible with sustainable use. Even better is to replant degraded forests, as FACE is attempting to do (Section 2.42).

6.2 Data gaps

Uganda's biodiversity is better-known than that of many other tropical African countries. At the same time, it is being degraded or lost quite rapidly (Section 2.3). Better information is needed for proper planning, to help minimize losses, and to enable Uganda to meet its international obligations, for example under the Convention on Biological Diversity and the Ramsar Convention on wetlands.

We also have very little accurate information on the effects of changing land use on biodiversity. For cultivated areas the report of Nachuha & Pomeroy is just a start, and it only considers birds.

The increasing short-fall in the supply of trees for timber, charcoal and other uses, is well-known, but why do many tree species regenerate so slowly (Section 2.4), with consequent implications for carbon sequestration?

The economic values of land for alternative uses are poorly known. Options include sustainable uses and non-consumptive uses of the natural vegetation. At present, the more extensive studies (Clausen & Gholz 2001; Emerton & Muramira 1999) depend heavily upon secondary data, and deal with very broad types of vegetation (basically those of the NBS 1996). Filling these gaps involves further research (there are inadequate data from the field) as well as following-up some existing data sources, which have only been mentioned in this report. There is a strong case for well-targeted original research, rather than the present heavy reliance on research which, for the most part, has been done for other reasons, often of an academic nature.

6.3 Recommendations

There is an urgent need to devise more innovative ways of using Uganda's biological resources without necessarily converting much more land to agriculture. For example, many desirable plant species can be cultivated to supplement what is available from the wild. Likewise, opportunities for game ranching, although limited, could be explored more fully.

The outcomes of this study will, we hope be useful for SCRIP (Section 1.1) in considering what and where to be worth following up. And it has left many gaps, such as the very limited extent to which, at present, we can put economic values on various alternative land uses in different vegetation types. For example, what is foregone by allocating land on vegetation type α to conservation, rather than to peasant agriculture, tree farming, or some alternative new land use? Some useful data exist, but a detailed study would be a large undertaking.

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