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VOLUME 11
TECHNICAL REPORTS

Consultancy report prepared for
Direcção Provincial de Agricultura e Pecuaria (DPAP),
Tete Province, Mozambique

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ZAMBEZI SOCIETY/BIODIVERSITY FOUNDATION FOR AFRICA
PROPOSAL FOR
BIODIVERSITY EVALUATION FOR DPAP, TETE PROVINCE

1. INTRODUCTION

Direccao Provincial de Agricultura e Pecuaria (DPAP), Tete Province, in collaboration with the Ford Foundation, wishes to undertake an ecological zoning exercise in the Tchuma Tchato project area on the north and south sides of Cabora Bassa lake. The geographical area of the study will extend southwards to the Zimbabwe border, downstream to Songo, and northwards to the Zambian border, as outlined on the attached map. The purpose of the zonation is to provide an ecologically sound basis for developmental planning that will maintain maximum biological diversity within the area, and also to provide an indication of potential areas for biodiversity- and/or wilderness-based tourism.

The Zambezi Society/Biodiversity Foundation for Africa (ZAMSOC/BFA) partnership has been asked by DPAP and the Ford Foundation to develop a proposal for ecological zonation that will fulfil these requirements by: -

Creating a broad ecological map of the area;

Identifying areas of particular biodiversity conservation interest;

Identifying areas of particular wilderness value;

Making a preliminary identification of specific sites of high biodiversity importance; and

Providing recommendations enabling developmental planning agencies to minimise impacts on sites and areas with high biodiversity and wilderness values.

The southern portion is likely to be similar to the mid-Zambezi valley communal lands in Zimbabwe, which have been well studied from this perspective. Mopane and short woodland types are likely to predominate. A number of sites of high botanical interest and importance, which extend across the international border, have already been identified within Zimbabwe. The northern sector appears to comprise various types of moister miombo woodland. Information from Zambia, in particular from areas adjacent to the Luangwa Valley, may prove useful.

As a cautionary note, it is important to appreciate that a full biodiversity study across an area of this size is an open-ended task, and it is impossible to acquire realistic data on all groups and taxa within the resources and time-frame of a project of this kind. It is, however, possible to gain a useful understanding of probable diversity, sufficient for planning purposes, firstly from a broad study of vegetation type, and thereafter by acquiring data on carefully-selected taxonomic groups.

It is therefore proposed to undertake a two-phase study. The initial, preliminary phase will be undertaken by utilising existing literature, satellite imagery, and light aircraft overflights in order to produce an ecological stratification, a preliminary landscape vegetation map, and a broad indication of areas of probable conservation interest. This will provide useful data for broadscale developmental planning. The second phase will verify and refine the findings from the preliminary stratification, acquire data on selected taxonomic groups, and provide an indication of sites (as opposed to broader areas) of high biodiversity importance.

During early discussions DPAP asked whether the mapping of human settlement was practical during this exercise. Such settlement does not necessarily show up well on satellite imagery. Also, the cost of flying sufficient transects to identify all such settlement, coupled with difficulties in producing accurate mapping from subjective observation, renders the use of light aircraft unsuitable for this purpose. Should this be a major requirement, it is recommended that DPAP explore the possibility of acquiring aerial photography as a separate project. Such photography would also have applications during the ecological stratification.

It is also important to note that any assessment of wilderness values will largely reflect the views of project personnel. This is because of the absence of any universally-recognised criteria for the determination of wilderness values. However, The Zambezi Society is currently attempting to identify such criteria within the Zambezi Basin context in the course of a separate project. An attempt will be made to utilise the findings from this project in the assessment required by DPAP and Ford Foundation.

2. PHASE I: RECONNAISSANCE PHASE

This phase will be based primarily on three sources of information:

a. Existing published literature.

b. Satellite imagery (Landsat TM and/or SPOT), and

c. Overflights by light aircraft.

It would be most useful if air photo coverage were available, although it is understood that this would be expensive for such a large area. Aerial photography has not therefore been included in this proposal, but will be utilised should DPAP decide to acquire such photography for other purposes.

There will be four major activities during Phase I:

a. Activity: Literature search and analysis:
Obtain all available literature concerning the project site and adjacent areas. Much of this is already available to ZAMSOC/BFA, but additions will be acquired from libraries such as INIA Maputo. We are also aware that further information may have been acquired by the former Gabinete do Plane de Zambezi, and is likely to be located in Tete. A brief consultancy and copying costs would be required for the Mozambican component.

Output: Bibliography and review of existing geographical, biological and conservation information. This would clearly indicate the state of existing formal knowledge, indicate major points of interest or concern, and possibly also give an indication of conservation and other potentials. Major gaps in knowledge would be identified.

b. Activity: Preliminary ecological stratification:
Satellite imagery will be purchased, if not already available in suitable format. This will provide sufficient information to produce a preliminary ecological stratification at landscape levels. The stratification will require verification from aerial reconnaissance and on the ground.

Output: The main output will be a broadscale map with perhaps 20 mapping units at a scale of around 1:250,000.

c. Activity: Aerial reconnaissance by light aircraft:
Long transects will be flown to partially verify the preliminary interpretation, and to acquire a sense of the terrain. The bases from which the transects are flown will depend on the availability of airstrips and the practicalities of transporting aviation fuel. ZAMSOC/BFA has access to suitable aircraft and piloting skills.

Output: Modification of the preliminary ecological stratification, greater confidence in the mapping units, and a preliminary statement on vegetation types. Areas of possible conservation interest should be identified.

d. Activity: Synthesis of results of activities a-c and reporting

Output: Preliminary identification, description and mapping of:

i. areas (broader units than sites) of possible conservation interest;

ii. Indications of species of particular conservation interest or concern; and

iii. Areas of potential wilderness value.

3. PHASE II: VERIFICATION AND REFINEMENT

This phase will require ground visits to the various mapping units to fully describe them in terms of vegetation and species composition, and to undertake inventorisation work on appropriate taxonomic groups. Visits would also be made to identified areas of conservation interest or concern to confirm their validity and determine their status, and to provisionally identify sites of high biodiversity importance.

As noted earlier, it is not possible to inventorise all taxonomic groups and taxa within the constraints of a project of this nature. Firstly, however, vegetation type provides a useful indication of potential diversity. Secondly, it appears that the major requirements of DPAP will be fulfilled by an indication of the diversity of plants, vegetation, large mammals and birds; and by an indication of lakeshore biodiversity focused on the Cabora Bassa lake shore and offshore islands. It is understood that the large mammal requirement will be substantially fulfilled by the WWF survey proposed for August 1998. It is therefore proposed that the present study focus on plants, vegetation, birds, and lakeshore biodiversity.

The scale of Phase II is largely dependent on the findings of Phase I. However, proposed activities are:

a. Ground-based fieldwork and visits to areas of interest: Appropriate botanical and ornithological expert will visit the mapped units, with particular reference to identified areas of interest. They will record vegetation types, plant and bird species present, and analyse these data to provide a vegetation legend, preliminary checklists, and more detailed descriptions of the areas of interest identified during Phase I. These areas will be re-evaluated in the light of field data and a revised and prioritised descriptive account produced.

Output: Reconnaisance-scale vegetation map and legend, preliminary plant and bird checklists, indication of areas of avian interest, and descriptions of areas and sites of high biodiversity interest and/or importance.

b. Lakeshore diversity survey: Waterborne survey of the Cabora Bassa lakeshore by botanist and ornithologist.

Output: Detailed notes on shoreline sections of biological & conservation interest, constraints on development from a conservation perspective, and an indication of areas of high ecotourism interest.

c. Activity: Synthesis and reporting: The information acquired during both project phases will be synthesised and final maps and report produced.

Output: Refined ecological stratification and vegetation maps; mapping of areas and sites believed to be of importance to biological diversity; species lists in appropriate taxa; description of areas of potential biodiversity tourism interest; description of areas of high wilderness value; recommendations designed to facilitate appropriate developmental planning from the perspective of biodiversity and wilderness maintenance.

4. GIS MAPPING

Hard-copy maps will be provided by the project. However, DPAP also wish to develop a GIS capability. The establishment of a full GIS facility requires expensive plotting equipment and software and a high level of technical expertise. The ability to read GIS data, on the other hand, requires only a suitable desktop computer, readily-available software, and a reasonable level of computer skills. It is therefore proposed that the results of these studies be inputted by WWF Harare, and subsequently provided to DPAP in read-only form, formatted for a suitable desktop GIS application. This will enable DPAP to access appropriate mapping while further developing their GIS capacity over time.

5. TIMING

The first phase of the project can be undertaken during 1998. However, for biological reasons the second phase will need to be undertaken in 1999, close to the end of the rains.

6. COSTINGS

The proposed project budget is attached. All costs are quoted in United States dollars.

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VOLUME 11
TECHNICAL REPORTS

CABORA BASSA
ANNOTATED BIBLIOGRAPHY

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November 2000

Consultancy Report Prepared For
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1. INTRODUCTION

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An important first step in any study is to gather as much published information as is practicable on the area or topic concerned. In these days of high staff turnover at institutions and poorly-referenced and scattered libraries in the region, this is not always easy. Generally, there is a fair amount of information available in the region, but it is scattered across a range of libraries and institutions, while much of it is "grey literature" and inadequately referenced. This type of literature comprises reports of limited circulation rather than formally published papers or books. Such reports are often very difficult to access or even to get to hear about.

The purpose of this annotated bibliography is to provide a list of printed articles, reports, papers and books that are directly concerned with the biodiversity and renewable natural resources of the Tchumo Tchato study area surrounding Lake Cabora Bassa. The area is shown in Map 2, and consists of Lake Cabora Bassa, the area to the north extending from the Zambian border in the west and north to the Rio Luia, and, in the south, from the Zambian and Zimbabwe borders eastwards to a line running south from the Luia-Zambezi confluence.

Although the principal emphasis is on publications concerning this part of Mozambique, articles and reports on immediately-adjacent parts of Zimbabwe and Zambia are included. Also included are some publications on geology, fisheries, hydrology and history of the area that are directly relevant to biodiversity, or provide important background material. Not included, however, are general papers or publications which may cover the area among many others, and publications at a national level, unless specific local detail is given.

2. METHODS

The major initial sources of citations were the annotated bibliography on wetland biodiversity produced for IUCN Zambezi Basin Wetlands project (ZBWCRUP) biodiversity component by the BFA/Zambezi Society, the library of the Natural History Museum in Bulawayo, and personal collections. From citations in these references the bibliography was enlarged. The soils library of the Departamento de Terra e Agua of the Instituto Nacional de Investigaçoes Agronómica in Maputo was searched by Mario Ruy Marques.

Most of the cited references were looked at in detail and a brief abstract written indicating its scope, coverage and major findings. Those it was not possible to physically locate are indicated by "N/S" (not seen). Full citation details are given including author, date, title, series (if applicable), publisher, place of publication and pagination.

For easy reference a set of keywords are used (Table 2.1) to indicate topics covered. Asterisks show the relative importance of each reference to biodiversity knowledge of the study area: * = peripheral or background reference, ** = useful reference, and *** = important or essential reference. These categories are somewhat subjective, but hopefully will assist the user in determining which are most useful.

3. FINDINGS

The total number of references directly relevant to the biodiversity of the Cabora Bassa study area was 34, while an additional 34 are useful but peripheral; a total of 68 references. A breakdown of the numbers for each of the topics is given in Table 2.1.

Table 2.1: Key words used in Cabora Bassa bibliography and numbers of references for each topic.

Topic	**no. refs.**
Plants	22
mammals	8
birds	3
herps	3
fish	16
invertebrates	11
ecology	26
conservation	9
water (including hydrology)	15
agriculture (including livestock)	12
fishing	13
tourism	1
checklist	6
survey	21
history	7
Total no.	**68**

History
A significant number of references (7) cover various historical aspects (pre-1950). Most of these are hunting books from early European travellers to the area. As such they often contain interesting anecdotal evidence of the presence of large mammals, vegetative cover and land use practices. However, as most of them are not rigorously recorded they have limited scientific value. Of particular note is the book by Maughan (1910) who spent much time travelling the broad Zambezia area and made many useful observations on natural history.

Two general travel books from recent years, Edwards (1974) and Main (1992), also contain much useful information on history, landscape and natural history.

Natural Resource Surveys
Of the few references on the natural resources of the area, most are national studies that cover the whole country and are thus not particularly detailed. The vegetation map of Pedro and Barbosa (1955) was updated by that of the Flora Zambesiaca area (Wild & Barbosa 1967). Detailed vegetation studies have been done in Zimbabwe immediately to the south of the study area (Du Toit 1993, Timberlake & Mapaure 1992), while Timberlake (1996) has identified various sites of botanical interest in this part of Zimbabwe, some of which extend into the study area.

The nationwide woody cover mapping exercise in Mozambique (CENACARTA 1995) covers the study area in three sheets at a scale of 1:250,000, but with limited detail. Unfortunately field checking was very limited.

The most recent geological map of the country (Instituto National de Geologia 1987) provides good detail for this geologically-complex area, and that of Broderick (1984) covers this section of the mid-Zambezi valley.

Development and Hydrology
Although this bibliography does not cover developmental issues or hydrology, there have been a number of publications on these topics (31) that incorporate useful information on agriculture, natural resources and physical features. The study on agricultural potential carried out by Loxton-Hunting in the early 1970s (Gabinete do Plano de Zambèze 1973, 1975) in particular is very comprehensive. Others include Fontes (1970), Hidrotécnica Portuguesa (1993) and Missão de Fomento e Povoamento do Zambèze (1961). Publications more related to hydrology, hydropower generation and the hydrological impacts of the dam include Bolton (1978), Davies (1998), Hall & Davies (1974), Pinay (1988), Suska & Napica (1986), World Bank (1996) and ZACPRO (1994). A major recent study (Joint Venture 1999) looking at the potential environmental impacts of new hydroelectric sites, either at Cabora Bassa or downstream, summarises much of this information.

Biodiversity
Most of the publications on the biodiversity of the study area are concerned with either the effects and changes that came about in the few years between construction, filling and "settling down" of Cabora Bassa dam, or with the fish and fisheries of the lake. The main exceptions to this appear to be a 1928/29 study on the birds of a locality outside the study area to the north east (Brooke 1965), some records of freshwater molluscs (Fraga de Azevedo *et al*. 1961), a detailed study of the large mammal of the area from the point of view of conservation (Tinley & Sousa Dias 1973), and a record of the mammals found (Smithers & Tello 1976). A paper by Pinhey (1976) gives an initial list of butterflies and a few other insects. All specimens were collected during a survey before the filling of the dam.

The major work on plants is the series of papers by Gonçalves (1978-1982) who compiled an annotated list of 877 species from Tete Province from specimens deposited at herbaria in Lisbon, Coimbra and Maputo.

The fisheries of Lake Cabora Bassa have been studied by a number of people, both before or soon after its formation (Jackson 1975, Jackson & Rogers 1976, Morais 1974) and following more detailed studies by FAO projects in the early 1980s, particularly relating to kapenta introduction (Bernacsek & Lopes 1984a, 1984b,Gliwicz 1984, 1986, Somer & Gliwicz 1986, Vostradovsky 1984, 1986).

The changes (or potential changes) in ecology and biodiversity resulting from the formation of the lake, and during its "settling down" period in the mid-1970s, were the subject of various careful studies (Bond *et al*. 1978, Bond & Roberts 1978, Davies *et al*. 1975, Hall & Davies 1974, Jackson & Davies 1976, Jackson & Rogers 1976, Macedo 1974 and Morais 19754), while pre-impoundment studies focused on physico-chemical features of the river (Hall *et al*. 1976, 1977, Hall & Vicente 1977). A major recent environmental study (Joint Venture 1999) has looked critically at some of the potential impacts on biodiversity, including the effect on birds residing in the Zambezi Delta.

4. CONCLUSIONS

Our knowledge of biodiversity in Lake Cabora Bassa and the Tchumo Tchato project area is limited, and also very uneven. Compared to the Zimbabwe portion of the mid-Zambezi valley, it is remarkable how little is known.

However, comparatively-speaking, there is adequate coverage in the published and "grey" literature on fish composition and fisheries of the lake. There have also been some good studies of the effects of lake formation on aquatic ecology in the initial years, particularly aquatic weeds, but this does not appear to have been followed up. Detail on the vegetation composition and other terrestrial biodiversity for the project area has been very scant to date. The area was not well-studied in the past, in contrast to the region from Tete downstream to the Shire confluence and the coast which were the focus of a number of early biological collecting trips. This may, perhaps, be due to the inhospitable and inaccessible nature of the terrain in those days, the inability to navigate by boat upstream of the Cabora Bassa rapids, and the fact that the major trading routes used to pass up the Mazoe River, not the Zambezi.

Of major concern, and reflected in the literature (although not cited here as it is more relevant to the Lower Zambezi), has been the impact of Cabora Bassa dam on downstream hydrology and ecology. This concern continues today, but unfortunately most of the baseline studies necessary to determine type and extent of change were not fully implemented or followed up.

It is clear that many more studies need to be done on the general biodiversity, particularly terrestrial, of the project area in order to obtain a clearer idea of what species are present, their conservation status and importance. Coupled with this, some of the earlier studies on changes in lake ecology post-formation need to be followed up. If, as has been suggested, the water release regime of the dam is changed in order to ameliorate some of the downstream ecological and agriculture/fisheries effects of flood control, then attention also needs to be paid to the possible effects on the aquatic biodiversity of the lake and lakeshore.

In summary, except for the lake itself there is inadequate published information available on terrestrial biodiversity to make anything other than inspired guesses as to conservation status or significance. Hopefully, studies under the present project will reduce that significantly.

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ANNEX 2.1 : CABORA BASSA ANNOTATED REFERENCES

Each reference is classified as follows:

* - peripheral
** - useful
*** - important

1. Bernacsek, G.M. & Lopes, S. (1984). Cahora Bassa (Mozambique). In: *Status of African Reservoir Fisheries* (editors J.M. Kapetsky & T. Petr). CIFA Technical Paper No. 10. FAO, Rome, Italy. pp. 21-42.
Account of the fisheries of Cabora Bassa. Fishery at present is grossly underutilised and few data are available. Large fluctuations in water level and high clay loads reduce potential productivity. Data are given on hydrology and water quality. Conflict and inadequate attention paid to biological concerns during design are outlined. From an ecological viewpoint, Cabora Bassa could be "the least studied and least environmentally acceptable dam project in Africa".
*** water, fishing

2. Bernacsek, G.M. & Lopes, S. (1984). Investigations into the fisheries and limnology of Cahora Bassa reservoir seven years after dam closure. FAO/GCP/MOZ/006(SWE) Field Document No. 9. FAO, Rome, Italy. 145 pp. N/S
* water, fishing

3. Bolton, P. (1978). The control of water resources in the Zambezi Basin and its implications for Mozambique. In: *Proceedings of a seminar held at the Centre for African Studies, UEM, Maputo*. University of Edinburgh, Edinburgh, UK. pp. 142-160. N/S
* water

4. Bond, W.J., Coe, N., Jackson, P.B.N. & Rogers, K.H. (1978). The limnology of Cabora Bassa, Moçambique, during its first year. *Freshwater Biology* **8**(5): 433-447.
Account of changes in water quality during the first year of impoundment of Cabora Bassa. There were significant changes in thermal conditions, H_2S levels, water transparency, conductivity and alkalinity associated with the seasons. The high inflow to volume ratio are mentioned which results in a high turnover of waters.
** water

5. Bond, W.J. & Roberts, M.G. (1978). The colonization of Cabora Bassa, Moçambique, a new man-made lake, by floating African macrophytes. *Hydrobiologia* **60**(3): 243-259.
Account of the spread of *Salvinia* and *Eichhornia* on Cabora Bassa in the first year of formation. Mats of the weeds were distributed in the E and W extremities of the lake, with *Eichhornia* being dominant. Heavy drawdown of water led to destruction of half of the mats, but populations quickly recovered. Long term problems are likely to be less than with Lake Kariba.
** plants, ecology

6. Broderick, T.J. (1984). A geological interpretation across a portion of the mid-Zambezi valley lying between the Mkanga and Hunyani rivers, Guruve District. *Annals of the Zimbabwe Geological Survey* **9**: 59-79.
Brief account and map of the geology of part of the mid-Zambezi valley from the northern shoreline of Lake Cabora Bassa south to the Zambezi escarpment in Zimbabwe.
* survey

7. Brooke, R.K. (1965). Ornithological notes on the Furancungo District of Mozambique. *Arnoldia (Rhodesia)* **2**(10): 1-13.
Account of habitats and birds found in a district, outside of the present study area, in the north of Tete Province. These are based on notes made by D. Macpherson in 1928/29. The area consists of miombo woodland and dambos. 105 species are listed with brief notes.
** birds, ecology

8. CENACARTA (1995). Woody cover map of Mozambique. CENACARTA/DNFFB, Maputo, Mozambique.
Maps of woody cover produced for a national forest inventory based on satellite imagery and airphotos. The project area is covered by 8 units, principally 3.2, 3.3, 4.1 and 4.2.
* survey, agriculture, plants

9. Cunliffe, R.N. (1999). Biodiversity evaluation of Tete Province project area, Tete Province, Mozambique: interim progress report. Biodiversity Foundation for Africa/Zambezi Society, Harare, Zimbabwe. 10 pp.
Interim consultancy report including preliminary landscape/vegetation classification of the Cabora Bassa project area (31 units), areas of conservation interest (8 units) and wilderness areas (8 units).
*** survey, ecology, conservation

10. Davies, B.R. (1998). Abstracts and summary. In: *Sustainable Use of the Cahora Bassa Dam and the Zambezi Valley* (editor B.R. Davies). Arquivo do Patrimonio Cultural, Maputo, Mozambique. 37 pp. Draft manuscript.
Proceedings of a workshop on the potentials and problems of Cabora Bassa dam. The downstream effects on fisheries, agriculture and biodiversity are outlined. It was recommended that water release from the dam should closely simulate natural wet and dry season patterns.
** conservation, water, fishing, ecology

11. Davies, B.R., Hall, A. & Jackson, P.B.N. (1975). Some ecological aspects of the Cabora Bassa dam. *Biological Conservation* **8**: 189-201.
Account of the potential impacts of the impoundment of the Zambezi at Cabora Bassa. Discussion includes sections on aquatic weeds, fisheries, bush clearing, wildlife, human health and downstream effects.
*** water, ecology, conservation, fishing

12. Davies, C. (1999). Aerial survey of elephants and other large mammals in the Magoe District in north west Tete Province, Mozambique: 1999. Multispecies Animal Production Systems Project Paper No. 74. WWF SARPO, Harare, Zimbabwe. 14 pp.
Technical account of aerial survey of elephants and other large mammals carried out in the southwestern part of study area (2637 km²) north of the Zimbabwe border. Elephant population was estimated at 400 ±61% giving a density of 0.2 head/km², and 67 elephant carcasses. Other estimates were 22 eland, 222 hippo, 1290 impala, 289 kudu, 22 roan, 22 sable, 178 zebra, 245 ground hornbills, 89 crocodile, 779 cattle, 5028 sheep/goats, 133 donkeys and 200 unidentified carcasses. 22 species were recorded.
** survey, mammals

13. Decle, L. (1974). *Three Years in Savage Africa.* Facsimile reprint of 1900 edition. Books of Rhodesia, Bulawayo, Zimbabwe.
N/S. Travels from Mashonaland through eastern Zimbabwe to the Zambezi in the vicinity of Dande area, down the Zambezi to the Shire confluence, then through Malawi via the Shire river to Lake Malawi. Mainly ethnographic observations with some notes on the large mammal fauna.
* history, mammals

14. Direcção Nacional de Florestas e Fauna Bravia (1995). Mapa Florestal. DNFFB, Ministry of Agriculture and Fisheries, Maputo, Mozambique. A national series of 1:250,000 scale map sheets showing woody cover under 18 units based on density and type of woody cover. Categories are determined from air photos, Landsat TM (1990-1992) and some field work. 12 sheets cover the study area.
* survey, agriculture, plants

15. Du Toit, R. (1993). Reconnaissance vegetation survey of the Chewore-Angwa-Kanyemba area of the Zambezi Valley, Zimbabwe. *Kirkia* **14**(1): 61-77. Detailed vegetation survey of part of the mid-Zambezi Valley adjacent to the southern portion of the Cabora Bassa study area. 18 vegetation types are described and environmental relationships discussed.
* survey, plants, ecology

16. Edwards, S.J. (1974). *Zambezi Odyssey.* T.V. Bulpin, Cape Town, South Africa. 230 pp.
Account of a canoe trip down the Umfuli and Zambezi rivers from Hartley to Chinde at the mouth. Numerous observations on natural history along the way.
* ecology

17. Fontes, F.C. (1970). O plano de desenvolvimento do Vale do Zambezi e o aproveitamento de Cabora-Bassa. *Boletim de Soc. Estudos Moçambique* **39**(164/165): 1-12. Account of potentials for development of the Zambezia region based on the proposed construction of Cabora Bassa dam. A brief history of the project is given.
* history, agriculture

18. Fraga de Azevedo, J., Medeiros, L.d., Faro, M.M.d.C., Xavier, M.d.L. & Gandara, A.F.E.M.T. (1961). Fresh water mollusks of the Portuguese Overseas Provinces III - mollusks of Mozambique. *Estudos, Ensaios e Documentos* **88**: 205-394.
English section of longer work. Review of information on 28 freshwater molluscs across Mozambique with particular reference to those which are potential carriers of bilharzia. Study looks at biology, ecology and taxonomy. 11 species are recorded from Tete Province.
* invertebrates, ecology

19. Gabinete do Plano do Zambèze (1973). Relatorio sobre o potential de pascigo dos Blocos 1-8. Recursos agrarios e planeamento do uso da terra, Bacia do Rio Zambèze. Empresa Técnica de Levantamentos Aereas/R.F. Loxton, Hunting & Associates, Lisbon, Portugal. 8 vols.
N/S. Consultants' report on the grazing potentials of part of the lower Zambezi.
* survey, agriculture

20. Gabinete do Plano do Zambèze (1975). Relatorio sobre o potential de pascigo dos Blocos 9-11. A.O.C. Technical Services/R.F. Loxton, Hunting & Associates, Lisbon, Portugal. 3 vols.
N/S. Consultants' report on the grazing potentials of part of the lower Zambezi.
* survey, agriculture

21. Games, I. (1990). *The feeding ecology of two Nile Crocodile populations in the Zambezi Valley*. PhD thesis, University of Zimbabwe. Harare, Zimbabwe. 265 pp.
Thesis based on studies done on Lake Kariba and western Cabora Bassa. Juvenile crocodiles fed on insects, small mammals, amphibians, birds and fish, while sub-adults fed on fish.
* ecology, herps

22. Games, I. (1992). Utilization of the crocodile resource of Lake Cahora Bassa, Mozambique, 1987 and 1988. In: *The CITES Nile Crocodile Project* (editors J.M. Hutton & I. Games). CITES Secretariat, Lausanne, Switzerland. pp. 133-142.
Account of crocodile harvesting (skins and eggs) from the western portion of Lake Cabora Bassa. 1000 animals were harvested. 281 nests were found.
** survey, herps

23. Games, I., Zolho, R. & Chande, B. (1992). Estimation of crocodile numbers in the Zumbo and Messenguezi basins of Lake Cahora Bassa during 1988 and 1989. In: *The CITES Nile Crocodile Project* (editors J.M. Hutton & I. Games). CITES Secretariat, Lausanne, Switzerland. pp. 122-132.
Account of a crocodile survey of the western portion of Lake Cabora Bassa. Estimated numbers are 3197-6207 in June 1988, thus another 1000 crocodiles could be harvested.
** survey, herps

24. Gliwicz, Z.M. (1984). Limnological study of Cahora Bassa reservoir with special regard to sardine fishery expansion. FAO/GCP/MOZ/006/SWE Field Document No. 8. FAO, Rome, Italy. 71 pp.
Consultants' report on the feasibility of introducing kapenta into Cabora Bassa. Water quality is discussed, along with phytoplankton, primary productivity, zooplankton and kapenta biology.
** fishing, fish, invertebrates, ecology

25. Gliwicz, Z.M. (1986). A lunar cycle in zooplankton. *Ecology* **67**(4): 883-897.
Account of variations in zooplankton density in Cabora Bassa which are linked to phases of the moon. The sudden decrease in density between full moon and last quarter was a result of predation by kapenta fish.
* invertebrates, ecology, fish

26. Gonçalves, A.C.B. (1969). Reconhecimento glossinico no Distrito de Tete. *Vetérinaria Moçambicana* **2**(1): 21-30.
Account of a tsetse survey of the southeastern part of the Cabora Bassa study area between the Luenha, Mazoe and Zambezi rivers. Tsetse is common in the Changara area towards Massanga.
* agriculture, invertebrates

27. Gonçalves, A.E. (1978/79). Catálogo das espécies vegetais vasculares assinaladas na província de Tete, Moçambique – I. Pteridophyta, Gymnospermae e Angiospermae (Ranunculaceae-Oxalidaceae). *Garcia de Orta, Série de Botânica* **4**(1): 13-92.
First part of a list of 877 plant species recorded from Tete Province based on herbarium specimens from Lisbon, Coimbra and Maputo. This part covers 271 species. The districts where each species are found are given, along with specimen citations and habitat.
*** checklist, plants

28. Gonçalves, A.E. (1980). Catálogo das espécies vegetais vasculares assinaladas na província de Tete, Moçambique – II. Angiospermae (Rutaceae-Leguminosae, excl. Papilionoideae). *Garcia de Orta, Série de Botânica* **4**(2): 93-170.
Second part of a list of 877 plant species recorded from Tete Province based on herbarium specimens from Lisbon, Coimbra and Maputo. This part covers 219 species. The districts where each species are found are given, along with specimen citations and habitat.
*** checklist, plants

29. Gonçalves, A.E. (1981). Catálogo das espécies vegetais vasculares assinaladas na província de Tete, Moçambique – III. Angiospermae (Leguminosae, Papilionoideae). *Garcia de Orta, Série de Botânica* **5**(1): 59-124.
Third part of a list of 877 plant species recorded from Tete Province based on herbarium specimens from Lisbon, Coimbra and Maputo. This part covers 187 species. The districts where each species are found are given, along with specimen citations and habitat.
*** checklist, plants

30. Gonçalves, A.E. (1982). Catálogo das espécies vegetais vasculares assinaladas na província de Tete, Moçambique – IV. Angiospermae (Chrysobalanaceae-Rubiaceae). *Garcia de Orta, Série de Botânica* **5**(2): 139-212.
Fourth and last part of a list of 877 plant species recorded from Tete Province based on herbarium specimens from Lisbon, Coimbra and Maputo. This part covers 200 species. The districts where each species are found are given, along with specimen citations and habitat.
*** checklist, plants

31. Hall, A. & Davies, B.R. (1974). Cabora Bassa: apreciação global do seu impacto no vale do Zambeze. *E.M.* (July): 15-25.
General account in Portuguese of the possible effects and economic opportunities associated with Cabora Bassa dam. Concerns on aquatic weeds are discussed, and the potential introduction of kapenta.
** fishing, ecology, plants, fishing, tourism

32. Hall, A., Davies, B.R. & Valente, I. (1976). Cabora Bassa: some preliminary physico-chemical and zooplankton pre-impoundment survey results. *Hydrobiologia* **48**(1): 17-25.
Account of 1974 survey on the physical and chemical parameters of the waters of the Zambezi river prior to impoundment. Zooplankton composition is also described. The eutrophic Hunyani River input should be significant.
** ecology, invertebrates, water, survey

33. Hall, A. & Valente, I. (1977). The Zambezi river in Moçambique: the suspended solids regime and composition of the middle and lower Zambezi prior to the closure of the Cabora Bassa dam. Departamento de Quimica, Universidade de Aveiro, Portugal. 12 pp. Unpublished report. N/S.
* water, survey

34. Hall, A., Valente, I.M.C.B.S. & Davies, B.R. (1977). The Zambezi river in Moçambique: the physico-chemical status of the middle and lower Zambezi prior to the closure of the Cabora Bassa dam. *Freshwater Biology* **7**: 187-206.
Account of 1974 pre-Cabora Bassa research into water quality of the waters of the Zambezi. Temperatures increase going downstream and average pH is 7.8. The river is well oxygenated, but transparency is low. Water quality of the mid Zambezi was principally determined by Lake Kariba.
* water, survey

35. Hidrotécnica Portuguesa (1993). Aproveitamento do Vale do Zambèze: plano prospectivo. Hidrotécnica Portuguesa, Lisbon, Portugal.
Recent account of prospects for development of the Zambezi Basin within Mozambique. Vegetation details based on earlier reports are given along with present agricultural land use.
* survey, agriculture, plants

36. Howells, W.W. (1985). The birds of the Dande communal lands, middle Zambezi valley, Zimbabwe. *The Honeyguide* **31**(1): 26-48.
Account of the birds seen over a year in the Mushumbi Pools area, fairly close to part of the study site. 280 species were recorded.
* birds, checklist

37. Hughes, R.H. & Hughes, J.S. (1992). *A Directory of African Wetlands.* IUCN/UNEP/ WCMC, Gland, Switzerland. pp. 683-685.
A major reference work on wetlands; there is a section on Cabora Bassa. Details are given on the hydrology and capacity of the lake and water quality. The aquatic weeds *Azolla*, *Eichhornia*, *Pistia* and *Salvinia* are present, but are not yet a nuisance. Submerged macrophytes are beginning to establish. Phytoplankton densities are low. The fish fauna is different from that of Kariba and there is a growing avifauna. The fishery is briefly described.
* plants, ecology, conservation, fish, fishing, invertebrates

38. Instituto Nacional de Geologia (1987). *Carta Geológica.* Instituto Nacional de Geologia, Maputo, Mozambique. 2 sheets.
Detailed geological map of Mozambique at a scale of 1:1 million. The study area comprises 32 types. A simplified legend of 11 types is given in the Tchumo Tchato project report.
* survey

39. Jackson, P.B.N. (1975). Relatório sobre o plano de desenvolvimento para indústria piscatória em Cabora Bassa. R.F. Loxton, Hunting & Associates/Gabinete do Plano do Zambeze, Maputo, Mozambique.
Consultancy study on the fisheries potential of the Cabora Bassa dam. The detrimental effect of aquatic weeds is highlighted. Various fish species found, or with potential, are listed.
** fishing, fish

40. Jackson, P.B.N. & Davies, B.R. (1976). Cabora Bassa in its first year: some ecological aspects and comparisons. *Rhodesia Science News* **10**(5): 128-133.
General account of the early ecological effects of Cabora Bassa dam, including details of aquatic weed infestation and changes in fish populations.
*** fishing, ecology, plants, conservation

41. Jackson, P.B.N. & Rogers, K.H. (1976). Cabora Bassa fish populations before and during the first filling stage. *Zoologica Africana* **11**(2): 373-397.
Study of the effects on fish species and populations of the filling of Cabora Bassa dam. 38 species are listed pre-impoundment. The effects over a short period are shown to be marked, with rapid disappearance of some species and population increase of others. Breeding patterns were also disrupted. Aquatic weeds have also had an effect.
*** survey, fish, ecology

42. Joint Venture LI-EDF-KP (1999). *Mepanda Uncua and Cahora Bassa North Project: feasibility study. Preliminary Environmental Impact Assessment.* Technical Unit for the Implementation of Hydropower Projects (UTIP), Maputo, Mozambique.
Series of technical appendices on geology; vegetation, flora and plant use patterns; risks to wildlife and their habitats and associated ecotourism; status of waterbirds; ecological features of the Lower Zambezi system of the Zambezi Delta; farming. The potential environmental impacts of raising the height of Lake Cabora Bassa, among other options, are discussed.
*** ecology, conservation, water, agriculture

43. Júnior, J.T., Teles da Cunha, J. & Fernandes, É.F. (1962). O abeberamento e sua relação com a pecuaria de carne na região do Distrito de Tete. *Anais dos Serviços de Veterinária de Moçambique* **10**: 1-30.
Account in Portuguese of factors important for livestock production in Tete Province. The present study area was classified as sweetveld south of the Zambezi, mixed veld immediately to the north, and sourveld towards the Zambia border - classification follows the vegetation types described by Pedro & Barbosa. The Cabora Bassa area did not support many cattle or goats in 1960; livestock were more common south of Magoe and north of Fingoe. Tsetse fly (*Glossina morsitans*) was present over much of the western part of the present study area, and *G. brevipalpis* also occurred near Zumbo.
** agriculture, plants

44. Letcher, O. (1987). *Big Game Hunting in North-Eastern Rhodesia*. Fascimile of 1911 edition. St Martin's Press, New York, USA. 266 pp.
N/S. Early account of journey from Tete in Mozambique across eastern Zambia through the Luangwa valley on an extended hunting trip. Anecdotal references to encounters with large mammals in the area and impressions of local people.
* history, mammals

45. Macedo, J.d.A. (1974). Vegetação aquática em Cabora Bassa: alguns problemas futuros. Memorias No. 5. Instituto de Investigação Agronómica de Moçambique, Maputo, Mozambique. 86 pp.
Detailed account, written prior to lake formation, of the potential problems of aquatic weeds that may be faced on Lake Cabora Bassa. Parallels are drawn with other large African man-made lakes, including Kariba.
** plants

46. Mackie, C. & Chafota, J. (1995). Aerial survey of large mammals in Magoe District (north west Tete province) Moçambique: 1995. Multispecies Animal Production Systems Project Paper No. 47. WWF SARPO, Harare, Zimbabwe. 18 pp.
Technical account of aerial survey of elephants and other large mammals and livestock carried out in the southwestern part of the study area (3815 km²) north of the Zimbabwe border. Elephant population was estimated at 137 (0.04/km²) with an equal number of carcasses. Numbers were much lower than in a 1980 survey. Impala numbers were also low (mean 0.4/km²). There is a relation between human settlement and goat distribution, with low numbers on the lakeshore and central south bank area.
** survey, mammals

47. Main, M. (1992). *Zambezi: Journey of a River*. Southern Book Publishers, Halfway House, South Africa. 313 pp.
Popular account of the history, geology, ecology and natural history of the Zambezi river from source to mouth. The Cabora Bassa gorge is described as is the construction of the dam. The effects of aquatic weeds on the lake are discussed.
** ecology, history

48. Mandima, J.J. (1997). Some limnological aspects of Lake Cahora Bassa, Mozambique. *Transactions of the Zimbabwe Scientific Association* **71**: 14-18.
Comparative survey of water quality (nutrients, dissolved oxygen) and zooplankton of Lake Cabora Bassa. Nutrient concentration was higher than in Lake Kariba but zooplankton composition was similar, although numbers appear to have decreased since the early 1980s. The declining inflow of water leading to reduced nutrient supply is mentioned.
** survey, invertebrates, ecology, water

49. Martins, J.N.O. (1970). Reconhecimento glossinico de parte do Distrito de Tete. *Vetérinaria Moçambicana* **3**(1): 31-39.
Tsetse survey of part of the Cabora Bassa study area with map to show its historical spread. Tsetse were present near Zumbo and have spread westward. A brief account of vegetation is given; most is mopane woodland with baobabs.
* agriculture, invertebrates

50. Maughan, R.C.F. (1910). *Zambezia: a general description of the valley of the Zambezi River, from its delta to the River Aroangwa, with its history, agriculture, flora, fauna, and ethnography.* John Murray, London, UK. 408 pp. Early account of the Zambezi area covering Tete Province to the coast north of the Zambezi. Chapters are given on history, flora, fauna and people. Species lists from the broad area are included, although there is no clear indication as to localities.

* history, plants, mammals, birds, agriculture

51. Maughan, R.C.F. (1914). *Wild Game in Zambezia.* John Murray, London, UK. 376 pp.
Early account of large mammals and hunting in the area covering Tete Province to the coast north of the Zambezi. Anecdotal impressions of large mammal populations are given, but there is no clear indication of localities.

* history, mammals

52. Missão de Fomento e Povoamento do Zambèze (1961). Aspectos pecuários (1958-1960). In: *Bacia do Zambèze: elementos económico-sociais* Ministério do Ultramar, Província de Moçambique, Maputo, Mozambique. pp. 12-28.
Early report on suitability for livestock production of a large part of the Zambezi valley in Mozambique. The study area is classified as agro-ecological zones 1 (sweet veld; *Colophospermum mopane* woodland with *Adansonoia digitata*, *Combretum* spp., *Cordyla africana*, *Sclerocarya birrea*, *Acacia* spp., and *Ziziphus mauritiana*), 8 (mixed veld; *Julbernardia globiflora*, *Brachystegia* sp.) and 9 (sourveld; *Brachystegia* spp., *Julbernardia globiflora*, *Uapaca* spp., *Parinari curatellifolia*, *Protea* sp., *Faurea* sp., *Swartzia madagascariensis*).

** agriculture, plants

53. Morais, R.T. (1974?). *Estudos ictiológicos no Rio Zambeze.* Brigada de Estudos Piscicolas de Cabora Bassa, Universidade de Lourenço Marques, Maputo, Mozambique. 49 pp.
Account of fish studies in the Cabora Bassa area carried out pre-impoundment. The water is fairly nutrient-rich. Aquatic weeds can be expected to be a problem. Lists are given of fish (34 species), aquatic or semi-aquatic plants (39 species) and various aquatic invertebrate and phytoplankton taxa. Hippopotamus and crocodile are reported. Notes on the various fish species are given.

*** fish, plants, invertebrates

54. Pedro, J.G. & Barbosa, L.A.G. (1955). A vegetação. In: *Esboço de Reconhecimento Ecologico-Agricola de Moçambique* Memórias e Trabalhos 23. Centro de Investigação Científica Algodeira, Maputo, Mozambique. pp. 67-224.
N/S. Main vegetation survey of Mozambique with detailed descriptions. The map (scale 1:2 million) shows 117 vegetation units. The map has been revised slightly for Flora Zambesiaca (Wild & Barbosa 1967).

* survey, plants

55. Pinay, G. (1988). *Hydrobiological assessment of the Zambezi River system: a review.* Working Paper WP-88-089. International Institute for Applied Systems Analysis, Laxenburg, Austria. 116 pp.
Account of the hydrology and biology of the Zambezi system. Details are given on the history, hydrology, operations and water quality of Cabora Bassa. Ecological and fishery aspects are discussed. Its "riverine reservoir" nature is pointed out.

** water, ecology, fishing

56. Pinhey, E.C.G. (1976). Entomofauna from Cabora Bassa. Results of the Entomological Brigade of the IICM. *Garcia de Orta (Zoologia)* **5**(2): 25-64.
N/S. Report on 99 species of insects collected by M.C. & G.V. Ferreira around Cabora Bassa, 66 of which were butterflies.

*** survey, invertebrates

57. Smithers, R.H.N. & Tello, J.L.P.L. (1976). Check list and atlas of the mammals of Moçambique. Museum Memoir No. 8. National Museums and Monuments of Rhodesia, Harare, Zimbabwe. 184 pp.
Comprehensive and detailed descriptive account of all Mozambique mammals. Distributions are given, and the main habitat/vegetation types outlined. A total of 71 species are noted for the study area.

* checklist, ecology, mammals

58. Somer, U. & Gliwicz, Z.M. (1986). Long range vertical migration of *Volvox* in tropical Lake Cahora Bassa (Mozambique). *Limnology and Oceanography* **31**: 650-653.
Account of diurnal movements of algae in Lake Cabora Bassa. Distribution is determined by light regime and phosphorous uptake.
* invertebrates, ecology

59. Suschka, J. & Napica, P. (1986). Ten years after completion of Cahora Bassa dam. Direcção Nacional de Aguas, Maputo, Mozambique. 32 pp.
Account of the downstream effects of Cabora Bassa, particularly flooding and salinity. The effects have not been as great as feared. * water

60. Tabler, E.C. [editor] (1963). *The Zambezi Papers of Richard Thornton. Vol. 1 (1858-1860) and Vol. 2 (1860-1863).* Chatto & Windus, London, UK.
N/S. Two volumes giving a detailed account of Livingstone's Zambezi expedition focussing on observations from the lower Zambezi and Luangwa rivers. After leaving Livingstone's expedition, Thornton travelled alone as far west as Chikwenya islands at the Sapi-Zambezi confluence, and as far north as Fundo on the Luangwa. Detailed records on natural history and geography of the region are given.
* history

61. Timberlake, J.R. (1996). Sites of interest for botanical conservation in the communal lands of the Zambezi Valley, Zimbabwe. Zambezi Society/Biodiversity Foundation for Africa, Harare, Zimbabwe. 52 pp.
Consultants' report with account and descriptions of relatively small sites of interest for botanical conservation in the communal lands of the Zambezi valley in Zimbabwe. Some riparian sites on recent alluvium are described from along tributaries of the Zambezi running into Cabora Bassa.
* conservation, plants

62. Timberlake, J.R. & Mapaure, I. (1992). Vegetation and its conservation in the eastern mid-Zambezi Valley, Zimbabwe. *Transactions of the Zimbabwe Scientific Association* **66**: 1-14.
Account of the vegetation of the communal lands of the mid-Zambezi valley in Zimbabwe adjacent to the Cabora Bassa study area. 12 vegetation types are described, one of which is on recent alluvium (alluvial floodplains and riverine woodland). Environmental relationships are discussed and areas suitable for botanical conservation are mapped and described.
** ecology, conservation, plants

63. Tinley, K.L. & Sousa Dias, A.H.G.d. (1973). Wildlife reconnaissance of the mid-Zambezi Valley in Moçambique before formation of the Cabora Bassa dam. *Veterinária Moçambicana* **6**(2): 103-131.
Detailed account of the ecology, large mammals and conservation potential of the mid-Zambezi river between Zumbo and the proposed Cabora Bassa dam. Mammal populations were low (0.1 ungulates/km^2), partly due to excessive hunting. The main animals were impala and kudu.
*** survey, conservation, ecology, plants, mammals

64. Vostradovsky, J. (1984). Fishery investigations on Cahora Bassa reservoir (March 1983-May 1984). FAO/GCP/MOZ/006/SWE Field Document No.11. FAO, Rome, Italy. 30 pp.
Consultants' report on fish biology in Lake Cabora Bassa. Particular reference is given to kapenta.
** fishing, fish

65. Vostradovsky, J. (1986). On the ichthyofauna and possibilities of fishery utilisation of the Cahora Bassa reservoir on the Zambezi river (1983-1984 period). *Prace VURH Vodnany* **15**: 3-20.
Lists the 20 fish species caught in Cabora Bassa 8-9 years after its creation, with some data on their relative abundance and ecology. Suggestions as to fisheries potential are given.
** fishing, fish, ecology

66. Wild, H. & Barbosa, L.A.G. (1967). Vegetation map of the Flora Zambesiaca region. M.O. Collins, Harare, Zimbabwe. Supplement to Flora Zambesiaca, 71 pp. plus 2 maps.
Descriptions of vegetation types of Zambia, Botswana, Zimbabwe, Malawi and Mozambique with accompanying colour map at 1:2.5 million scale, based on previous surveys. The Cabora Bassa study area is described as *Colophospermum* woodland and *Adansonia/Sterculia/Cordyla* woodland around the lake and to the south, with *Julbernardia globiflora* woodland and *Brachystegia boehmii*/*B. allenii* woodland to the north. There are smaller areas of *Brachystegia floribunda*/*J. globiflora* woodland *Commiphora*/*Combretum* thicket.
** plants, ecology

67. World Bank (1996). Information memorandum to request support for feasibility studies and environmental impact assessments: Cahora Bassa North Bank and Mepanda Uncua Hydroelectric projects. World Bank, Washington DC, USA. 44 pp.
Background document on proposed additional hydroelectric schemes on the Zambezi. The current impacts of Cabora Bassa dam and lake are outlined.
* water

68. ZACPRO (1994). Zambezi River Basin: Country Report, Republic of Mozambique. 12 pp.
Background document giving details on the Zambezi Basin in Mozambique. Cabora Bassa dam and the importance of the Zambezi for Tete town are discussed. 21 fish species from Cabora Bassa are listed, with a brief account of the fishery. Power generation is mentioned.
* water, fishing, fish

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VOLUME 11
TECHNICAL REPORTS

VEGETATION SURVEY OF THE TCHUMA TCHATO PROJECT AREA SURROUNDING LAKE CABORA BASSA, TETE PROVINCE, MOZAMBIQUE

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Consultancy Report Prepared For
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SUMMARY

Background

Tchuma Tchato is a community based natural resource management project being implemented in the area surrounding Lake Cabora Bassa by the Direcção Provincial de Agricultura e Pecuaria (DPAP) Tete Province, under Direcção Nacional de Florestas e Fauna Bravia (DNFFB) - National Directorate of Forestry and Wildlife. Much of the area is only sparsely settled and supports little in the way of development or infrastructure. Faced with an increasing number of development proposals DPAP are looking to develop an ecological framework whereby they can ensure that biodiversity concerns are incorporated into the future planning and development process. For this purpose, DPAP commissioned the Biodiversity Foundation for Africa/Zambezi Society partnership to carry out a biodiversity assessment of the region, and to provide recommendations to guide the future planning and development of the region. This work was funded by the Ford Foundation.

The present study forms one of five components of the overall biodiversity assessment. It aims to provide a broad ecological zonation for the project area, together with descriptions of vegetation types and plant species composition and, based on these results, to identify priority areas for conservation of biodiversity and wilderness value.

Approach

The development of an ecological zonation was based on the interpretation of Landsat false colour satellite imagery, supported by aerial observations and limited field sampling. The flying was carried out during April and May 2000, and the field sampling during June 2000. Due to time and logistical constraints, field sampling was limited to the south of the lake. The 67 samples taken provided the basis for the description of vegetation units for the southern portion. In the absence of any sampling it is not possible to provide detailed descriptions for the northern section.

The identification of sites and areas of biodiversity interest and wilderness value was based on consideration of the interpretation of the whole area. The final vegetation units and various areas of interest were entered into a GIS system. The data is available in both ArcView and MapInfo formats.

Vegetation Units

Vegetation units are presented separately for the southern and northern portions, for in the absence of any fieldwork those to the north remain hypothetical.

Eighteen units are described for the southern portion. These are grouped under five types. The bulk of the area is dominated by extensive mopane woodland units on Karoo sediments and basalt formations. These are grouped under Type 3 vegetation, which includes 5 units. Scattered throughout are smaller but important occurrences of Type 1 vegetation on alluvium/colluvium and Type 2 communities on unconsolidated sands, both of which include four units. Two aquatic units that are described from Lake Cabora Bassa are grouped together under Type 4. Collectively, the valley units cover virtually the whole of the southern portion. There is very limited exposure of basement terrain in the vicinity of Songo and where the southern Zambezi escarpment intrudes marginally to the extreme southeast. The vegetation of these portions is described under Type 5 which includes three units.

The northern portion has relatively limited exposure of valley terrain, with the bulk of the area comprising upland basement country. The representation of Type 1-4 valley units appears similar to that to the south of the lake. The vegetation of the basement area is described under two types. Type 6 consists of what appear to be various mixed mopane/miombo communities (three units). The remaining area is covered by eight miombo type units, which are grouped together to form Type 7.

Considering the area as a whole, the major divide in terms of vegetation communities is between the valley and adjacent upland areas. The valley portion is dominated by extensive mopane woodland types, whilst the basement mainly consists of extensive mixed mopane/miombo or miombo units. Both portions support additional smaller components that are restricted to particular ecological conditions, many of which are of considerable interest from a biodiversity perspective.

Conservation Assessment

Each unit was rated in terms of conservation importance, based on a subjective combination of species diversity, extent and threat. The following nine units were identified as being of greatest biodiversity conservation significance.

I. Type 1.1 - River Beds and Lowest Alluvial Terraces
II. Type 1.2 - Riparian Forest
III. Type 1.3 - Mixed Woodland on Sandy Alluvium and Colluvium
IV. Type 1.4 - Seasonally Inundated Grassland on Clay Alluvium
V. Type 2.1 - *Xylia* Dry Forest
VI. Type 3.1 - Mixed Woodland on Sandstone Ridges and Hills
VII. Type 4.1 - *Phragmites* Reedbeds on Sandbanks
VIII. Type 7.7 - Bamboo Thickets
IX. Type 7.8 - Serpentine Grasslands

Plant Species and Species of Interest

A total of 301 woody species were recorded, but with further work this could easily be extended. Based on known distribution ranges, some 58 species are tentatively identified as being of possible conservation concern. Of these, 22 were identified as being of particular interest. These include six possible new records for Mozambique; an additional five species for which very few other records exist from this area; seven species which are near their southern or northern extent of their range; three near endemic species, and two species which if correct represent significant extensions to their known ranges.

Sites and Areas of Biodiversity Conservation Interest

The aim of identifying sites and areas important for biodiversity conservation is to draw attention to their particular interest and to identify those portions of the overall landscape with significant biodiversity resources, which should be given particular consideration in terms of future planning and development. To achieve this, the area was examined from four different perspectives, which roughly correspond to different spatial scales.

At the finest level, individual occurrences of the nine units of highest biodiversity conservation interest are highlighted as being potential sites of interest. The next stage resulted in the identification of a number of features of interest, comprising clearly recognizable elements within the landscape, most of which include portions of several units of interest. These are: the Luangwa alluvial/colluvial fan, a northern grassland patch, the Gonono sand ridge, Comboio, the Luia alluvium, plus a number of hill features, including the prominent sandstone ridge running

behind Magoe, Mt. Bungue near Daque Camp, Mt. Changaudze (to the extreme southeast beside the Luia River) and, Mt. Ngosi, this being the prominent conical feature to the north of the lake more or less opposite the Musengezi inlet.

The identification of broader areas of interest was based on the incorporation of a wide variety of units and thus overall diversity within a relatively confined (roughly 30 x 50 km) area. Ten such areas of interest were identified. These are all focused on the valley portion, although several include representation of adjacent upland units. Three are situated to the north of the lake, two to the southwest, and five to the southeast.

The final step involved the identification of extensive regions of greatest biodiversity importance, based on the distribution of the previous units, features and areas of interest. Two such regions are apparent. The western region covers the valley portion to the west of the Musengezi inlet, and can be split into two to either side of the lake. The eastern region stretches from Comboio southeast across the Luia basalt dome and the valley system associated with the Metangua and Canguedze drainages, into the hills on the eastern border of the study area.

These results draw attention to the biodiversity resources of the valley portion. Whilst this appears to be valid, the possibility remains that it may, at least in part, be an artefact of the lack of data from the northern portion.

No attempt was made to place these portions into any priority for conservation action.

Areas of Wilderness Value

The identification of areas of wilderness value was based on the combination of one or more requirements of large areas, little existing settlement, minimal potential for crop production, but good potential for wildlife and tourism development. Based on these considerations, eleven areas with wilderness potential were identified. These make up four blocks. To the northwest, the western valley portion and adjacent escarpment contain four contiguous areas. A further two areas are delineated to the south and west of the Musengezi inlet. The other two portions are to the northeast, comprising the northern lakeshore, gorge area and adjacent hills (2 areas) and, to the southeast, extending from Comboio, across the Luia basalt area and adjacent eastern valley portion (3 areas).

Collectively, these eleven areas block out more than half the study area. This serves to highlight the good wilderness potential of the region, and also those parts of the overall landscape where wilderness should be taken into account during planning and development.

Implications for Future Development

The results of this study show that the area does harbour important biodiversity and wilderness resources. The challenge is how to manage the future development of this region so as not to compromise these resources. The greatest threat is likely to be through the expansion of settlement and cultivation. Based on consideration of natural resources, and experience from adjacent portions of Zimbabwe and Zambia, it can be predicted that certain units will be more heavily impacted than others.

The development of wildlife and tourism could provide an alternative, or complementary but more sustainable form of land use, that is more compatible with the maintenance of biodiversity and wilderness resources. The area offers much the same mix of elements as has been the basis for the development of a successful tourism industry around Lake Kariba in Zimbabwe (lake, scenery and wildlife). The major difference is the much lower incidence of wildlife around

Cabora Bassa. The promotion of wildlife should be seen as a priority, but one that is likely to require considerable investment.

There is good coincidence between areas identified as being of biodiversity and wilderness value, and also with the principal wildlife areas. The development of a national park in the eastern region has previously been suggested. The results of this study suggest that this could incorporate important areas of biodiversity and wilderness. It is also clear that there are different ways of approaching this eastern area, and that the western valley portions to both the north and south of the lake are equally worthy of consideration (albeit that CBNRM may now offer a more appropriate option than the development of a national park).

A number of units, features and areas of biodiversity interest, and of wilderness value, continue across the border into adjacent portions of Zimbabwe and Zambia. These situations clearly call for the development of joint management approaches, a framework for which is currently in the process of being developed under the ZIMOZA initiative.

The lakeshore, although not necessarily of any particular biodiversity importance, is a key tourism resource. The designated wilderness areas were specifically selected so as to include those portions of the lakeshore with the best scenery, and which border against land with particularly low potential for cultivation and thus establishment of permanent settlements. The continued uncontrolled development of fishing camps, both informal and commercial kapenta operations, is likely to pose a significant threat to the wildlife and tourism potential of these areas. This situation calls for strategic planning input, particularly the development of some form of zonation.

Recommendations

A number of recommendations are put forward, the objective of which is to ensure that biodiversity and wilderness concerns are incorporated into the future planning and development process for the region. These fall into two categories.

Improving the data base:

- Complete the field work to the north of the lake.
- Include consideration of herbaceous species.
- Target the serpentine hills and northern dambo areas for collecting, as these areas are likely to support a relatively high number of species of interest.
- Target additional work at the alluvial and colluvial areas, as these areas are under disproportionately high risk of modification through expansion of settlement and cultivation.
- Identify more precise areas of wilderness value so as to provide a means of focusing attention down on smaller, more specific areas.
- Re-examine the sites and areas of biodiversity and wilderness interest with the aim of prioritising them for conservation action.

Putting the Findings Into Action:

- Present the findings of this study to planners and developers at a workshop in Tete, as a first step towards incorporating the findings into the planning and development process for the region.

- Encourage the acceptance of maintaining biodiversity and wilderness values as legitimate planning and development goals for at least those portions of the study area which have been identified as being of particular biodiversity or wilderness interest.

- Promote the reestablishment and building up of wildlife populations, as a key stimulus for the development of tourism.

- Develop a system of zonation for the lakeshore, as a means of ensuring the better integration of different forms of use, and thus optimizing the benefit from this key resource.

- Support policies that discourage in-migration, so as to limit the future rate of population expansion, and thus counteract what is likely to be the greatest threat to the future maintenance of areas of biodiversity and wilderness importance.

- Seek to work together with Zimbabwe and Zambian stakeholders so as to develop joint management strategies for shared areas of high biodiversity and wilderness interest, and for shared wildlife populations.

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1. INTRODUCTION

The Biodiversity Foundation for Africa/Zambezi Society partnership was requested by Direcção Provincial de Agricultura e Pecuaria (DPAP) Tete Province, in collaboration with the Ford Foundation, to develop an ecological zonation for the Tchuma Tchato project area on the south and north sides of Lake Cabora Bassa. The intended purpose for the zonation is to provide an ecologically sound basis for development planning, that seeks to maintain maximum biological biodiversity within the area, and to provide an indication of potential areas for biodiversity and/or wilderness based tourism.

In order to produce the required zonation the partnership was requested to:

I. Create a broad ecological map of the area
II. Identify broad areas of particular biodiversity conservation interest
III. Identify areas of particular wilderness value
IV. Make a preliminary identification of specific sites of high biodiversity importance, and
V. Provide recommendations so as to enable developmental planning agencies to minimize impacts on areas and sites of high biodiversity and/or wilderness values.

Study Area

The study area is centred around Lake Cabora Bassa and includes most of the portion of Mozambique that protrudes to the west between Zambia and Zimbabwe. This includes Magoe, Cahora Bassa and part of Changara Districts to the south of the lake and, to the north, Zumbo and much of Maravia District, all within Tete Province. The boundary is based on a hand drawn map provided by DPAP (Map 2).

General Approach

The purpose of the present study is to provide a broad ecological zonation for the project area, together with descriptions of vegetation types and plant species composition and, based on these results, to identify priority areas for conservation of biodiversity and wilderness. The overall project includes four additional components. These comprise a bibliographic review of articles concerning biodiversity and renewable natural resources for the project area (Timberlake, 2000a); a study of birds done in conjunction with the current study (Chiweshe 2000); and two surveys done by boat on Lake Cabora Bassa covering the vegetation and plants of the lake and shoreline (Timberlake, 2000b), and water birds (Douglas, 2000), in more detail. The main findings from each of these components are drawn together in an overall synthesis report (Cunliffe, 2001).

Structure of the Report

The next two sections provide details of previous relevant work (Section 2), and the methods used for this study (Section 3). Results are presented in Sections 4.1 - 4.5, and discussed in Section 5. This provides the basis for the recommendations presented in Section 6.

2. PREVIOUS WORK

There is very little in the way of previous information relating to the natural resources of the project area (Timberlake, 2000a), which is one of the main reasons for carrying out the current study. Most of the studies that have been done, have focused on the lake itself, or have addressed the effects resulting through its construction both to the immediate environs and downstream. The bulk of the survey work that is available is in the form of national studies, and is not particularly detailed.

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The most recent geological map of the country (Instituto National de Geologia, 1987) provides good detail for this geologically complex area, but at a scale of 1:1,000,000. More detailed geological maps are believed to exist (1:250,000), but were not seen during the course of this study. Broderick (1984) provides good coverage of the Zambezi Valley from Zumbo to Daque (1:250,000).

The only comprehensive description of vegetation types is by Wild & Barbosa (1967), which covers the whole of the Flora Zambesiaca region at a scale of 1:2,500,000. Eight units are represented within the study area (out of a total of 74). The bulk of the valley portion, particularly to the west, is shown as consisting of Type 35 *Colophospermum mopane* dry early-deciduous savanna woodland (lowland), with minor inclusions of *Commiphora*/*Combretum* dry deciduous thicket (Type 12). To the east, on the Luia basalts and extending east to Changara, the area is mapped as *Adansonia, Sterculia, Kirkia, Cordyla, Acacia* dry deciduous tree savanna (Type 49), and between Songo and Tete as *Diplorhynchus, Pterocarpus brenanii, Combretum* spp. and *Diospyros* (lowland) dry early shrub deciduous savanna (Type 51). The other four types comprise versions of miombo woodland (Types 17, 18, 29 and 30) and, other than a small occurrence of deciduous dry miombo savanna woodland around Songo, are confined to the north of the lake.

There are two sets of national land cover maps (1:250,000 scale), derived through the interpretation of satellite imagery (CENECARTA, 1995 and DNFFB, 1999). Both depict woody plant cover, but the more recent set also shows different types of land use, and the extent to which the natural vegetation has been modified through use.

A number of more detailed vegetation studies have been carried out within Zimbabwe, covering the immediately adjacent portion of the mid-Zambezi Valley. These include Timberlake and Mapaure (1992), covering the communal lands of Guruve, Muzarabani and Mount Darwin Districts; Timberlake (1996) which describes various sites of botanical interest for the same area (some of which extend into the present study area); Du Toit (1993), covering Chewore, Angwa and Kanyemba areas; and Timberlake et al. (1998) which addresses the area between the Angwa and the Musengezi Rivers. Gonçlaves (1978, 1980, 1981, 1982) has compiled an annotated plant list for Tete Province, based on herbarium records. Species are listed by families, but unfortunately not all families are covered.

3. METHODS

Work was carried out in four stages. The first step involved an initial classification of the satellite imagery, to produce a preliminary ecological stratification for the project area. Thereafter, parts of the area were overflown in a light aircraft, so as to provide an overview of the area and enable an initial verification of the satellite classification. The third stage involved ground work, including sampling of the proposed units. Due to time and logistical constraints, field work was restricted to the area to the south of Cabora Bassa. The final component comprised analysis of the vegetation data. This included further refinement of the ecological stratification; assessment of the conservation significance of vegetation types; the identification of sites and areas of conservation interest and wilderness value, and the production of maps.

Satellite Interpretation
Interpretation was based on three false-colour (spectral bands 3, 4 and 5), geo-corrected (level 8) Landsat-5 satellite images (scene 169-71, dated 28/06/1998, and scenes 170-70 and 170-71, both dated 28/05/1998). Each scene covers roughly 185 x 185 km. The selection of particular images was done on the basis of achieving zero or minimal cloud cover, and minimal incidence of fires. The digital data was obtained from the Satellite Application Centre, Pretoria, South Africa, converted to a colour positive in Germany, and then printed photographically at a scale of 1:250,000 in Harare.

Interpretation was done by delineating potential units onto transparent overlays. Units were determined on the basis of their homogeneity, or regular recurring pattern, of tone, texture and colour. Delineation of units for the valley portion was informed by experience of the vegetation composition from the adjacent part of the Zambezi Valley within Zimbabwe. The preliminary interpretation was presented at a meeting of DPAP, Tchuma Tchato and Zambezi Society representatives held at Bawa Camp, Zumbo, 7-8 September, 1999 (Cunliffe, 1999).

Aerial Reconnaissance
The purpose of the aerial work was to obtain an overview of the whole project area, thereby enabling initial verification and refinement of the preliminary classification. It also afforded an opportunity to examine specific sites and areas tentatively identified as being of particular botanical interest. A third objective was to reach specific units and areas which, in the absence of roads, it would not be possible to access during the subsequent field sampling.

Blanket air coverage was not considered necessary, nor possible within the available budget. Instead, specific flight paths were carefully selected so as to obtain maximum overall coverage. Nine routes were flown. The first four trips, covering the portion to the west of the Musengezi inlet, were conducted on 2-3 April 2000 from Bawa, using Chapoto airstrip. The next three routes were flown on 12-14 April, from Muzarabani, and covered the southern central portion between the Musengezi inlet and Daque. Both these exercises were carried out using a Supercub aircraft, flying slow and at an altitude of 100 - 300 m. The final two flights were carried out on 17 May 2000, using a Cessna aircraft, which entailed flying higher (c. 500 m) and faster (130 - 150 km/hr). This was considered more appropriate for the more remote terrain covered under this segment. The first leg, from Harare to Tete, provided coverage of the south eastern sector, whilst the return trip enabled coverage of the north eastern sector. Overall, the air time came to a total of 30 hours, of which 26 were spent observing the study area.

The timing of the flying was specifically selected so as to coincide with maximum differentiation among vegetation types, as well as to take advantage of the clear conditions that prevail at that time of the year. Written notes were taken whilst flying, and use was made of a hand held video recorder.

Field Sampling
The purpose of the field work was to gather data on vegetation and environmental parameters for the range of units identified through the satellite interpretation. Based on this data, the classification was re-evaluated and descriptions were drawn up for each of the units. It also provided opportunity to visit certain areas thought to be of particular interest.

Field sampling was carried out during a single field trip from 2-21 June 2000. The timing of the trip was a compromise between being sufficiently early in the dry season such that the deciduous trees had not yet dropped all their leaves, and sufficiently late such that roads, particularly streams and river crossings, would be passable. At the outset it was anticipated that it would be

possible to cover the whole study area, but this proved too ambitious. Following considerable unexpected bureaucratic delays, it was decided to restrict sampling to the south of Cabora Bassa.

The route followed was from west to east. The initial entry point was at Bawa (Kanyemba), from where the sector to the west of the Angwa River was covered. In order to cross the Angwa/Panyame Rivers it was necessary to come back into Zimbabwe, to Mashumbi Pools and then reenter Mozambique at Chikafa. From here the expedition travelled east to the Musengezi inlet. Once again it was necessary to return to Zimbabwe at Chidodo, travel through Muzarabani, and cross back into Mozambique at Mukumbura. From here, the area covered included Comboio, Magoe, Daque, south along the powerline into the basalt area south of Jeke, back to Estima, to Tete, west along the Luia River to Chipembere, and then out via Nyamapanda border post.

A total of 67 samples were recorded (Annex 3.1). Given that the area covered is roughly 17,000 km^2, this gives an overall sample intensity of about 1 plot per 250 km^2. Due to the limited time available for sampling, and a prior perception that vegetation types on alluvium and sandy substrates were likely to be most varied and of highest diversity, greater emphasis was given to these units than the more widespread mopane woodland types.

The method of sampling was based directly on that used by Timberlake, Nobanda and Mapaure (1993). Sample points were subjectively selected in accessible areas, where the vegetation was relatively intact and considered to be representative of a particular unit, as demarcated during interpretation of the satellite imagery. At each sample point, data was recorded on woody species composition, vegetation structure and environmental parameters. This was done using a plotless sample, typically covering 1-3 ha. Within this area, all tree and shrub species were listed, and their cover abundance estimated for three height classes (< 0.5 m, 0.5-3 m and > 3 m). Any species which could not be reliably identified in the field were collected, and later confirmed at the National Herbarium in Harare, by Bob Drummond. Data on grasses and other herbaceous species were not collected. Environmental parameters recorded were those considered to be relevant to the interpretation of plant distributions. A GPS reading (Garmin 12, WGS 84 datum) was taken at each point and, for many of the localities, one or more photographs, the aim of which was to capture the "general feel" of the particular vegetation type.

As part of the same field trip, Ngoni Chiweshe carried out a bird survey, although his bird observations were not always done in precisely the same areas as the vegetation samples (Chiweshe, 2000).

Data Analysis

The primary objective of the analysis was to group samples into discrete vegetation types, to provide a classification and description of types, and to map their distribution. This provided the basis for subsequent identification of sites of biodiversity and wilderness importance.

Analysis was carried out manually rather than by computer. This entailed grouping samples based on similarities and differences in terms of species composition, structure and environmental variables. This was a subjective process and relied heavily on field and aerial observations and notes. The keeping of a visual record, in the form of photographs of plots and, particularly, through use of a video camera during the flying, proved extremely useful when it came to writing up the vegetation descriptions. Based on this process the boundaries of landscape units, as interpreted from the satellite imagery, were again modified and redrawn on transparencies.

The delineation of vegetation units to the north of Cabora Bassa is based entirely on the satellite imagery and aerial observations, and their classification and mapping should be considered as only a preliminary working hypothesis. Similarly, in the absence of any field sampling, it is not possible to provide detailed descriptions for the proposed units.

An assessment was made of the **conservation significance** for each unit, or group of units, based on a subjective combination of species diversity, extent and threat of modification. This methodology is based on that developed by Timberlake (1996) for the identification of sites of conservation interest within the Zimbabwean portion of the Zambezi Valley. Aspects of species diversity include the diversity of plant species; the occurrence of any species that appear to be restricted to a particular type; the presence of any rare or unusual species, as well as the diversity and abundance of other taxa, such as birds and mammals. Consideration of extent, in addition to total area, included the overall distribution of the unit and the number of discrete occurrences. As regards the likelihood of significant modification, the major threat appears to be conversion through use for settlement and cropping. Fire and/or large numbers of herbivores, particularly elephant and livestock, for some units, are also likely to be important forms of disturbance.

The identification of **sites and areas of conservation interest** was approached in four ways. The initial cut involved an examination of the **vegetation units** and identification of which of these are of greatest interest from a biodiversity conservation perspective. Individual patches of units identified as being of high biodiversity interest can be considered to comprise sites of interest. The next level sought to identify specific **features** of interest, comprising clearly recognisable elements within the landscape, but often incorporating portions of several vegetation units. The third pass attempted to define broader, but still relatively contained, **areas** of interest, which incorporate a wide diversity of units, and thus overall diversity. To do this an oval shape roughly 50 km long by 30 km wide was floated across the study area, and the positions supporting the greatest number of units were then noted. The final approach was to delineate several extensive **regions** of interest, on the basis of their appearing to offer the best potential for biodiversity conservation at the broadest scale.

In terms of identifying **areas of wilderness value**, the approach adopted was to try and identify those portions of the landscape with significant wilderness potential, and for which the consideration of wilderness qualities should be an important part of the planning process.

Wilderness, like conservation, is somewhat subjective, and can have widely different meanings to different people. A common perception is of extensive areas of natural habitat, devoid of any development or anthropogenic disturbances. The only parts of the study area that are likely to conform to this definition, in the longer term, are those portions that have marginal potential for any alternative forms of land use, particularly subsistence agriculture and the grazing of livestock.

Alternatively, a more “active” concept of wilderness can be adopted, whereby wilderness areas can be taken to include those portions of the landscape that are best suited to wildlife production and tourism purposes (and any other forms of land use that are compatible with the maintenance of natural systems). The thinking behind this concept is that wilderness areas should be expected to make a direct contribution to the local and regional economy, and that this can be achieved through using such areas for wildlife and tourism purposes.

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Size is another important consideration. For the larger the available area, the greater the possibility of introducing zoning for different forms of use, and thus of maintaining a core wilderness area with minimal or no disturbance or development.

The identification of wilderness areas was based on these considerations of potential for wildlife and tourism, potential for other forms of land use, and size.

Mapping

The resulting final interpretation was used as the basis for creating a digital vegetation map. This work was carried out by Ian Games. The satellite images were accessed using ER Mapper. Their position and projection were taken from the header file information supplied for each image by the Satellite Application Centre. Close inspection revealed that all three images had slightly different positions in space. Sheet 170-71 was arbitrarily selected as a reference, and the positions of the other two images were rectified to this, using ER Mapper. This meant that the position of all three images were correct relative to each other (but not necessarily to data from other sources).

Recognisable points were selected on each satellite image that were visible on the mylar sheets. UTM coordinates were generated from the satellite image and these were then used to ensure that the mylar sheet was in the same space as the image. Once the images were rectified, they were digitised on a tablet in ArcView. The lake water surface, sandbanks, the Luangwa River and floating aquatic vegetation were digitised on screen using a mouse.

The basic polygons were exported to MapInfo to solve problems related to projections and for labelling. The resulting final file was exported back to ArcView for presentation. As a result of these manipulations the file can be delivered in both ArcView and MapInfo. The projection and datum for both formats is UTM WGS84, Zone 36 (Southern Hemisphere).

Additional layers captured on the GIS included administrative boundaries, drainages, roads, geology, lakeshore vegetation communities (after Timberlake, 2000b), and the areas identified as being of particular biodiversity or wilderness value.

The scale of the satellite prints used for the interpretative work was 1:250,000. However, for the purpose of this report, the overall vegetation map (Map 4) has been reduced so as to fit on an A3 page, which corresponds to a scale of roughly 1:1,000,000.

4. RESULTS

Descriptions of the landscape units and accompanying vegetation types for the southern portion are first outlined, together with a brief statement about their conservation significance (Section 4.1). Potential ecological units to the north of the lake (Section 4.2) are presented separately, for in the absence of any field work these still remain to be confirmed. The third section (Section 4.3) provides a list of plant species recorded. The final two components outline potential areas of particular biodiversity interest (Section 4.4) and wilderness value (Section 4.5), based on consideration of the area as a whole.

4.1 Vegetation Units to the South of Cabora Bassa

The 67 plots were classified into 14 vegetation types (Table 3.1). Four additional types were identified from the satellite imagery and air observations, but were not sampled. Two of these (Types 4.1 and 4.2) are from the lake, which Timberlake (2000b) had already covered under his lakeshore survey. The other two are confined to the southern escarpment in the vicinity of the Luia River (Types 5.2 and 5.3).

These 18 vegetation types can, at the broadest level, be divided into two groups comprising valley and escarpment portions.

The valley terrain covers the bulk of the area. Geology is mainly Karoo sediments, together with an extensive basalt outcrop to the north of the Luia River. Vegetation is dominated by various types of mopane woodland with additional smaller but important types occurring on sandy and clay rich depositional soils. This accounts for 13 units, which are described under Types 1-3. These are separated according to differences in substrate (alluvium, unconsolidated sands, sandstone hills and ridges, shallow sandstone or basalt derived soils, and shallow and deeper clay soils derived from various clay-rich Karoo sediments), vegetation structure (riparian forest, woodland, grassland, dry forest, thickets, low open woodland), and species composition. The two aquatic units associated with Lake Cabora Bassa (reed beds, floating aquatic vegetation) form a fourth grouping (Type 4).

The escarpment portion, comprising basement geology, is limited to minor occurrences in the vicinity of Songo, and to the extreme southeast where the southern escarpment marginally impinges on the study area. Minimal sampling was carried out for these areas (a single plot for the Songo portion and none for the southern escarpment portion). Three units are described which together make up Type 5.

4.1.1 Type 1: Vegetation on Alluvium/Colluvium

The major alluvial occurrences are associated with the larger rivers and the almost level terrain of the Zambezi Valley. These include the Angwa, Panyame, Mukumbura and Daque Rivers, all of which drain into Cabora Bassa and, to the east, the Luia River (particularly around Chipembere), and its principal tributaries, the Metangua and Cangudeze, which drain the valley portion east of the Luia basalt dome. Discharge of sediments from the Luangwa River, which joins the Zambezi just upstream of Zumbo, has resulted in the development of a considerable area of sandbanks at the top end of Cabora Bassa. The vegetation of these is described separately under Type 4.1. Downstream of the Cabora Bassa wall the Zambezi passes through a narrow gorge and is virtually devoid of any alluvium until it emerges into gentler terrain, some 60 km further downstream (outside of the study area). Alluvial deposits along the major rivers typically comprise an irregular strip, varying in width from as little as 100 m to about 6 km, and with an overall mean of about 2.5 km. Many of the smaller drainages support some development of alluvium, but the extent is often too limited to be mapped at the 1:250,000 scale used for this study. The major development of colluvium is around the edge of the Luia basalt dome, with smaller occurrences at the base of the Magoe ridge, around Comboio, and at the base of the hills north of Estima.

Despite the allocation of a disproportionately large number of plots to alluvial/colluvial areas (n=18), this was still inadequate to do these areas justice. Vegetation is extremely varied, ranging in structure from grassland to tall, closed canopy, riparian forest. Species composition is equally varied. Four types are described (Types 1.1-1.4). Key determinants appear to include

the depth and seasonality of the water table and the nature of the deposits (sand to clay), as well as the extent of modification, particularly through high densities of settlement and conversion for agriculture. The nature of alluvial systems is such that differences in these factors typically manifest themselves over short distances. This makes it difficult to reliably distinguish between the four types at 1:250,000 scale, and for the most part they are mapped as a single community (Type 1.2).

Type 1.1 - River Beds and Lowest Alluvial Terraces

The river beds and lowest alluvial terraces, which are best developed along the largest drainages, support a varied but relatively distinctive community. Substrate is typically sandy, and the areas are frequently subjected to flooding. Vegetation is usually very open (total woody cover of less than 10% to 20%), but can reach up to 50-60%. Dominant woody species are *Faidherbia albida* (in places forming monospecific stands), *Acacia tortilis* and *Ziziphus mauritanius*. Other characteristic species include *Abutilon angulatum*, *Acacia sieberiana*, *Combretum mossambicense*, *Combretum obovatum*, *Croton megalobotrys*, *Ficus sycomorus*, *Grewia flavescens* var. *olukondae*, *Kigelia africana*, *Philenoptra violacea*, *Phyllanthus reticulatus*, *Ricinus communis* and *Senna singueana*, as well as certain species that were not recorded from elsewhere, such as *Acacia galpinii*, *Ficus capreifolia*, *Mimosa pigra*, *Phragmites mauritianus,* and creepers and vines such as *Ampelocissus africana*, *Cissampelos mucronata*, *Cocculus hirsutus*, *Commicarpus plumbagineus*, *Cryptolepis obtusa*, *Ipomoea eriocarpa*, *Jacquemontia tamnifolia*, *Paederia bojeriana*, *Pergularia daemia* and *Taccazea apiculata*. Grasses are tall and their cover typically high. One of the commonest species is *Panicum maximum*. For the purpose of mapping, no attempt was made to distinguish Type 1.1 from adjacent alluvial types, within which it is included.

Type 1.2 - Riparian Forest

Riparian forests are distinguished from other alluvial types on the basis of high canopy cover, typically 90-100%. Its occurrence appears to be linked to year round access to underground water. Like the previous type, it is characterised on the satellite imagery by bright red colouration, which is indicative of active photosynthesis. Such forest areas are found along virtually all watercourses, varying in extent from the width of a single tree to much broader strips. Being linked to the water table, they tend to be found relatively close to drainage channels, and thus on alluvium of relatively recent origin. The depiction of Type 1.2 on the map probably corresponds more closely to the occurrence of recent alluvium than to riparian forest itself, and includes major portions of associated Types 1.1 and 1.3.

Species composition of the riparian forest is highly varied. Dominant tree species include *Acacia robusta*, *Acacia tortilis*, *Combretum imberbe*, *Philenoptera violacea*, *Tamarindus indica* and *Xanthocercis zambesiaca*. Other common trees are *Acacia nigrescens*, *Balanites maughamii*, *Berchemia discolor*, *Cordyla africana*, *Diospyros mespiliformis* and *Garcinia livingstonei*. Typical shrub species include *Abrus* sp., *Acacia schweinfurthii*, *Allophylus rubifolius*, *Artobotrys brachypetalus*, *Capparis tomentosa*, *Cleistochlamys kirkii*, *Cordia pilosissima*, *Diospyros senensis*, *Friesodielsia obovata*, *Gymnosporia senegalensis*, *Lecaniodiscus fraxinifolius*, and *Maclura africana*. Where best developed, the forest is made up of multiple layers comprising tall emergent trees up to 25 m, a tree layer at about 10-15 m, and a shrub layer to 3 m. In such cases the ground herbaceous layer remains poorly developed, presumably due to low light levels. Any thinning of the canopy is accompanied by a marked increase in the shrub and grass layers.

There are few species that are specifically linked to riparian forests, as most constituent species also occur in more open alluvial types. One example is *Ziziphus pubescens*, a relatively rare species, and which was only recorded to the west of the Musengezi River.

Type 1.3 - Mixed Woodland on Sandy Alluvium and Colluvium
This type is characterised by being more open than riparian forest, with a total woody cover of about 30%, but varying between about 25% and 60%. Typically this comprises an open shrub layer (5-30% cover) some 2-3 m in height, a lower tree layer (4-10 m tall), and a sparse cover of taller trees (8-16 m in height, 5-10% cover). The grass layer is well developed, with 70-90% cover, mainly comprising medium to tall (25-75 cm), but occasionally taller, grasses.

The tall tree species are much the same as for the riparian forests, the dominant species being *Acacia robusta*, *Acacia tortilis*, *Berchemia discolor*, *Combretum imberbe*, *Philenoptera violacea* and *Xanthocercis zambesiaca*. Smaller trees include *Acacia tortilis*, *Albizia anthelmintica*, *Boscia mossambicensis*, *Capparis tomentosa*, *Combretum adenogonium*, *Combretum apiculatum*, *Combretum eleagnoides*, *Grewia bicolor*, *Grewia flavescens* var. *flavescens*, *Philenoptera violacea*, *Ziziphus mauritianus* and *Ziziphus mucronata*. Many of these are also common in the shrub layer, together with additional species such as *Cleistochlamys kirkii*, *Combretum mossambicense*, *Diospyros squarrosa*, *Flacourtia indica* and *Salvadora persica*.

This type is typically found further away from river beds than riparian woodland, on somewhat older alluvium or colluvium. It appears to be less dependent on the water table, although the height of the taller trees may be determined by access to underground water. The type often displays a markedly uneven texture, with clumps of woody vegetation interspersed by more open areas. In some situations this relates to seasonal water logging which tends to preclude most woody species other than on locally elevated areas such as termitaria.

The main occurrences of Type 1.3 are along the Daque River, and in association with the Luia River and its major tributaries.

Type 1.4 - Seasonally Inundated Grassland on Clay Alluvium
The occurrence of grasslands within alluvial areas is linked to seasonal flooding on heavy clay soils. This has the effect of excluding most woody species, whilst providing suitable conditions for abundant growth of particular grass species, such as *Ischaemum afrum* and *Setaria incrassata*. In places annual shrubs such as *Duosperma quadrangulare* are abundant. The occurrence of such grasslands is relatively restricted. A number of discrete patches occur in association with the Panyame River, but the largest portion is found near Chioco, in association with the floodplain of the Metangua River. The Metangua drains southeast from the Luia basalt area, carrying with it clay rich sediments. Some 15 km upstream of its junction with the Luia, the river channel becomes relatively indistinct and the seasonal waters spread out over a broad floodplain some 5 km in width. The core of the floodplain area comprises open grassland, roughly 8 km long. Away from the centre, the grassland grades into open woodland or riparian woodland. Within these grasslands there are scattered individuals of *Philenoptera violacea*, and less commonly *Albizia anthelmintica*, *Colophospermum mopane*, *Combretum imberbe*, *Cordyla africana*, and *Hyphaene petersiana* and, to the east, *Acacia xanthophloea* and *Ziziphus mucronata*. Portions of open *Hyphaene* palm savanna were also observed, both from the air and on the ground, but were not sampled.

Areas of clay-rich depositional soils, but that are less affected by water logging, support a distinctive mopane woodland type. Vegetation is dominated by *Colophospermum mopane* (mopane) trees, reaching to 15 m in height. Beneath the trees, the vegetation is typically very open, comprising a sparse cover of low shrubs and grasses. Species diversity is low. Its occurrence on alluvium is restricted, but there are relatively extensive colluvial portions, particularly at the base of the Luia basalt area. It also occurs in response to minor changes in topography which result in the accumulation of clay material in the vicinity of drainages. This vegetation is described more fully under Type 3.5.

Conservation Assessment
A key feature of alluvial and colluvial vegetation is variability. This leads to an overall large variety of plant species, a number of which are restricted to alluvial areas or particular kinds of alluvium and are not found elsewhere. So, from a perspective of plant biodiversity, alluvial areas are of high significance. Numbers of woody species increase from grassland, to riparian forest, to recent alluvium, to more open mixed woodland (Table 3.2). Woodland is richest both in terms of numbers of species per plot as well as overall number of species recorded, although there are few if any species that occur here but not in other more open or closed alluvial types. The overall count of 74 species for riparian forest can be expected to increase markedly with additional plots.

The variety of plant species found within alluvial areas is mirrored by other taxa. For example, they support high diversities and abundances of birds (Chiweshe, 2000), and also provide important wildlife habitat, as seen from the abundant signs of wildlife within these areas. Rich constituent soils, together with favourable soil water conditions, result in high plant productivity. Given the proximity of alluvial areas to permanent water sources, this provides favourable conditions for settlement and agriculture. As a result, alluvial areas are typically subject to intensive levels of use and modification. These aspects of high species diversity and high risk of modification, together with their relatively restricted distribution within the landscape, result in an overall high rating in terms of conservation significance.

4.1.2 Type 2: Dry Forest, Thicket and Woodland Types on Unconsolidated Sands

Four types are grouped together here on the basis of occurring on similar unconsolidated sandy substrates. Woody cover is typically high and species composition, although showing considerable variation among the four types, is relatively distinctive. Types 2.1 (*Xylia* dry forest) and 2.2 (mixed dry thicket and woodland) have clear similarities in terms of species composition and, to a lesser extent, structure. Both are multilayered, but whilst Type 2.1 is a closed canopy formation, Type 2.2 is typically slightly more open, to open vegetation. Types 2.3 (*Terminalia* thicket) and 2.4 (*Terminalia* woodland) are distinctive in terms of species composition, with *Terminalia brachystemma* being an important component of both. *Terminalia* thicket (Type 2.4) has structural similarities to the previous two types, although the layering is less marked, partly due to the lack of taller emergent trees. *Terminalia* woodland (Type 2.4) is closer in structure to the mixed dry thicket and woodland (Type 2.2), but in terms of species composition is closer to Type 3.2 (low open woodland on shallow sandstone soils).

Type 2.1 - Xylia Dry Forest
Xylia dry forest is confined to a few relatively small patches to the west of the Musengezi River, in association with the Gonono sand ridge and the Angwa and Panyame Rivers. Its occurrence seems to be related to the presence of particular deep, freely drained, fine to medium grained sands (Timberlake et al., 1998).

Structurally this type is a closed-canopy dry forest. The upper layer comprises an open cover (5-10%) of tall trees (15-20 m), containing species such as *Acacia nigrescens*, *Adansonia digitata*, *Afzelia quanzensis*, *Berchemia discolor*, *Commiphora karibensis*, *Cordyla africana*, *Entradrophragma caudatum*, *Kirkia acuminata*, *Philenoptera violacea*, *Pteleopsis myrtifolia*, *Pterocarpus antunesii*, *Strychnos potatorum* and *Xeroderris stuhlmannii*. Below this is a shorter (6-10 m) and denser (20-50% cover) tree layer dominated by *Xylia torreana*. Beneath this is a thicket layer dominated by *Acacia ataxacantha*, *Croton longipedicellatus*, *Friesodielsia obovata* and *Meiostemon tetrandus*. Other common species include *Boscia mossambicensis*, *Capparis tomentosa*, *Combretum eleagnoides* and *Monodora junodii*. Total canopy cover is almost 100%. The herbaceous layer is very poorly developed, with grasses being virtually absent.

Conservation Assessment
Although the total species count is not exceptional (50 species from 3 plots), there are a number of species, such as *Xylia torreana*, *Meiostemon tetrandus* and *Zanthoxylum lepreurii*, that were only recorded from this type. Other constituents with limited distributions include *Croton longipedicellatus* and *Strychnos decussata*. However, the bulk of the constituent species also occur within more open woodland formations on sand and in riverine woodlands, both of which have considerable affinity to this type.

Xylia thickets are favoured by elephants, which were either present or there were obvious signs of their recent presence at all three sample sites. In neighbouring portions of Zimbabwe, similar dry forest areas are being cleared for cultivation. Conservation significance, based on the occurrence of particular species, limited extent, and the fact that these sites are prone to high levels of use and modification by both wildlife and people, is high.

Type 2.2 - Mixed Dry Thicket and Woodland
Mixed dry thicket and woodland communities are similar to the last type, but overall woody cover is usually lower (40-100%), the trees are not quite as tall (10-20 m), layering is less developed, grasses are more abundant, and certain dry forest species such as *Xylia torreana* and *Meiostemon tetrandus* are absent. This type occurs as relatively small patches scattered right across the valley portion, wherever there is any accumulation of sands.

Overstory tree species (5-10% cover) include *Acacia nigrescens*, *Acacia robusta*, *Acacia tortilis*, *Adansonia digitata*, *Berchemia discolor*, *Colophospermum mopane*, *Cordyla africana*, *Kirkia acuminata*, *Philenoptera violacea*, *Sterculia africana*, and *Xeroderris stuhlmannii*. Common smaller trees are *Acacia nilotica*, *Albizia anthelmintica*, *Cassia abbreviata*, *Combretum apiculatum*, *Combretum zeyheri*, *Commiphora glandulosa*, *Dalbergia melanoxylon*, *Lannea schweinfurthii*, *Lecaniodiscus fraxinifolius*, *Schrebera trichoclada* and *Strychnos madagascariensis*. The shrub layer is usually > 3 m in height, the principal species being *Boscia mossambicensis*, *Carphalea pubescens*, *Cleistochlamys kirkii*, *Combretum eleagnoides*, *Combretum mossambicense*, *Dichrostachys cinerea*, *Diospyros quiloensis*, *Friesodielsia obovata*, *Grewia bicolor*, *Markhamia zanzibarica*, *Monodora junodii*, *Reissantia buchananii*, *Reissantia indica* and *Xylotheca tettensis*. Structure is variable, ranging from thicket to more open woodland, and with the tree (5-70%) and shrub (20-90%) layers having higher or lower cover values. In the more open communities (total woody cover of 40-70%) the tree layer tends to dominate (20-60%), the shrub layer is less well developed (typically 15-30% cover), and the grass layer correspondingly better developed (20-70% cover). Both tree and shrub layers tend to be dominated by *Combretum* species.

This type has similarities with alluvial/colluvial woodland on sand (Type 1.3), but lacks a number of the species more strongly associated with alluvial conditions and, overall, has closer affinity to the previous Type 2.1 *Xylia* thickets. It is often found interspersed with, and grades into, Type 3.2 low open woodland that covers the bulk of the valley floor. It is also found on sloping riverine areas and, to the west, on sandy ridges amongst mopane vegetation.

A sizeable patch of this unit is mapped to the extreme southeast of the study area between the Luia and Mazoe Rivers, on what appears to be a marked colluvial fan at the base of the southern escarpment. It was not possible to reach this portion on the ground, but from the air it appears to consist of a low thicket type with a high representation of *Commiphora* species. A similar vegetation type appears to extend up into the escarpment area to the south and west, but being on basement material there are likely to be significant differences in species composition. This has been separated out as Type 5.3.

Conservation Assessment
This type is varied, with high numbers of species per plot (range = 28 - 59), and the highest overall species total (136 species). Three taxa were not recorded from elsewhere (*Eminia antennulifera*, *Gymnosporia putterlickioides* and *Solanum tettense*). The threat of modification appears to be low to moderate, although where elephants are present they are likely to favour it. It is considerably more extensive than Type 2.1. Based on these considerations, the conservation significance can be regarded as moderate.

Type 2.3 - *Terminalia brachystemma* Thicket to Wooded Bushland
This type is confined to the west, occurring to either side of the Musengezi inlet, particularly in association with the Gonono sand ridge between the Angwa and the Zimbabwe border, and extending into the neighbouring portions of Zimbabwe. It is characterised by dominance of *Terminalia brachystemma*, although this species is not restricted to this type. Structurally, it varies from a dense, almost mono-specific thicket (> 80% cover) some 2-6 m high, to more of a wooded bushland, comprising a lower open *Terminalia* shrub layer (2-3 m high, c. 25% cover) with scattered larger trees (up to 12 m, c. 15% cover) of *Terminalia* and other species (such as *Combretum zeyheri*, *Combretum collinum*, *Dalbergiella nyasae* and *Diospyros kirkii*). Although not well sampled during the course of this survey (only two plots), it is described in some detail by Timberlake et al. (1993), Du Toit (1993) and Timberlake et al. (1998).

The overall species complement is more akin to that of miombo communities and Type 3.2 low open woodland, rather than the preceding dry thicket and woodland type. Given the limited exposure to this type in the field, some difficulties were encountered during the interpretation of the satellite imagery, as regards separating it from Type 2.2.

Conservation Assessment
Species diversity is much lower than for the dry forest, thickets and woodlands, both within and between patches. It also appears to be less favoured by wildlife, and less suited to agricultural purposes, such that the level of threat is relatively low. Conservation significance is thus lower, but based on its relatively limited extent is rated as moderate.

Type 2.4 - *Julbernardia*/*Terminalia* Woodland on Comboio
Julbernardia/Terminalia woodland was only recorded from the summit of Comboio (The Train), although the more open portions of the previous unit show marked similarity and could possibly be included as part of this unit. Comboio is the prominent feature between Mukumbura and Magoe that rises abruptly above the surrounding landscape to a height of some 300 m. In places it is bounded by steep cliffs, which make it difficult to scale, although elsewhere the slopes are

gentler. The summit is a virtually level sand cap, developed from weathering of the underlying sandstone formations, and is devoid of rock outcrops.

Vegetation on top consists of a relatively dense woodland type (c. 60-80% cover), to about 12 m in height, and dominated by *Julbernardia globiflora* and *Terminalia brachystemma*. Associated trees species are *Combretum apiculatum*, *Combretum zeyheri*, *Commiphora mollis*, *Crossopteryx febrifuga*, *Diplorhynchus condylocarpon*, *Kirkia acuminata*, *Pseudolachnostylis maprouneifolia*, *Strychnos madagascariensis* and *Xeroderris stuhlmannii*. The shrub layer is relatively sparse and easy to walk through. It comprises small individuals of the above species, together with *Boscia mossambicensis*, *Commiphora mossambicensis*, *Dalbergia melanoxylon*, *Dichrostachys cinerea*, *Friesodielsia obovata*, *Holarrhena pubescens*, *Markhamia obtusifolia*, *Pterocarpus brenanii*, *Solanum incanum* and *Vangueria infausta*. Ground cover was very sparse (< 5%), but there were signs of a severe burn from the preceding dry season, which suggests the previous existence of a high fuel load.

Comboio supports at least two other vegetation types. These stand out on the satellite imagery, and were observed from the air, but were not sampled on the ground. The one community comprises a thicker, virtually closed canopy formation, including emergent species such as *Adansonia digitata* (baobabs) and *Kirkia acuminata*. This occurs on up slope portions of the landscape, possibly in association with deeper sands, and is likely to be a form of Type 2.2 (mixed dry thicket). The other type comprises small localised patches of a low, dense, and apparently mono-specific shrub community (perhaps *Diplorhynchus condylocarpon*), seemingly associated with slight depressions in the landscape. This was not mapped. It does not appear to occur anywhere else in the study area.

There is no settlement or cultivation on Comboio or within its immediate surrounds. Local people consider it to be a sacred mountain. Permission to access the mountain was negotiated through the District Administrators office in Magoe with a representative of the relevant spirit medium. Elephants are reported to visit during the wet season, and old tracks were seen, as well as kudu spoor. A few pans were noted from the air, although it is not clear as to how long these retain water. Some villagers are reported to visit the area for hunting. The former Rhodesian army maintained a helicopter fuel base somewhere on top of Comboio, and the surrounding area is believed to be heavily mined, and should be avoided.

Conservation Assessment
This woodland type does not appear to be particularly special in terms of species composition, and the threat of modification is low. Conservation significance would thus appear moderate. However, this seems to be the only occurrence of this particular type of woodland, and it is suggested that Comboio, as a discrete and distinctive landscape unit, together with its cultural significance, should be considered as a high conservation priority.

4.1.3 Type 3: Units on Karoo and Basalt Formations

The five Type 3 units collectively cover the bulk of the valley area. Types 3.2 and 3.4 comprise the largest of the valley units. Types 3.3 and 3.5 are smaller, but still relatively extensive, whilst Type 3.1, being dependent on particular environmental situations within the landscape rather than occupying an entire geological formation, is much more limited in occurrence. Following on from the Type 2 units on unconsolidated sands, the order of presentation is consistent with a gradual transition from sandier to heavier soils. The five units also follow a trend from shallower (skeletal on the ridges, Type 3.1) to better developed soils, particularly the deeper depositional clay soils that support Type 3.5 “cathedral mopane” woodland.

Type 3.1 - Mixed Woodland on Sandstone Ridges and Hills

Much of the valley floor is relatively flat and devoid of any significant features. Where sandstone ridges and hills do occur, these support a varied but relatively distinct woodland type. The most obvious occurrence is on the extended sandstone ridge running directly behind Magoe. It is also found on the slopes of Comboio, Bungue mountain (near Daque) and Changaudze (near Chioco). Additional patches occur on sandstone outcrops within the Luia basalt area and, from the air, it appears to be relatively widespread on the hills to the east of the Cangudeze drainage, although it was not possible to confirm this on the ground.

Key determinants of this varied type appear to include geology, the proportion of surface rock outcrop, and the steepness of slope. Structurally, the vegetation ranges from thicket to more open woodland, depending on the presence of sands and surface rock. Species composition is similar to dry thicket and woodland communities on sands (Type 2.2), the major difference being the presence of *Brachystegia* species on the Magoe ridge, Luia outcrops, and Changaudze (but not on Bungue or Comboio). Steep and broken rocky slopes support a particular dense thicket type, including a number of spiny species, such as *Acacia ataxacantha*, *Acacia nigrescens*, *Acacia nilotica*, *Acacia senegal*, *Canthium glaucum* subsp. *frangula*, *Commiphora glandulosa*, *Dichrostachys cinerea*, *Psydrax livida*, *Psydrax martinii*, *Zanthoxylum chalybeum*. These make it difficult to move through.

This type supports the highest number of species per plot (range = 41-63) and includes a wide overall variety of species, the total count of 124 being the second highest of all types. It also contains a large number of species (31, which is more than 10% of the total species from all plots) that were not recorded from any other types - *Albizia tanganyikensis*, *Anisotes bracteatus*, *Barleria albostellata*, *Barleria senensis*, *Brachystegia allenii*, *Brachystegia longifolia*, *Combretum padoides*, *Commiphora marlothii*, *Crabbea hirsuta*, *Crotalaria moneiroi*, *Dombeya kirkii*, *Elaeodendron matabeleicum*, *Entada spicatum*, *Erythrococca menyharthii*, *Euphorbia espinosa*, *Ficus cordata*, *Haplocoelum foliosum*, *Kalanchoe lanceolata*, *Loeseneriella africana*, *Maerua buxifolia*, *Margaritaria discoidea*, *Mystroxylon aethiopicum*, *Psiadia punctulata*, *Psydrax martinii*, *Pteleopsis anisoptera*, *Strychnos usumbariensis*, *Tarchonanthus camphoratus*, *Tarchonanthus trilobus*, *Tephrosia rhodesica*, *Terminalia sambesiaca* and *Vepris zambesiaca*. Although many of these species are likely to be found elsewhere, the considerable number involved suggests that this is an important vegetation type.

Conservation Assessment

Given the high diversity both at the plot level and overall, the considerable number of species not found in any other types, and the relatively restricted extent of this type, the conservation significance of this unit is rated high. This type would seem to be of little interest for either animals or people. It was surprising to see some clearing for fields relatively high up on the slopes of Mt. Bungue, but this would appear to be a localised rather than widespread threat.

Type 3.2 - *Diospyros/Combretum/Colophospermum* Low Open Woodland on Shallow Sandstone Soils

This extensive type occurs on shallow soils derived from Karoo sandstone deposits. It is found across the full extent of the valley portion of the study area, particularly to the east. Structurally it comprises a low (4-14 m), open (30-70% cover) woodland. Dominance varies according to local conditions, the most abundant species being mopane, *Combretum apiculatum*, *Combretum zeyheri*, *Commiphora mossambicensis*, *Diospyros kirkii*, *Diospyros quiloensis*, *Diplorhynchus condylocarpon*, *Julbernardia globiflora*, *Kirkia acuminata*, *Pterocarpus brenanii*, *Sterculia africana*, *Strychnos madagascariensis*, *Terminalia brachystemma* and *Terminalia stuhlmannii*. Other common tree and shrub species include *Acacia nigrescens*, *Acacia nilotica*, *Catunaregam*

spinosa, *Crossopteryx febrifuga*, *Dalbergia melanoxylon*, *Dalbergiella nyasae*, *Dichrostachys cinerea*, *Erythroxylum zambesiacum*, *Flacourtia indica*, *Grewia bicolor* and *Pseudolachnostylis maprouneifolia*. Despite the relatively open woody layer, grass cover is not particularly well developed, ranging in cover from some 20-70%.

On sandier soils this type grades into *Combretum*/mixed woodland (Type 2.2), or sometimes *Terminalia brachystemma* woodland (Type 2.3), whilst on heavier soils, such as along drainages, it grades into mopane woodland (Types 3.4 or 3.5). Even the smallest drainages are typically characterised by an increase in the incidence of mopane and the occurrence of bigger trees. This effect is particularly marked to the east where considerable portions around the drainages are depicted as Type 3.5. The landscape, although generally flat, typically shows marked microrelief, in places becoming quite heavily dissected. So, rather than consisting of level terrain, there is normally some slope, sometimes becoming relatively steep.

Conservation Assessment
This extensive unit is not of any great significance from a biodiversity perspective. It sustains a relatively low number of species per plot (range = 18-39), and although the overall species count is relatively high (92 species), this can partly be explained by the relatively large number of plots (8 plots), and perhaps also in that the unit is transitional to a variety of other types. Most constituent species are widespread, and are also found in sandier or more clay rich units. The shallow soils associated with this type are not favoured for agricultural purposes, although localised pockets of slightly deeper soils do occur. The principal use of this unit is for grazing purposes, either for livestock or wildlife. Conservation significance is low.

Type 3.3 - *Colophospermum/Combretum/Terminalia* Low Open Woodland on Shallow Basalt Soils
This unit is very similar to the previous type. It also consists of low (4-8 m) open (40-60% cover) woodland dominated by *Colophospermum mopane* (mopane), *Combretum apiculatum* and *Terminalia stuhlmannii,* but occurs on basalt outcrops rather than Karoo sediments. Associated tree and shrub species include *Acacia nigrescens*, *Acacia senegal* var. *leiorhachis*, *Carphalea pubescens*, *Commiphora caerulea*, *Commiphora glandulosa*, *Commiphora mossambicensis*, *Croton gratissimus*, *Diospyros quiloensis*, *Gardenia resiniflua*, *Grewia bicolor*, *Kirkia acuminata*, *Pterocarpus brenanii*, *Sclerocaryea birrea*, and *Sterculia africana*. The shrub layer is poorly developed, but grass cover is relatively high 70-90%. The terrain is typically dissected, such that slopes are moderate to steep. Soils are very shallow and stony. Towards the tops of rises there is often some surface rock outcrop, whilst at the base of hills soils are slightly better developed and support a thicker vegetative cover of taller trees, and typically with a higher proportion of mopane. Fire is likely to be an important determinant of woody cover. Grazing appears relatively productive and signs of elephant were observed in a number of places.

The extent of the Luia basalt deposits with which this type is associated is relatively easy to map. However, from the air it was apparent that the vegetation of this overall area is by no means uniform, and is far more varied than it appears on the satellite imagery. The extent of variation is from relatively thickly wooded ridges (at least some of which comprise inclusions of Karoo sandstones), to much more open communities, in places verging on grassland. The limited work carried out under this survey was insufficient to allow accurate mapping of this richness. Additional occurrences are shown to the extreme west of the study area

Conservation Assessment
As for the previous unit, the biodiversity value and conservation significance of this type are low. The number of species per plot is low (range = 20-24), and the overall total was only 27 species, although this is largely an artefact of the limited number of samples (only 2) and their relatively close proximity to one another. *Melhania acuminata* is the only species recorded as being particular to this type, although there are probably others. From a broader perspective, the Luia basalt block comprises a vast undeveloped area (other than the Songo-Zimbabwe power line), parts of which appear to be reasonably well watered, such that it could possibly comprise an important and productive wildlife area.

Type 3.4 - Mopane/Mixed Woodland
Mopane/mixed woodland is the largest of the valley units. It is found through out the valley portion, particularly to the west. It occurs on a variety of geological types. Soils are generally shallow and relatively clay-rich, but differ in other respects, sometimes having numerous pebbles on the surface, and sometimes a coarse gravelly texture or even a pronounced sand component. The terrain is usually slightly to moderately sloping, rather than comprising flat land or more pronounced low ridges or undulations.

Vegetation consists of moderately tall woodland, typically 8-12 m high, but sometimes as low as 4-8 m, and sometimes up to 14 m. Total woody cover is relatively high, ranging from 50-80%. It is characterised by the presence of both tree and shrub layers. The tree layer is often differentiated into two layers, comprising a shorter stratum and a scattering of taller trees, the combined cover of which is in the order of 20-50%. The shrub layer is typically fairly well developed (10-50% cover), in some cases providing the bulk of the cover. The grass layer is variable, being relatively sparse in some cases (5-15%), but elsewhere reaching 50-60%. The taller tree species include *Colophospermum mopane*, *Acacia nigrescens*, *Adansonia digitata*, *Sclerocarya birrea*, *Sterculia africana* and *Terminalia prunioides*, whilst the predominant smaller trees are *Combretum apiculatum*, *Commiphora glandulosa*, *Commiphora mollis*, *Commiphora mossambicensis*, *Pterocarpus brennanii* and *Terminalia stuhlmannii*. The shrub layer is dominated by small individuals of the above species, together with *Acacia nilotica*, *Cadaba kirkii*, *Carphalea pubescens*, *Combretum eleagnoides*, *Dalbergia melanoxylon*, *Gardenia resiniflua*, *Grewia bicolor*, *Karomia tettensis*, *Markhamia zanzibarica* and *Ximenia americana*.

It may be possible to separate out a number of subtypes for this unit on the basis of the different geological formations on which it occurs. The failure to do so under this study could be an artifact of the extremely low intensity of sampling.

Where the grass cover is relatively high, this type should afford a relatively high quality grazing resource for livestock or wildlife. The unit also includes portions of reasonable agricultural land. For example, much of the settlement and cultivation within the vicinity of Daque has been established within this unit. Fossil wood has been recorded from a number of localities.

Conservation Assessment
The biodiversity value of this type is moderate. Numbers of species per plot is moderate (mean = 35 species), and although overall diversity is high (120 species), this is probably a reflection of the inclusion of vegetation from several distinctive geological formations, which with more sampling, could possibly be subdivided into two or more separate types. The constituent species tend to be widespread, and none were recorded as being specific to this particular unit. And although the level of threat appears moderate, this is countered by the large extent of the unit, such that the overall conservation assessment is low.

Type 3.5 - Mopane Woodland on Deeper Depositional Soils
This type is more restricted in the landscape. It can be considered as an extreme variant of the previous type, occurring on flatter portions of the landscape where soil development is slightly deeper. It often occurs as small localised patches, particularly in regions with marked undulations, which are not possible to map at this scale. Elsewhere, particularly to the east, it covers relatively extensive areas, which are easier to map and which grade into the more diverse and mixed community of the previous type. It also occurs on colluvial deposits particularly around the base of the Luia basalt area. There are minor occurrences on clay-rich alluvial deposits associated with the Panyame River.

In such circumstances, mopane trees tend to achieve considerably greater stature and dominance. These woodlands tend to have fewer constituent species, comprising typical associates of heavy clay soils (*Acacia nilotica*, *Acacia robusta*, *Boscia mossambicensis*, *Dichrostachys cinerea*, *Diospyros quiloensis*, *Gardenia resiniflua*, *Grewia bicolor*, *Maerua decumbens* (*Courbonia glauca*), *Maerua prittwitzii*, *Terminalia prunioides* and *Ximenia americana*), together with a few more common and generalist species such as *Adansonia digitata*, *Combretum eleagnoides*, *Combretum mossambicensis*, *Commiphora mossambicensis*, *Dalbergia melanoxylon*, *Friesodielsia obovata* and *Markhamia zanzibarica*.

Conservation Assessment
Biodiversity value is relatively low, based on its low species richness (5-34 species per plot), low overall diversity (70 species), and lack of particular species. However, this type comprises good agricultural soils, particularly for cotton, and it can be anticipated that this type will be specifically targeted for clearing, as has occurred in the adjacent portions of Zimbabwe. So, as a vegetation type, it should be considered as a relatively high risk, and moderate priority for conservation.

4.1.4 Type 4: Aquatic Units

Timberlake (2000b) specifically covers the aquatic vegetation of Lake Cabora Bassa, and associated plant species, in some detail, so no effort was made to further sample these types. Descriptions are included here for the sake of completeness. Three of the six plant communities described by Timberlake for the shoreline (gorge and cliffs, mopane woodland, and riparian woodland) are covered under other units within this study (Types 3.1, 3.4 and 1.2, respectively); two (alluvial flats and sandbanks) are combined under Type 4.1 (*Phragmites* reedbeds on sandbanks); leaving the final unit (aquatic vegetation) which is described here as Type 4.2 (floating aquatic vegetation), and the open water of the lake.

Type 4.1 - *Phragmites* Reedbeds on Sandbanks
The principal occurrence of *Phragmites* reedbeds is at the extreme western end of the lake, on sandy alluvial deposits occurring within the initial 25 km downstream of where the Luangwa River joins the Zambezi and enters Cabora Bassa. Smaller patches are also found at the mouths of the major inlets, such as those of the Panyame and Musengezi Rivers. Vegetation comprises extensive beds of *Phragmites mauritanius*, with scattered *Sesbania sesban* and occasional trees of *Faidherbia albida*, *Ficus capreifolia*, *Ficus sycamorus* and *Ziziphus mauritanius*. Away from the lake, additional reedbeds are found within the beds and on the lowest alluvial terraces of the larger rivers. No attempt was made to map these latter patches, and for the purpose of this exercise they have been included under what is mapped as riparian forest (Type 1.2).

Conservation Assessment
This unit has little interest from a botanical perspective. However, on the basis of being of great significance for bird diversity, very restricted in occurrence, and heavily impacted through clearing for cultivation, it is suggested that this unit should be considered of high conservation priority. In addition, grazing by hippos is widespread and the banks are favoured by crocodiles.

Type 4.2 - Floating Aquatic Vegetation
This vegetation type is principally found floating just off the shoreline. Based on the 1998 satellite imagery, it is more extensive at the western end of the lake and on the southern shoreline, particularly within sheltered east-facing bays. However, its distribution and extent can be expected to vary considerably depending on the level of water in the lake. The vegetation comprises floating or rooted mats of the grass *Vossia cuspidata*, fringed by the free-floating aquatic fern *Azolla filiculoides*. Associated species include other floating plants, some submerged species, emergents, and occasional rooted shrubs.

Conservation Assessment
Conservation priority is moderate, mainly due to its very limited occurrence, the precise extent of which can be expected to vary from year to year depending on the water level in the lake. It is not threatened in any respect. Nor is it of any great importance from a plant biodiversity perspective, although it is important for the feeding of various waterbirds and, possibly, hippo.

4.1.5 Type 5: Units on Southern Basement Geology

The portion of the study area to the south of the lake includes only very minor exposures of basement geological formations. The two places where they do occur are, firstly, in the vicinity of Songo and continuing downstream along the Zambezi and, secondly, to the south and east of the Luia basalt area, where the southern escarpment region marginally intrudes across the international border into Mozambique. Three types are described, although field sampling was limited to a single sample in the vicinity of Songo.

Type 5.1 - Mixed Miombo Woodland on Songo Gneiss
The single sample does not provide an adequate basis for describing the vegetation of this area. The occurrence of considerable hills adds complexity, in the form of localised variations according to aspect, slope and position within the landscape. The generally high level of modification to which this area has been subjected presents a further complication. The clearing of fields even on the steepest upper slopes and tops of mountains, was clearly evident both on the ground and from the air and is a striking feature. The motive for doing this appears to be to tap extra moisture associated with the locally higher elevations. Once disturbed, the rate of soil loss from these steep slopes must be extremely rapid, leaving little opportunity for the subsequent regeneration of plant communities. The argument that the occurrence of this practice relates to excessive land pressure seems only partially true.

Conservation Assessment
The single sample plot recorded suggests a relatively high species diversity and, as expected, there are a number of the species found here that are not associated with the valley units. The extent to which the unit continues to the north is not clear, but for the southern portion the flatter arable portions (and even many of the slopes) have been extensively modified through clearing for cropping. Although more information is needed to reliably assess the conservation significance of this unit, given the extensive occurrence of miombo woodland to the north of the lake, it is suggested that this type should be considered to be of low conservation priority.

Type 5.2 - *Brachystegia allenii* Escarpment Open Woodland on Gneiss
This type occurs on Changara and Rushinga gneisses which make up the escarpment foothills to the south of the Luia River, and which extend south into Zimbabwe. This unit was not sampled on the ground, but from the air appears similar to the low open escarpment woodland that has been described from further west within Zimbabwe, for example along the base of the Mavuradonha mountains (Cunliffe, 1997a; Timberlake et al., 1993). This comprises a low open miombo woodland type dominated by *Brachystegia allenii*, together with species such as *Combretum apiculatum*, *Commiphora mossambicensis*, *Diospyros kirkii*, *Diplorhynchus condylocarpon*, *Lannea discolor*, *Ormocarpum kirkii*, *Pterocarpus brenanii* and *Terminalia stenostachya*. Key features of this type are steep slopes and skeletal soils. The gullies tend to support richer and more interesting communities (Timberlake, 1996).

Conservation Assessment
This type appears to be of little interest from a biodiversity perspective, being of low diversity and comprising widespread species that are also common constituents of other types. Moreover, these escarpment areas appear to be of little use to people or animals, such that the threat of modification is minimal. The overall conservation rating is low.

Type 5.3 - Mixed Dry Thicket on Gneiss
Extending southeast from the Luia basalt area (Type 3.3), the vegetation on the Rushinga gneiss, at low altitude, appears to comprise a form of deciduous dry thicket similar to that of the adjacent portion of Type 2.2 (mixed dry thicket). The boundary between this unit and the small adjacent portion of Type 5.2 is not clear on the satellite imagery, but based on aerial observations the distinction appears to be valid. The area was not reached on the ground, such that the composition and extent of this type should be regarded as a working hypothesis only.

Conservation Assessment
In the absence of any sound information it is not possible to reliably assess the conservation significance of this unit, However, as a thicket type but occurring on basement formations, it is possible that its species composition may be somewhat different from other dry thicket types identified from within the valley portion, such that it may be of some (moderate) conservation interest.

4.2 Vegetation Units to the North of Cabora Bassa

The bulk of the terrain to the north of the lake comprises basement granites and gneiss. The valley portion, comprising Karoo sediments, is restricted to a narrow strip some 5 - 20 km wide, which extends west from a point roughly opposite Magoe, and for some 60 km up the Luangwa valley to the north of Zumbo. Vegetation composition mirrors the valley/basement divide. The valley portion consists of much the same mix of units as found on corresponding Karoo sediments to the south of the lake, whilst the escarpment and upland country mainly comprises various forms of miombo woodland or, to the east, of mixed mopane/miombo woodland.

The identification of units to the north of the lake, in the absence of any sampling, is based entirely on aerial observations and interpretation of the satellite imagery. The resulting classification and mapping is much less certain than for the southern portion. Nevertheless, the presentation of units is believed to comprise a reasonable working hypothesis, and should be adequate for the identification of areas of conservation and wilderness value.

4.2.1 Valley Units

The major difference between the northern valley portion and that to the south of the lake, is the proximity of the escarpment terrain. Although the boundary between the valley and upland basement portions is as clear and sharp as along the southern divide within Zimbabwe, the northern escarpment portion is less dramatic, comprising very broken terrain which gradually increases in altitude, as compared to the more abrupt mountainous transition to the south.

The proximity of the escarpment and upland areas appears to have a noticeable impact on the vegetation of the valley. Rainfall can be expected to be locally higher along the base of the hills, and the development of colluvium gives rise to soils which are relatively deep and fertile. These factors result in enhanced soil moisture and nutrient levels. The overall effect in terms of vegetation, is the occurrence of more mesic communities, as evidenced by taller trees, thicker cover, a higher proportion of thicket types, and the inclusion of species that are more usually associated with alluvial conditions.

Eleven of the 18 units described to the south of the lake are mapped for the northern valley portion (these being Types 1.1-1.4; Types 2.1 and 2.2; Types 3.2, 3.4 and 3.5; and Types 4.1and 4.2). One additional valley unit is newly described (*Terminalia* open woodland, Type 2.5), whilst another 11 units are identified for the basement portion (Types 6 and 7), giving an overall total of 23 units.

Type 1: Vegetation on Alluvium/Colluvium
Due to the smaller valley portion, there is much less development of alluvium to the north than to the south of the lake. The major occurrence is in association with the Luangwa River, with lesser portions along some of the smaller drainages. The extensive alluvial/colluvial fan situated to the north of the valley portion, in association with the Rio Mese, is of particular note.

The alluvial/colluvial areas are expected to include portions of all four of the Type 1 units described for the southern portion. As described above, due to the proximity of the escarpment zone, the colluvial influence on the valley vegetation is more marked than to the south.

Conservation Assessment
The same considerations of high plant diversity, the presence of particular species, limited extent, and high threat of modification, are equally applicable as to alluvial communities to the south of the lake, such that the northern occurrences must also be considered as high conservation priorities. The marked alluvial portion extending east of the Luangwa River in association with the Mese River, appears to be particularly diverse and important. This is mapped as riparian forest but includes substantial patches of other alluvial types.

Type 2: Dry Forest, Thicket And Woodland Types on Unconsolidated Sands
Communities on sand are relatively well represented within the valley portion to the north of the lake. There are several significant patches of *Xylia* thicket (Type 2.1), and also mixed dry thickets (Type 2.2), but the other two types (2.3 and 2.4) were not identified from here. One additional sand unit is described, this being *Terminalia* open woodland (Type 2.5). This is expected to have strong similarities to Types 2.3 and 2.4 in terms of species composition, but structurally looks to be a more open community. It also has a very different appearance on the satellite imagery.

Conservation Assessment
The *Xylia* dry forests, as for the southern portion, should constitute the highest conservation priority among the various Type 2 units that occur here. The large portion situated up the Luangwa River at the base of the escarpment appears to be especially significant. From the air it appears to consist of a moister version of *Xylia* forest, with particularly dense vegetation cover and tall emergent trees, and quite possibly includes species that do not occur elsewhere in this type. This is possibly the most important conservation site of the whole study area.

Types 2.2 and 2.5 are both of moderate conservation priority. Type 2.2 is expected to be relatively diverse, but being of greater extent, is of lower conservation priority than the *Xylia* forests. The open *Terminalia* woodland, as for the two *Terminalia* types to the south of the lake (Types 2.3 and 2.4) is not expected to be particularly diverse, nor exposed to any significant threat of modification. Its rating as moderate conservation priority is based mainly on its limited extent.

Type 3: Units on Karoo Formations
Three of the five units identified from Karoo sediments and basalts to the south, are represented to the north of the lake. These consist of *Diospyros*/*Combretum*/Mopane low open woodland (Type 3.2), mopane mixed woodland (Type 3.4) and mopane woodland on deeper depositional soils (Type 3.5). No occurrences were noted of either sandstone ridges or basalt types. Collectively, these types constitute a smaller proportion of the overall landscape, as compared to the valley portion to the south of the lake.

Conservation Assessment
The conservation significance of these three units is the same as for their occurrences to the south of the lake, namely low for the widespread Types 3.2 and 3.4, but moderate for the less extensive and more threatened mopane woodland on deeper depositional soils (Type 3.5).

Type 4: Aquatic Units
The representation of aquatic units is the same as for the southern portion of the lake, comprising *Phragmites* reedbeds (Type 4.1), floating aquatic vegetation (Type 4.2) and open water. The floating aquatic vegetation is less extensive than on the southern shores, but is also more abundant at the western end of the lake.

Conservation Assessment
The conservation assessment of the aquatic units is the same as discussed under the previous section, namely high for the *Phragmites* reedbeds and moderate for the more resilient floating aquatic vegetation.

Type 5: Units on Basement Geology
The valley area contains several isolated occurrences of basement rocks, such as the hills behind Zumbo, Mt. Metaafuro (10 km to the northeast), and another portion 10 km further to the north. These are mapped as Type 7.1 (open woodland on dry lithosols), which is described in the following section.

4.2.2 Basement Units

The geological map shows considerable complexity within the basement portion to the north of Cabora Bassa (Instituto Nacional de Geologia, 1987). However, the degree to which the different geological units result in vegetation changes appears to be less marked than for the

Karoo sediments of the valley portion (although it is possible that differences may be clearer in the field than they appear on the satellite imagery).

Eleven units are described for this portion. These are split into two groups, the first of which consists of various types of woodland in which mopane is present (Type 6, three units), and the other comprising various miombo and associated formations (Type 7, eight units). The Type 6 mixed mopane/miombo units are confined to a block, extending from opposite Songo to the northeast of the study area, and extending west as a narrow irregular strip along the lakeshore to roughly opposite Magoe. The Type 7 miombo woodlands cover the remainder of the basement area.

Type 6: Mopane/Mixed Units on Northern Basement Geology
The area mapped as Type 6 vegetation, in comparison to the adjacent miombo areas to the north and west, appears to be relatively low lying, hot and dry. Although described as mopane types, much of the vegetation may actually constitute a mopane-miombo mix, or even a low open miombo type.

The distinctions between the three units are very broad. The more rugged and broken terrain, with skeletal soils, is mapped as Type 6.1 (mopane/mixed open woodland on lithosols). This can be expected to consist of a low open woodland type. The difference between this unit and Type 5.1 (mixed miombo woodland) to the south of the lake (also on lithosols), is not clear, and the dividing line between them has been arbitrarily inserted just south of the Zambezi River.

Types 6.2 and 6.3 occur on gentler terrain, where soils can be expected to be slightly better developed. Vegetation is likely to consist of a slightly taller woodland and with greater cover. Type 6.2 (mixed deciduous woodland) appears to comprise a mixed deciduous woodland with mopane, *Sterculia*, *Acacia nigrescens* and *Commiphiora* spp. Type 6.3 (mopane/miombo mixed woodland), to the north, appears to be a slightly moister community, possibly with greater dominance of mopane, and in places with an increased presence of miombo components.

Type 6.1 does not appear to offer much potential for agriculture, and even as a grazing resource is likely to be marginal. It does, however, support some settlement. The satellite imagery shows extensive burning in Type 6.2, which suggests a good grass cover, and also suggests that this is either a drier type than 6.3, or else has a higher intensity of occupation.

Conservation Assessment
The conservation significance of these units is expected to be low. Given that these types are likely to contain both mopane and miombo species, overall plant diversity may be relatively high. However, constituent species are likely to be widespread, the presence of unique species is not anticipated, the units are relatively extensive, and the level of threat appears relatively low.

Type 7: Miombo/Other Units on Northern Basement Geology
Eight miombo type units are recognised for the northern basement area. These can be grouped into two lithosols units (Types 7.1 and 7.2), four extensive units on gentler terrain (Types 7.3-7.6), and two more specific types, namely bamboo thickets (Type 7.7) and serpentine grasslands (Type 7.8). Apart from the broken and sometime mountainous lithosol areas, the general pattern is of irregular parallel bands, running roughly east - west. Altitude, and thus rainfall, increases to the north and, in conjunction with more subdued relief, results in increasingly denser woodland types.

Types 7.1 and 7.2 - Open/Closed Woodland on Lithosols
The two lithosol units are separated out on the basis of rainfall and moisture conditions. Those situated at lower altitude, particularly to the south and west (Type 7.1 - open woodland on drier lithosols), appear to be relatively dry, and to support an open miombo community in which *Brachystegia allenii* and *Sterculia quinqueloba* are common. This type has a relatively pale appearance on the satellite imagery as compared to the much redder hue of Type 7.2 (denser woodland on moister lithosols). The vegetation of Type 7.2 appears to comprise a denser woodland type, almost with a closed canopy, and presumably with a different species composition.

Conservation Assessment
It is possible that the more elevated hills of Type 7.2 may contain some species not found elsewhere, and thus be of some interest. However, both types are relatively extensive, and neither offers much potential for either cropping or grazing activities, such that the threat of modification is minimal. Overall conservation significance is probably low. The occurrence of an extensive cluster of granite "whaleback" outcrops, situated some 10 km northeast of the Type 7.8 serpentine outcrops (centred on UTM 269.8297), comprises an unusual feature that may be of particular interest.

Type 7.3 - Western Miombo Open Woodland
The next four types (Types 7.3-7.6) occupy the intervening gentler terrain between the lithosol outcrops, and cover a similar gradient from lower lying drier areas to the south and west, to higher and moister conditions in the north. Type 7.3 western open miombo woodland occurs as an arc to the west, and comprises a transitional community between the drier lithosol Type 7.1 and the moister central and northern miombo units (Types 7.5 and 7.6). It constitutes very broken country with marked micro-relief, which gives rise to a characteristic stippled appearance on the satellite images. Vegetation consists of an open miombo type.

Conservation Assessment
There are no apparent reasons as to why this type should be of any particular conservation interest.

Type 7.4 - Southern Miombo Open Woodland
This unit is probably very similar to the previous type, but occupies the transitional area between the drier southern mixed mopane unit (Type 6.2) and the moister central miombo unit (Type 7.5). It is separated out on the basis of a slightly different appearance on the satellite imagery. It occurs as an irregular belt, starting almost on the lake opposite Magoe, and extending east from here.

The potential of units 7.3 and 7.4 for settlement and cropping would appear to be limited. The paucity of settlement in Type 7.3 is consistent with this, but the eastern part of Type 7.4 supports relatively extensive and dense settlements. The presence of these villages may be related, in part, to the proximity of this unit to the lake.

Conservation Assessment
As for the previous unit, this type is not expected to be of any particular conservation significance.

Type 7.5 - Central Miombo Closed Woodland
This unit comprises a markedly denser and taller miombo woodland than the previous two units. This is due to higher altitude, higher rainfall conditions, gentler terrain, and deeper soil development. Species composition is presumably also somewhat different. In places, *Acacia* spp. are prominent, and mukwa trees (*Pterocarpus angolensis*) are also common. Another difference is that Type 7.5 includes some dambo areas, albeit not particularly well developed, but which are absent from the western and southern open miombo types. The central miombo appears to comprise good agricultural land, and in places supports sizeable settlements.

Conservation Assessment
The species composition of this extensive unit is not anticipated to be of any particular interest. However, the threat of modification is moderate, such that the overall conservation significance can be rated as low to moderate.

Type 7.6 - Northern Miombo Closed Woodland
Situated to the north of the study area, this unit continues into Zambia. It is the wettest type. Topography comprises gentle and broad undulations. The development of dambos is far more pronounced, with the open grassy areas being more frequent and broader. Between the dambo areas the natural vegetation consists of a tall and dense miombo woodland. In preparing the vegetation map (Map 4), no attempt was made to distinguish between the woodland areas and the intervening grassland patches. In the neighbouring portions of Zambia this type has been heavily modified and, in time, the same intensity of modification can be expected to occur within Mocambique too.

Conservation Assessment
It is likely that the dambo components of this unit will provide habitat for a number of species that do not occur in the other types, particularly of woody suffrutices which may be of relatively restricted distribution (Timberlake, pers. comm.). This, coupled with a high threat of modification, suggest that this unit should be considered of relatively high conservation priority. There is one extensive grassland patch, situated some 25 km northeast of Zambue, that stands out as a feature of particular interest (centred on UTM 292.8338 but not mapped).

Type 7.7 - Bamboo Thickets
Within the moist northern miombo unit there are a number of dense bamboo thicket patches. These stand out clearly on the satellite imagery. Bamboo occurs more widely in some of the other miombo units, particularly Type 7.5, but tends to comprise scattered clumps rather than closed canopy thickets. The precise environmental conditions that give rise to these bamboo patches are not clear. Some of the patches appear to have been impacted through clearing for cultivation.

Conservation Assessment
Bamboo thickets are unlikely to be special from a biodiversity perspective. However, as a particular vegetation type, that is of limited extent, and has a relatively high risk of modification, it can be considered to be of high conservation significance. The fact that bamboo comprises a useful and valued construction material, and that similar bamboo thickets in the Mavuradonha mountains of Zimbabwe appear to be highly favoured by elephants, further supports this assessment. It should be noted that the south westernmost bamboo patch is situated at considerably lower altitude (c. 550 m) than the other portions (c. 900 m) , and can thus be expected to have a different set of associated species.

Type 7.8 - Serpentine Grasslands

The occurrence of serpentine grasslands (Type 7.8) is limited to three relatively small and associated patches. These are situated within the basement terrain, just north of the valley portion, opposite the area between the Panyame and Musengezi inlets. On the satellite imagery, and from the air, these areas have the same appearance as the Great Dyke region within the Mavuradonha mountains of Zimbabwe. Vegetation consists of an open grassland with occasional small trees. Watercourses support a fringe of evergreen tree species, with scattered palms (*Phoenix reclinata*). This is another lithosol type, but in which the vegetation structure and composition is influenced not only by the lack of soil depth, but also by the particular nature of the rock. This unit has little potential for grazing, and is completely unsuited to cropping.

Conservation Assessment

The serpentine grasslands are likely to be of high biodiversity interest. Similar serpentine grasslands on the Great Dyke in northern Zimbabwe are known to include a number of endemic species with relatively restricted distributions, and it is likely that this will be the situation here too. Although these areas are under little threat of modification, owing to their limited extent and likely biodiversity interest they can be considered to be a high conservation priority.

4.3 Plant Species

The list of plant species recorded from the 67 plots is given in Annex 3.2. This is arranged in alphabetic order by family, genus and species. Nomenclature follows that in current use at the National Herbarium, Harare, Zimbabwe. A total of 301 dicotyledon species are recorded, virtually all of which are perennial shrubs or trees. Little effort was made to record herbaceous species, and only 18 monocotyledons are listed. With only 2 or 3 samples for many of the types, and a maximum of 10 samples (for Type 2.2), the list is by no means comprehensive even for woody species, but this was not the intention.

4.3.1 Species of Interest

Species identified as being of particular interest are separated into two groups. The initial list of 22 species (Table 3.3) contains what appear to be six new records for Mozambique (*Anisotes bracteatus*, *Psiadia punctulata*, *Tarchonanthus camphoratus*, *Maerua buxifolia*, *Psydrax martinii* and *Elytrophorus globularis*); another five species for which only very few other records exist from this area (*Anisotes formosissimus*, *Crotolaria monteiroi*, *Rhynchosia wildii*, *Newtonia hildebrandtii*, and *Ziziphus pubescens*); seven species which are near the southern or northern extent of their range (*Commiphora zanzibarica*, *Maytenus pubescens*, *Combretum goetzei*, *Combretum kirkii*, *Monotes katangensis*, *Caucanthus auriculatus* and *Trichilia capitata*); three near endemic species (*Rhynchosia wildii*, *Mimosa mossambicensis* which is endemic to Mozambique but does extend north of the study area, and *Turraea zambesica*), and two species which, if correct, represent significant extensions to their previously known ranges (*Brackenridgea zanguebarica* and *Ochna multiflora*).

The second listing of 36 species (Table 3.4) contains additional taxa of interest, but of somewhat lesser importance. These constitute relatively unusual occurrences, or species that are known to occur here but are not frequently encountered. The conservation status of all these species is of possible concern. The plots where each of these species were recorded are given, and also whether or not it has been recorded among 175 similar plots from the adjacent Zambezi valley portion within Zimbabwe (Cunliffe, 1997a,b; Timberlake and Cunliffe, 1997; Timberlake et al., 1998).

Analysis of the occurrences of these 58 species of interest within the 14 vegetation types sampled, shows that one or more species were recorded from all types other than seasonally inundated grasslands on clay alluvium (Type 1.4) and Type 3.3 low open woodland on shallow basalt soils (Table 3.6). Type 3.1 includes a particularly high number of species of interest (22). Seven to ten species of interest were recorded from Types 1.2, 1.3, 2.1, 2.2 and 3.4, and the remaining six units each include six or less species of interest.

The alluvial area associated with the lower Luia River supports a number of species that, although common here, were not found elsewhere in the study area. These include *Acacia xanthophloea* and *Sterculia appendiculata*, both striking large trees, and *Trichilia capitata*.

4.4 Sites and Areas of Conservation Interest

The aim of identifying particular sites and areas of high biodiversity conservation interest, is to draw attention to relatively discrete and confined portions of the overall landscape, with the suggestion that these can serve as logical foci for subsequent conservation efforts. Four different approaches were used, resulting in the identification of a number of units, features, areas and regions of interest. These categories follow a gradient of increasing spatial scale. There is considerable overlap between the portions identified at each scale.

4.4.1 Units of Interest

Certain of the 30 proposed vegetation units are of higher biodiversity conservation interest than others. The criteria used to evaluate the units were species composition, extent of the unit, and perceived level of threat. Each of these factors is rated as high, medium or low, with the overall ranking being based on a subjective combination of these aspects (see Table 3.5).

Based on this analysis, nine units are identified as being of highest priority for conservation purposes Table 3.5 (Map 6). These are: vegetation of alluvial/colluvial areas (Types 1.1-1.4), *Xylia* dry forest (Type 2.1), mixed woodland on sandstone ridges and hills (Type 3.1), *Phragmites* reedbeds on sandbanks (Type 4.1 - see Map 5), bamboo thickets (Type 7.7) and serpentine grasslands (Type 7.8).

The **alluvial Types 1.1-1.4** are spread right across the valley portion, but are absent from the upland basement area (Map 6). Types 1.1 and 1.2 are mapped in association with all the larger rivers, with particularly extensive and unspoilt areas occurring in association with the Luangwa River and Luia River, together with its major tributaries the Metangua and the Cangaudeze. Type 1.3 is mapped in association with the Gonono sand ridge and the Luia basalt, where there are relatively large portions that are still largely undisturbed. The portion at the base of the hill behind Estima appears to be highly disturbed. Six small occurrences of Type 1.4 alluvial grasslands are mapped, one in association with the Luangwa alluvial system, three with the Panyame, and two, including the most extensive portion, with the lower Luia River. These four types vary greatly in terms of diversity, but all are already subject to considerable modification, or are considered to be at high risk of modification in the future.

Eleven patches of ***Xylia* dry forest (Type 2.1)** are mapped, eight to the south of the lake and three to the north, and all to the west of the Musengezi inlet. The northern patches have a similar appearance on the satellite imagery as those to the south, but occur in somewhat more mesic conditions and so may have a different species composition. The largest and best developed

Xylia forest portion is that which occurs in association with a marked colluvial fan between the Luangwa River and the base of the escarpment. Several of the portions demarcated to the south, in the vicinity of the Angwa and Panyame Rivers, continue across the border into Zimbabwe.

Seventeen portions of **mixed woodland on sandstone ridges and hills (Type 3.1)** are mapped. All are situated to the east of the Musengezi inlet, and most are found to the south of the lake, but with a few occurrences on islands within the lake. Overall, the vegetation shows considerable variety, ranging from low spiny thickets to more open *Brachystegia* woodland, depending, for example, on factors such as the substrate, slope and proportion of surface rock. Species diversity is consistently high, and includes many species that were not found elsewhere in the landscape. Individual occurrences tend to be relatively confined in extent, but the level of threat to each patch is relatively low.

The ***Phragmites*** **reedbeds (Type 4.1)**, although not of any special interest in terms of plant biodiversity, are included among the units of greatest conservation interest on the basis of their limited extent, high threat of modification and importance in terms of bird populations (Douglas, 2000; Timberlake, 2000b). A number of patches are mapped, all to the western end of the lake. There are additional occurrences within the beds of the larger rivers, but no attempt has been to separate these out, and they are included within the area shown as Type 1.2 (riparian forest), together with other Type 1.1 formations.

The **bamboo thickets (Type 7.7)** are, likewise, included here on the basis of comprising a distinct, limited and threatened vegetation type, but which is probably not of any special biodiversity interest. The southern most bamboo patch appears from the air to have a more mixed species composition than the other seven occurrences, and may be of particular interest.

The three **serpentine grassland patches (Type 7.8)**, in contrast to the previous two units, are included among the units of highest biodiversity interest, specifically on the basis of their assumed interesting species composition, together with their limited extent, rather than due to any perceived threat.

Nine other units are identified as being of moderate conservation interest (Table 3.5). These consist of four additional types of dry thicket or woodland on sands (Types 2.2 - 2.5), mopane woodland on deeper depositional soils (Type 3.5), floating aquatic vegetation (Type 4.2) and the basement types 5.1 (mixed miombo woodland on Songo gneiss), 5.3 (mixed dry thicket on gneiss) and 7.6(northern miombo closed woodland). The latter is included on the basis of the potentially high biodiversity interest of the included grassland dambo areas, rather than the miombo woodland portions, together with an apparently high level of threat of clearing for agriculture.

4.4.2 Features of Interest

There are a number of distinctive features that stand out clearly within the landscape (and on the satellite imagery), which support vegetation of high biodiversity interest (see Map 7). These features mostly include occurrences of more than one of the units identified above as being of high conservation interest.

Northern Grassland Patch
Within the extensive northern miombo closed woodland area (Type 7.6), some 25 km northeast of Zambue (centred on UTM 292.8338), there is a sizeable grassland patch (c. 5 km diameter) that stands out as potentially being of particular interest. From the air, there were no obvious signs of any large wildlife.

Luangwa Colluvial Fan
To the north of the valley portion extending up along the Luangwa River, there is a prominent alluvial/colluvial fan extending from the base of the escarpment down to the Luangwa River. This includes particularly well developed portions of Types 1.2, 1.4, 2.1, 2.2 and 2.5, and as yet has been little impacted through settlement and cultivation. This is possibly the most important conservation site for the whole study area.

Gonono Sand Ridge
Straddling the international border with Zimbabwe, the Gonono sand ridge comprises a low but distinctive sand feature, which supports a variety of important vegetation types including important occurrences of Types 1.3, 2.1, 2.2 and 2.3.

Comboio
The prominent raised plateau feature between Mukumbura and Magoe, commonly known as Comboio (The Train), comprises an obvious feature of conservation interest. The dominant vegetation on top is a form of *Terminalia-Julbernardia* woodland (Type 2.4), not identified from elsewhere in the study area. There appear to be at least two other associated types, although these were not mapped. These comprise a form of thicket community (Type 2.2), and a low shrub community which was not observed anywhere else. The slopes of Comboio form a rich and varied Type 3.1 thicket community. The mountain is considered by local people to be a sacred area. Indications are that it is used seasonally by low numbers of elephants.

Luia Alluvium
As the Luia River leaves Zimbabwe into Mozambique, it opens up for some 10 km from a narrow and steep course running through hills into a wide sand river flanked by prominent alluvial areas. This portion supports a wide range of alluvial/colluvial types within a confined area, and is quite distinctive from surrounding vegetation types. It also supports an established settlement, and must be considered to be under relatively high threat of modification.

Hill Features
There are a number of prominent hill features that support Type 3.1 vegetation, which is considered to be of high biodiversity conservation interest. The most notable of these is the sandstone ridge running behind Magoe. Other hill features include Bungue mountain beside Daque camp, and Changaudze hill (beside the Luia River and to the extreme southeast) and Mt. Ngosi, this being the prominent conical feature to the north of the lake and more or less opposite the Musengezi inlet (not mapped). The geology of Ngosi is particular, such that it could well support species and vegetation formations not found elsewhere.

4.4.3 Areas of Interest

The concept of area of interest is taken here as meaning a relatively confined portion of the landscape that contains a good variety of units, such that the overall diversity is high. Ten such areas of interest were identified (A1 - A10 (Map 8). Three of these are to the north of the lake, two to the southwest, and the other five to the southeast. All ten are centred on the valley

portion, although a number include representation of adjacent basement units. Only three areas (A2, A3 and A4) impinge on the lake and, of these, only A2 and A3 include a transition from the lake to the basement hills. The number of units included within each area varies from 9 to 12. Collectively, the areas include representation of all but seven units, all of which constitute basement units situated to the north of the lake. These include northern closed miombo woodland (Type 7.6) and bamboo thickets (Type 7.7), both of which are identified as being of potentially high conservation interest.

A1 - Luangwa North (11 units)
This area conforms closely to the Luangwa alluvial/colluvial feature identified in the previous section. It includes important sites of riparian forest (Type 1.2) and *Xylia* dry forest (Type 2.1), which form the essence of the area. Parts of the two adjacent escarpment units (Types 7.2 and 7.3) are also included.

A2 - East of Zumbo (12 units)
This portion constitutes the valley zone extending east from Zumbo. It includes the alluvial area and *Xylia* patch associated with the Metamboa River. It also includes the aquatic Types 4.1 and 4.2, and two escarpment units (Types 7.1 and 7.3). Changing the orientation of this area to a more southwest - northeast direction, away from the lake, could result in the inclusion of the southern most bamboo thicket patch (Type 7.7), but at the exclusion of the *Xylia* thicket site along the lakeshore.

A3 - Serpentine Hills (11 units)
The serpentine hills (Type 7.8) comprise the core of area A3, but this also includes a representation of lake, valley and escarpment units, including an important occurrence of *Xylia* dry forest (Type 2.1). Another possible permutation, which would also include Type 7.8, would be to delineate an area centred on the overlap between areas A2 and A3. This could include a total of some 13 units.

A4 - Panyame West (11 units)
This unit constitutes the portion to the west of the Panyame and Angwa Rivers. It includes the aquatic Types 4.1 and 4.2 and adjacent valley units, particularly all five Type 1 alluvial/colluvial units, and important occurrences of Type 2 vegetation on unconsolidated sands (Types 2.1 - 2.3). A number of the constituent types of high interest continue into the neighbouring portions of Zimbabwe.

A5 - Angwa/Panyame (10 units)
The Angwa/Panyame area overlaps with the previous Panyame west unit, covering the extreme southwestern corner of the study area. Although it includes much the same mix of types, other than the lake aquatic units, it is the sand units which form the core of this area. These occur in a belt running northwest-southeast through this portion. It also includes good representation of alluvial vegetation in the vicinity of the Angwa/Panyame junction. And again, a number of the important constituent types extend into Zimbabwe.

A6 - Comboio (10 units)
Although Comboio forms the heart of this area, it continues to the southeast so as to include the rich alluvial/colluvial area at the base of the hills of the Luia basalt portion, and a small part of the basalt area itself.

A7 - Luia Colluvium (9 units)
The essence of this portion is the diverse colluvial area extending southeast along the base of the Luia hills. It also includes alluvial areas in association with the Daque River, and Type 3.1 vegetation on sandstone hills incorporated within the basalt area.

A8 - Luia River West (10 units)
The Luia River west area conforms closely to the Luia alluvium/colluvium feature of interest, identified under the previous section. The core of this area is the diverse alluvial/colluvial area where the Luia leaves the escarpment hills. Overall diversity is further enhanced through the inclusion of patches of the adjacent escarpment woodland (Type 5.2) and the Luia basalt area (Type 3.3).

A9 - Chioco (10 units)
The Chioco area of interest extends east from the Luia basalt block and, like the previous area, includes a good representation of alluvial and colluvial vegetation at the base of the Luia hills, as well as a portion of Type 5.3 vegetation on the escarpment to the south.

A10 - Luia River East (10 units)
Situated to the extreme southeast of the study area, this portion is centred on the lower Luia River. In addition to the alluvial areas associated with the Luia and Cangaudeze Rivers, this area extends north to include Type 3.1 vegetation on the adjacent hills, thus considerably enhancing the overall diversity.

4.4.4 Regions of Interest

The identification of regions of interest is intended to capture, at the broadest level, which portions of the study area are likely to be of greatest interest from a biodiversity conservation perspective. In looking at the distribution of the ten areas of interest (A1 - A10), these fall into two distinct regions, each of which can be further subdivided into two (Map 8).

Western Region
The western region can be thought of as broadly covering the valley portion to the west of the Musengezi inlet. This can be subdivided into northern and southern portions on either side of the lake.

Eastern Region
The eastern region covers the valley portion extending east from Comboio, across the Luia basalt dome, and following southeast along the course of the Luia River to where it leaves the study area. The major split for the eastern region is the Comboio/Daque and northern portion of the Luia basalt dome, versus a second area centred on the lower Luia River and linking across the valley portion between the Luia basalt and the hills on the eastern border of the study area.
The western and eastern regions, in addition to including all ten of the preceding areas of interest, both constitute portions of relatively low agricultural potential, incorporate existing wildlife populations, especially elephant ranges, and are currently only sparsely settled.

4.5 Areas of Wilderness Value

Areas of wilderness value were identified on the basis of potential for wildlife and tourism, the lack of potential for alternative forms of land use, and large size. In order to do this it is necessary to have some feel as to what the key tourism features of the study area are likely to be. In this respect it is instructive to consider the situation of Lake Kariba, where the development of the tourism industry has been based on the combination of the lake, outstanding scenery and wildlife. Cabora Bassa would seem to offer much the same mix of natural features, except that wildlife is much less prevalent and abundant.

The key features of the lake will include the shoreline, inlets, islands and gorge areas. In terms of scenery, the lake will again be a prime component, together with areas of elevation, particularly where the hills come down close or even right on to the lake, as occurs along much of the northern shoreline. The gorge area along the Zambezi River below the dam wall is also spectacular. From a wildlife perspective, the valley portion has markedly higher potential than the uplands. The principal populations are currently found to the south of the lake and to the west of the Musengezi inlet, with additional smaller populations in the vicinity of Daque, the Luia basalt area, and in association with the Luia alluvial and colluvial system to the southeast of the study area.

Based on these considerations, eleven areas are put forward as being of potential wilderness importance (Map 9. W1 - W11). These fall into four discrete blocks, namely: northwest (W1-W4), southwest (W5 - W6), northeast (W7 - W8), and southeast (W9 - W11). The focus is largely on the valley portion, which includes 8 of the 11 areas. This is due to the presence of the lake; the relatively good potential for wildlife; and the occurrence of poor rainfall and soils, which act as significant constraints to the development of subsistence agriculture. For the upland areas to the north, soil and moisture conditions are generally more favourable for cropping, such that most of this area is excluded. The portions identified as being of possible wilderness value are mainly restricted to the more broken and hilly terrain to the southwest (W2-W4) and southeast (W7 and W8).

W1 - Luangwa Valley
The valley portion extending north of Zumbo terminates in a prominent alluvial/colluvial fan. This has been identified as a feature and area (A1) of high biodiversity interest. The wilderness area W1 includes this area, and extends up into the hills behind. The combination of valley and hills offers spectacular scenery, and this is reinforced by the variety of constituent vegetation types. Existing wildlife populations have been reduced to low levels, but in terms of the available habitat the potential for re-establishment appears excellent. There is little existing settlement.

W2 - Western Lakeshore
The western lakeshore wilderness area (W2) extends east from the above Luangwa wilderness area (W1), and covers the western valley floor and adjacent hills through to opposite the Musengezi inlet. Key features are similar to those of W1, but W2 also includes frontage onto the lakeshore, and the Type 7.8 serpentine hill patches. This portion of the lakeshore has a certain amount of settlement, but the intensity is relatively low compared to other parts of the lake. The area around Zumbo is excluded due to the high intensity of settlement.

W3 - Western Uplands
The western uplands wilderness area (W3) constitutes an extensive portion of escarpment hills, dominated by vegetation Types 7.2, 7.3 and 7.5. The terrain consists of rugged and broken lithosol country, with very limited potential for agriculture, and which is virtually devoid of any settlement. The potential for grazing by either livestock or wildlife is limited. Positive features include the considerable size of the area, and the attractive scenery associated with the larger hills. Depending on ones specific objectives, it would probably be feasible to break this area down into two or more smaller sub-components, rather than to deal with the entire block.

W4 - Islands East of Musengezi Inlet
The prominent narrow spits and associated islands extending across the lake to the east of the Musengezi inlet offer notable lakeshore frontage and scenery. Being relatively rocky, the area has little attraction in terms of cultivation and settlement, but does support scattered small fishing camps. From a biodiversity perspective these promontories comprise Type 3.1 vegetation (mixed woodland on sandstone ridges and hills), which is of relatively high importance. The depicted area extends north across the narrow valley portion (c. 5-10 km), which is also relatively rocky and of low agricultural potential, to link up to wilderness areas W2 and W3. The valley portions to either side of this strip appear to be impacted by relatively high densities of settlement and associated disturbances.

W5 and W6 - Panyame West and East
The wilderness portions depicted to either side of the Panyame River (W5 to the west, and W6 extending east towards the Musengezi inlet), can be thought of as sub-components of what is really a single contiguous block. Key wilderness elements are that the area supports the major wildlife populations of the whole study area; is already being managed for wildlife purposes (under the Tchuma Tchato initiative); includes important lakeshore frontage; supports highly varied vegetation, including several types of particular biodiversity interest; links to important wildlife and wilderness areas in Zimbabwe; is potentially readily accessible from Zimbabwe; is largely unsettled, other than along the Angwa and Panyame Rivers, and parts of the lakeshore; and due to erratic rainfall and poor soils, is generally of low agricultural potential. The portion immediately west of the Musengezi inlet appears to have already experienced considerable disturbance, which is why the demarcated area stops short of the Musengezi. The lakeshore portion to the east of the Panyame mouth includes a number of pronounced inlets, the scenery (and probably fishing) of which offer obvious tourism potential.

W7 - Eastern Lakeshore and Gorge
W7 is depicted as an elongated block extending east along the northern lakeshore. Starting from opposite Magoe, the area includes the gorge area and the dam wall, and continues downstream along the Zambezi River to where it leaves the study area. Within this portion, the northern basement formations come right down onto the lakeshore. The resulting hilly terrain offers interesting scenery, including the spectacular gorge area immediately upstream of the dam wall. The area is of little interest from an agricultural perspective although, despite this, the portion from the gorge entrance through to below the dam wall supports a relatively high intensity of settlement, and has been strongly modified. Apart from the existing settlements, this stretch of the lakeshore is likely to experience the least demand in the long term, as regards the inevitable expansion of settlement and cultivation. There appears to be little in the way of existing wildlife, and the potential for wildlife seems limited. Road access to Songo is good, but the northern shores are virtually inaccessible except by boat.

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W8 - Eastern Uplands

Extending north, away from the lake and W7, there is an extensive portion of broken upland country that appears to have extremely little in the way of existing settlement. This is demarcated as the eastern uplands wilderness area (W8). Vegetation consists of Types 6.1-6.3 (mopane/mixed units on basement geology), none of which are anticipated as being of any particular biodiversity importance. Although possibly containing less varied and attractive country than W7, parts of it may have better potential for wildlife.

W9 - Comboio Plateau

Comboio has obvious potential as a wilderness area. It stands out from the surrounding landscape as a specific elevated feature; includes several communities of high biodiversity interest; affords great views from its summit; is considered a sacred area; is devoid of any settlement or development; supports limited and seasonal use by wildlife, particularly elephants; and, due to its predominantly sandy soils, is of extremely low agricultural potential. The surrounding lowland valley portion is strongly dissected by numerous deeply incised watercourses, such that this area can also be expected to remain free from cultivation.

W10 - Luia Basalt Area

Extending east from Comboio, the Luia basalt area comprises the next potential wilderness area (W10). The only disturbance within this portion, as yet, appears to be the power line linking Songo to Zimbabwe, and the accompanying access road. The colluvial areas within the adjacent valley portions already support a certain amount of settlement and cultivation. This pressure can be expected to intensify in the future, and these areas are therefore excluded. The vegetation of the basalt block appears to be considerably more varied from the air than suggested by the satellite image, in places comprising extensive open grassy areas, and elsewhere open woodland to much denser, almost thicket, vegetation. The pronounced hills add to the visual attraction. Parts appear to have relatively good water supplies, although elsewhere there are large portions that are possibly devoid of any surface water during the dry season. Elephants were observed along the power line, and the potential for wildlife would appear relatively high.

W11 - Eastern Valley

The final portion identified as being of wilderness value (W11), covers the valley area extending east from the Luia basalt, across the Metangua and Cangudeze drainages, and into the adjacent hills to the east. This portion includes a good variety of vegetation types; the presence of both hills and the valley offers good scenery, and its potential in terms of habitat for wildlife is high. It is sparsely settled, but borders onto much more heavily disturbed units to the east, and south along the Luia River. Either this area, or the previous one (W10), could extend south to include part of the escarpment zone (Type 5.3, mixed dry thicket on gneiss) and adjacent colluvial fan (Type 2.2, mixed dry thicket).

5. DISCUSSION

5.1 Vegetation Units

The 67 samples recorded from the southern portion represent an extremely low intensity of sampling, both overall (less than one sample per 250 km^2) and for each unit (Table 3.2). Preference was given to the seemingly complex Type 1 alluvial and colluvial vegetation and Type 2 communities on unconsolidated sands, but even so the numbers of samples were insufficient to do these areas justice. The aquatic units received the most intensive cover,

although this was done separately by Timberlake (2000b) rather than under this study. Two of the southern basement units were not sampled, whilst the other is represented by only a single sample. No field work was carried out in the northern sector, such that the depiction of the northern units remains hypothetical.

Overall Patterns

The study area can be split into a valley portion and upland basement area. The valley part is low lying, hot, and receives relatively low rainfall. Geology comprises mainly Karoo sediments, or basalt. There are limited, but important, developments of alluvium and colluvium, otherwise soils are typically shallow. The poor rainfall and soil conditions are serious constraints to small scale agriculture. Parts of the area are relatively well suited to wildlife and it is here that the major wildlife populations are found. The upland portions are dominated by basement formations, mainly granites and gneiss. Altitude is generally higher, and the climate cooler and moister. Away from the rugged escarpment terrain there is better development of soil, and these conditions are more favourable for small scale agriculture.

The distribution of vegetation units conforms to this valley/upland divide. The valley portion comprises Types 1, 2 and 3 vegetation, plus the Type 4 aquatic units associated with Lake Cabora Bassa. The upland basement portion comprises Types 5, 6 and 7, mainly miombo, units. The portion to the south of the lake is virtually all valley country. The only basement components are where the southern escarpment intrudes marginally to the extreme southeast, and in the vicinity of Songo and continuing downstream along the Zambezi River. The northern portion, in contrast, is dominated by basement terrain, with the valley being confined to a narrow strip extending west from opposite Magoe, and for some 60 km to the north of Zumbo along the Luangwa River.

The bulk of the valley comprises Type 3 mopane units, particularly Types 3.2 and 3.4. The Type 1 alluvial/colluvial units and the Type 2 dry forest, thicket and woodlands on unconsolidated sands, are less extensive, and tend to occur as smaller and more discrete patches. Many of these units support relatively high plant species diversity, and add greatly to the biological complexity of the valley. They also tend to be under greatest threat of modification. It is mainly these units that are identified as being of greatest interest for biodiversity conservation.

The basement portion is dominated by extensive Type 6 mopane/mixed units and Type 7 miombo woodlands. The major units tend to occur as irregular bands, running more or less parallel to the lake, reflecting a transition from very broken to gentler terrain, and of increasing moisture to the north. These units are interspersed by irregular lithosol blocks on hills. The small patches of Types 7.7 and 7.8 are confined to specific localized conditions, and it is these units that are identified as being of greatest biodiversity importance within this section.

Details of Units

Depositional soils often show marked changes over short distances, which complicates their mapping. No effort was made to separate out vegetation Type 1.1, which instead is included under Type 1.2. And what is shown as Type 1.2 probably conforms more closely to the extent of recent alluvium than actual riparian forest. Much of the mapped area actually comprises more open Type 1.3 woodland. This situation is further complicated by the high levels of disturbance, particularly for cultivation, encountered in many alluvial systems. The mapping of Types 1.3 and 1.4 is confined to the larger and more obvious occurrences.

The distinction between Type 1.3 and Type 2.2 mixed dry thicket and woodland on unconsolidated sands is not always clear. The field samples suggest reasonably clear differences in terms of species composition and structure, but relating these differences to the patterns observed on the satellite imagery is more difficult and less certain.

The lumping of dry forests, thickets and woodlands (Types 2.1 and 2.2) together with *Terminalia* communities (Types 2.3 - 2.5) is somewhat artificial. The Type 2.3 *Terminalia* thickets show some structural similarities to Types 2.2, but are entirely distinctive in terms of species composition. All these types seem to occur on similar unstructured sands, and the reasons for the development of such different communities in not clear. There is also a low shrub community that was observed on the summit of Comboio, but which was not reached in the field and so could not be described.

The Type 3.3 vegetation of the Luia basalt area appears reasonably uniform on the satellite imagery, but considerably more variation was apparent from the air. The only four samples from this portion were all taken along the powerline to the south of Jeke, and do not capture the range of types believed to occur here.

Mopane/mixed woodland (Type 3.4) was recorded from a variety of different geological formations, many of which are clearly distinctive on the satellite imagery. With further sampling it might be possible to subdivide this unit further into two or more discrete types.
The boundaries between Type 3.5 and adjacent portions of Type 3.2 are not always clear. Even along the smallest drainages, the woodland vegetation shows an increase in cover, the height of trees, and the incidence of mopane, presumably in response to locally deeper soil development and an accumulation of clay rich material. This effect is particularly marked to the east, where substantial portions of Type 3.5 have been demarcated along some of the drainages.

Types 5.2 and 5.3 were not sampled at all, and so must be regarded as tentative. The boundary between these two types is not particularly clear, and the relationship between Type 5.3 and the adjacent portion of Type 2.2 also requires clarification.

Type 5 and Type 7 units both comprise miombo communities on basement formations and could have been treated under a single category.

Confidence associated with the three Type 6 mopane/mixed units is particularly low. The Flora Zambesiaca map indicates the presence of mopane in this area, and this appeared to be the case from the air. Interpretation of the satellite imagery was complicated by the presence of extensive burning in this area. Types 6.1 and 5.1 appear to be different vegetation types, but on the satellite imagery it is difficult to make out any clear boundary between them. The line shown on the map was arbitrarily inserted to the south of the Zambezi River.

Comparison With Other Studies
The depiction of vegetation units does not conform well to either the Mozambiquan woody cover maps (CENACARTA 1995) or land use maps (DNFFB, 1999), but neither do these conform to one another. Both are also based on the interpretation of satellite imagery, and produced at a scale of 1:250,000 (to conform with national topographic series). Both were national studies, and neither was supported by much field work.

The range of vegetation types recorded from the valley portion is similar to that found in the adjacent portion of the Zambezi Valley within Zimbabwe, as described by Du Toit (1993), Timberlake et al. (1996) and Timberlake et al. (1998). Additional types identified during this

study, but that are probably absent from Zimbabwe include Type 3.1 (mixed woodland on sandstone ridges and hills), the aquatic units associated with lake Cabora Bassa (Types 4.1 and 4.2), and Type 2.5 (*Terminalia* open woodland) which occurs to the north of the Zambezi. Most of the units described by Du Toit (1993) and Timberlake et al. (1998) appear to be represented within the study area. The match between valley units of this study and their equivalents according to Timberlake et al. (1993) is shown in Table 3.6.
Most portions of the study area are currently subject to only very low levels of herbivory, by either livestock or wildlife, and this appears to have been the case for a considerable period. As a result, where not disturbed by other factors such as settlement and cultivation, the vegetation is often in excellent condition. This may be particularly important for some of the dry thicket and forest patches, which in Zimbabwe have mostly been subject to relatively high intensities of use by elephants.

5.2 Plant Species and Species of Interest

The list of 301 woody species is by no means comprehensive and, with further work, could certainly be extended. Recording was largely confined to woody plants, although a few of the more prominent herbaceous species were noted. This was not ideal, but most of the herbaceous species were already dying off, and the time spent in the field was insufficient to attempt any more systematic recording.

Timberlake et al. (1998) recorded a total of 625 plant species/subspecies from 46 samples within the adjacent lower Guruve region in Zimbabwe (3 pteridophytes, 496 dicotyledons and 126 monocotyledons). This included 321 perennial shrub and trees, and a much better representation of herbaceous species (304 species). Based on these results, Timberlake et al (1998) suggest a total species count for the lower Guruve area of about 800 species. The species listings provided by Gonçalves (1978-1982) provide another useful record for the study area, although unfortunately some families are not covered.

Several records appear to be new to Mozambique, notably *Anisotes bracteatus*, *Psiadia punctulata*, *Tarchonanthus camphoratus*, *Maerua buxifolia*, *Psydrax martinii* and *Elytrophorus globularis*. None of these are necessarily unexpected, in that they have all been recorded from the Zimbabwean portion of the Zambezi Valley.

The lack of endemic species is not surprising in that the study area forms part of a larger ecological system which continues into the neighbouring portions of Zimbabwe and Zambia. *Mimosa mossambicensis* is endemic to Mozambique but its distribution extends north of the study area. *Acacia eriocarpa*, *Combretum kirkii*, *Rhynchosia wildii* and *Turraea zambesica* appear to be endemic to the Zambezi Valley but also occur in neighbouring portions of Zimbabwe and Zambia.

The Great Dyke serpentine hills in Zimbabwe support a relatively high number of endemic plants. It is possible that some of these may occur on the serpentine hills to the north of Lake Cabora Bassa, and that others may be found there too. The grassland dambo areas associated with the northern miombo closed woodland (Type 7.6) may also yield some species with relatively confined distributions. Both these areas would be worth investigating.

Overall, some 58 species are tentatively identified as being of possible conservation interest or concern. This represents 18% of the total species count. The identification of these species is based mainly on their known extent of distribution, rather than any knowledge of their current status or of perceived threats to their populations. One or more of these species can be found

within virtually all the southern units, but with a particularly high number coming from Type 3.1 (mixed woodland on sandstone ridges and hills) and, to a lesser extent, from Types 1.2, 1.3, 2.1, 2.2 and 3.4.

5.3 Sites and Areas of Conservation Interest

The study seeks to identify relatively confined components of the overall landscape that are of greatest biodiversity conservation interest. The intention is that these can serve as useful targets for conservation action, and should provide a practical means for incorporating biodiversity concerns into the planning and development process. Given the importance of biodiversity to the maintenance of ecosystem processes and the sustained delivery of goods and services, this approach is believed to be valid.

However, the concept of conservation is multi-faceted, such that this need not be the only approach to identifying sites of conservation interest, nor necessarily the "correct" one, or even the "best" one. Depending on one's interpretation and specific objectives, it is possible that one could adopt a number of different approaches to this problem, which could conceivably result in the identification of quite different areas of conservation interest.

The identification of sites and areas of conservation interest is scale dependent. The approach adopted here of identifying regions, areas, features and units of interest, results in the demarcation of portions of decreasing size and increasing specificity. The resulting product should be relatively robust, in that while there may be considerable duplication and overlap between the portions identified at different levels, hopefully there is little chance of any gaps, particularly for the southern portion, whereby any significant areas may have been omitted. Working at a more detailed scale would enable the identification of even more precise sites of interest. This has been done for the neighbouring portion of Zimbabwe (Timberlake, 1996), but was not possible with the resources available for this study.

For the nine units identified as being of greatest conservation interest, no attempt was made to differentiate amongst the individual patches, in terms of which portions are likely to be of greater or lesser interest for conservation purposes. For example, much of the Type 1.2 alluvial area along the Mukumbura River has already been cleared for cultivation, such that little remains in the way of conservation opportunities for this portion. Much the same applies to the Type 1.3 colluvial woodlands near Estima which have been extensively modified. Similarly, no attempt was made to compare the occurrences of features, areas and regions of particular conservation interest against one another.

The features, areas and regions identified as being of conservation interest are predominantly from the valley portion. The exclusion of the bulk of the upland portions (other than Types 7.7 and 7.8) is consistent with the depiction of extensive miombo type units covering this area. However, this still remains to be validated. Depending on the actual composition of this portion, it is possible that additional components could be identified from here as being of biodiversity conservation interest.

A number of dry thicket patches were noted on the satellite imagery alongside the road from Tete to Furancungo and, although outside of the study area, were subsequently located during the flying. From the air they look similar to Type 2.2 thicket vegetation, but their appearance on the satellite imagery is quite distinct. It is possible that these communities have a somewhat different species composition, and they are likely to be of considerable conservation interest.

A logical next step would be to re-examine the identified portions, and attempt to place them into broad priorities for conservation action, in much the same way as Timberlake (1996) did for sites within the Zambezi Valley of Zimbabwe. In setting such priorities, it will be necessary to examine the existing condition of each portion in a more systematic manner than has been possible under this study.

5.4 Areas of Wilderness Value

Wilderness, by definition, requires relatively large areas, and the 11 portions identified as potential wilderness areas are all relatively extensive. Collectively, these cover roughly half the study area. However, it is not anticipated that these portions will all be retained as wilderness areas. The intention is, instead, to highlight those portions where wilderness should be considered as a potential form of land use, and thus provide a means for incorporating wilderness concerns into the future planning and development of the region. In the same spirit, the positioning of the boundaries is somewhat subjective, and the demarcated areas should be treated as indicative rather than as fixed entities.

The major threat to wilderness, in the longer term, is likely to be the continued expansion of settlement and associated small scale agriculture. One of the main considerations in identifying potential wilderness areas was to target areas that are currently devoid of, or have only low intensities of settlement, and for which the pressure for future expansion can be expected to be relatively low.

Valuable indications as to the likely pattern of future development can be gained through looking at the adjacent portions of Zimbabwe and Zambia. The neighbouring valley portion of Zimbabwe consists of very similar terrain and, over the last 20 years, has experienced an extremely rapid increase in population and settlement. A number of studies suggest that the current intensity of settlement is not sustainable. Drawing on this experience, the Mozambiquan government would be wise to consider policies that serve to limit in-migration, rather than to encourage it, as has been the case in Zimbabwe.

Another important consideration in identifying possible wilderness areas is the potential for wildlife and tourism developments. Such activities can play an important role in maintaining large natural areas, as are required for wilderness purposes. Tchuma Tchato is looking to promote tourism, as a means of increasing revenues and thus becoming more self sustaining and less reliant on external subsidies. However, it must be recognized that tourism developments can also conflict with, and lead to the erosion of, wilderness qualities, and should therefore be carefully planned.

The lakeshore is a key wilderness and tourism resource. The areas of the lakeshore demarcated as wilderness are confined to those portions that are most scenic, and to where the adjacent country is considered to be of low potential for agriculture. The proliferation of small fishing villages all along the lakeshore, is becoming a serious threat to realizing the tourism potential of even these more marginal areas.

As for the biodiversity areas, no attempt was made to prioritise the wilderness areas. Another logical step would be to attempt to identify more specific wilderness or tourism areas such as the key inlets, islands, shore and gorge areas of the lake.

5.5 Implications for Planning and Development

The results of this study show that the area harbours important biodiversity and wilderness resources. The challenge is how to manage the future development of this region so as to ensure the maintenance of these resources.

The main form of land use is small scale agriculture and, despite questionable sustainability, this is not likely to change. The intensity of settlement, as compared to the neighbouring portions of Zambia and Zimbabwe, is relatively low. This probably relates to the long period of conflict that Mozambique has gone through, and the consequent lack of infrastructure. However, the natural resources of the study area appear capable of supporting additional people, and it must be anticipated that populations will increase in the future. The example of Zimbabwe shows that the rate of increase can be extremely rapid. Some of the key stimulants for this were active government support, and the promotion of cotton as a cash crop.

The expansion of settlement will necessarily lead to a reduction in the remaining extent of the natural landscape, which is likely to impact on key biodiversity, wildlife and wilderness areas. There are different ways of responding to this situation. One option is to seek to slow down the rate of in-migration as a source of population increase. Another possibility is to be forward thinking in terms of developing conservation strategies.

The pattern of expansion can be expected to relate in part to the existing pattern of settlement and infrastructure. No attempt was made to delineate areas of settlement or cultivation under the current study. These do stand out on the satellite imagery, but to greater or lesser extent for different portions. Interpretation of the imagery could be expected to provide a reasonable overall picture, but would probably miss out on some of the detail. Such an exercise would need to be tackled under a separate study.

The distribution of natural resources will also strongly influence the pattern of any future expansion. Some units offer better potential for settlement and cultivation than others, and can be expected to be more heavily impacted than less favourable units. Within the valley portion, major agricultural expansion can be anticipated on Type 3.4 and 3.5 mopane units, and for the basement portion on the moister northern miombo units of Types 7.5 and 7.6. Other units likely to experience high levels of modification are all of the alluvial/colluvial units (Types 1.1-1.4); some of the units on unconsolidated sands (Types 2.1 and 2.2); the *Phragmites* reed beds (Type 4.1); Type 5.1 miombo woodland around Songo, and bamboo thickets (Type 7.7).

Wildlife and tourism could provide an alternative, or complementary, and more sustainable form of land use, that is more compatible with the maintenance of biodiversity and wilderness. The main wildlife area is to the south of the lake and to the west of the Musengezi inlet. This portion continues into Zimbabwe, and there is significant movement of wildlife across this border. Lesser populations occur in the vicinity of Daque, and further east in association with the Luia River and its tributaries, but only limited information was obtained about these areas. For other portions, such as the valley area to the north of Zumbo, the potential for wildlife appears excellent but existing populations seem to have been reduced to very low levels.

Field observations suggest that pressure on wildlife populations is continuing throughout the area visited. Given the importance of wildlife to the development of tourism, it is critical to reverse this situation and to provide a suitable environment for the re-establishment of wildlife populations. However, this will require considerable effort and investment.

The principal wildlife areas coincide well with portions identified as being of high biodiversity and wilderness interest. The development of a national park within the eastern Chioco region has previously been recommended by Tinley and De Sousa Dias (1973) and Tinley et al. (1974). The results of this study suggest that this could incorporate important areas of biodiversity and wilderness interest. It is also suggested that the area of consideration should be broadened to include the region extending east from Comboio to the hills to the east of the Cangaudze drainage, and that there may be a number of different ways of looking at this region. An equally strong case can be made for the western valley portion on both sides of the lake.

The important point for these areas is that biodiversity and wilderness concerns are incorporated within the overall management objectives at the landscape level. There are different approaches to achieving this. The development of community based natural resource management programmes, such as Tchuma Tchato, is one option, the designation of national parks is another. Comparison of such options is beyond the scope of this study.

A number of the portions identified as being of high biodiversity and wilderness interest are situated on the borders with, and continue into the adjacent portions of, Zambia and Zimbabwe. Work within Zimbabwe has also clearly demonstrated movements of wildlife between Zimbabwe and Mozambique, to the west of the Musengezi (ZAMSOC/MZEP, 2000) Any attempt to reestablish wildlife populations within the key valley area extending up along the Luangwa River would similarly require working together with, and securing the cooperation of, neighbouring Zambian communities. These situations obviously require the development of a joint management approach. A framework for developing collaborative management between Zimbabwe, Mozambique and Zambia is currently being developed under the IUCN sponsored ZIMOZA initiative.

The lakeshore does not stand out as being of any particular significance from a biodiversity perspective, but is clearly a key tourism resource. The portions highlighted as being of wilderness (or tourism) value are to the west and east, and cover those portions where settlement is least dense, where the natural resources are marginal, and which link to wildlife populations and larger wilderness areas in the interior. The continued proliferation of both fishing camps, both informal and of commercial kapenta operations, will pose a serious threat to the future development of tourism within these portions.

The presence of wildlife, the lakeshore and attractive scenery provide the same mix of elements that have formed the basis for the development of a successful tourism industry around Kariba (at least until such time as the recent political disturbances in Zimbabwe). The major differences as compared to Kariba are the lesser abundance of wildlife and that access is more difficult and expensive. The introduction of a ferry service linking Kanyemba to Feira and Zumbo would greatly improve access, and should serve as a key stimulant of growth. The general pattern of development can be expected to mirror that of Kariba, with larger developments being established at the main access points of Songo and Zumbo (together with Kanyemba and Feira), and a number of smaller developments scattered along the lakeshore in between.

The development of tourism should lead to increased revenues to the Tchuma Tchato project. Another way of achieving this could be to improve the collection of revenues from fishing communities and the kapenta industry, the bulk of which is currently diverted to the national coffers.

Other potential activities include timber production and mining. There are no significant mining activities at present, and nor are there any known major mineral resources. Timber potential for the valley portion appears limited. The situation to the north of the lake is less certain. Mukwa (*Pterocarpus angolensis*) appear to be relatively abundant, and there are reports of poaching of timber to the extreme north along the border with Zambia, but in the absence of any field work there these circumstances could not be confirmed.

5.6 Limitations of the Study

The major limitation of the study has been the inadequate allocation of resources. The budgets for the preliminary satellite interpretation and aerial work were reasonably adequate, but those for the field sampling and the subsequent identification of species, data analysis, mapping and write up, were quite insufficient. As a result fieldwork was confined to the southern portion, and difficulties have been encountered in delivery of the final product.

The planning of the field work, which was intended to cover the entire study area, was far too ambitious. In the event, sampling was restricted to the southern portion, and even here the intensity of sampling was extremely low. In the absence of any sampling to the north, the identification of the proposed units and areas of interest remains to be confirmed.

It would have been desirable to include more detailed consideration of the herbaceous component and species. This was precluded by the timing of the survey, but would also have required additional field time and resources.

In carrying out the field verification, it was difficult or impossible to access certain areas. This was partly due the magnitude of the area, coupled with resource constraints, such that it was not possible to satisfactorily cover even the southern area. The possible presence of landmines was a more practical, but real, constraint for some areas.

Some 4 field days, representing 20% of the overall field time, were lost in dealing with petty officialdom. The real problem here was one of poor organization and a lack of coordination with Mozambiquan counterparts, which resulted in fieldwork being started prior to securing an all-important letter of clearance from DNFFB in Tete.

The production of geo-referenced data, rather then just a series of maps, has undoubtedly resulted in a superior product. However, this consumed considerably more time than anticipated partly due to inexperience in working with this technology. The process employed could be improved upon if the exercise were to be repeated. The failure to ground truth the satellite data, through recording ground GPS readings from points that are clearly recognizable on the imagery, was a major omission. Instead, one image was arbitrarily selected, and the other two were corrected relative to this one. This is one potential source of error. The final interpretation was done onto 10 mylar sheets, which were then digitized and individually corrected to the satellite imagery. A better way of doing this would have been to first correct the mylar sheets to one another and then collectively, as a single sheet, to the satellite data. Due to these factors, the resulting map shows a distortion of up to about one km in the southeastern corner, but elsewhere is more precise.

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6. RECOMMENDATIONS

Recommendations fall into two categories. The first concerns improving the database for the identification of ecological units and areas of biodiversity and wilderness value. The second category concerns putting the results of this study into action.

Improving the Database
Additional resources should be made available so as to enable completion of the field work for the northern portion of the study area.

The areas identified as being of biodiversity and tourism interest should be prioritised in terms of need for conservation action. This is likely to require an analysis of their existing condition, the existing pattern of settlement, and of the likely pattern of future settlement.

The alluvial and colluvial areas of the valley portion should be re-examined in greater detail. For it is these units that can be expected to be most heavily impacted through further expansion of settlement and cultivation, whilst at the same time they have been identified as being of considerable biodiversity importance.

Provision should be made for inclusion of herbaceous species.

The serpentine hills and northern dambo areas should be targeted for collecting, as these areas are likely to support a number of species of limited distribution.

Organizations or projects dealing with more limited components of the overall area should be encouraged to make provision for more detailed biodiversity studies. This will enable the identification of additional and more precise sites and areas of biodiversity and wilderness interest.

Further effort should be made to identify more specific areas of wilderness value, that could serve as more specific foci for future conservation activities.

Implementation of the Findings
The results of this study should be presented to planners and developers at a workshop in Tete, as a first step towards incorporating the findings into the planning and development process for the region.

The maintenance of biodiversity and wilderness values should be accepted as legitimate planning and development goals for at least those portions of the study area which have been identified as being of particular biodiversity or wilderness interest.

The reestablishment and increase of wildlife populations should be promoted, as a key stimulus for the development of tourism, which can make an important contribution to the maintenance of extensive areas of natural habitat. This is likely to require considerable effort and investment.

Authorities should motivate for the introduction of an international ferry service at the western end of the lake, linking Zumbo to Feira and Kanyemba. This would provide a further significant stimulus for tourism development within this region.

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Future development around the lake should be regulated, with the purpose of achieving better integration of different forms of use, and thus optimizing the benefit from this key resource. This will require the development and implementation of some form of zonation. In doing so it would be useful to draw on experiences from Lake Kariba.

Mozambiquan authorities should seek to develop policies that discourage in-migration. The purpose of this is to seek to limit the rate of expansion of settlements, and thus counteract what is likely to be the greatest threat to the maintenance of areas of biodiversity and wilderness importance.

Mozambique, Zimbabwe and Zambia need to work together more closely so as to develop joint management strategies for shared areas of high biodiversity and wilderness interest, and for shared wildlife populations.

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TABLES

Table 3.1: Classification of 30 vegetation units identified from the Tchuma Tchato project area surrounding Lake Cabora Bassa

UNITS TO THE SOUTH OF THE LAKE
TYPE 1: VEGETATION ON ALLUVIUM/COLLUVIUM
Type 1.1 - River Beds and Lowest Alluvial Terraces
Type 1.2 - Riparian Forest
Type 1.3 - Mixed Woodland on Sandy Alluvium and Colluvium
Type 1.4 - Seasonally Inundated Grassland on Clay Alluvium
TYPE 2: DRY FOREST, THICKET AND WOODLAND TYPES ON UNCONSOLIDATED SANDS
Type 2.1 - *Xylia* Dry Forest
Type 2.2 - Mixed Dry Thicket and Woodland
Type 2.3 - *Terminalia brachystemma* Thicket to Wooded Bushland
Type 2.4 - *Julbernardia*/*Terminalia* Woodland on Comboio
TYPE 3: UNITS ON KAROO AND BASALT FORMATIONS
Type 3.1 - Mixed Woodland on Sandstone Ridges and Hills
Type 3.2 - *Diospyros*/*Combretum*/Mopane Low Open Woodland on Shallow Sandstone Soils
Type 3.3 - *Mopane/Combretum/Terminalia* Low Open Woodland on Shallow Basalt Soils
Type 3.4 - Mopane/Mixed Woodland
Type 3.5 - Mopane Woodland on Deeper Depositional Soils
TYPE 4: AQUATIC UNITS
Type 4.1 - *Phragmites* Reedbeds on Sandbanks
Type 4.2 - Floating Aquatic Vegetation
TYPE 5: UNITS ON SOUTHERN BASEMENT GEOLOGY
Type 5.1 - Mixed Miombo Woodland on Songo Gneiss
Type 5.2 - *Brachystegia allenii* Escarpment Open Woodland on Gneiss
Type 5.3 - Mixed Dry Thicket on Gneiss
ADDITIONAL UNITS TO THE NORTH OF THE LAKE
TYPE 2: DRY FOREST, THICKET AND WOODLAND TYPES ON UNCONSOLIDATED SANDS
Type 2.5 - *Terminalia* Open Woodland
TYPE 6: MOPANE/MIXED UNITS ON NORTHERN BASEMENT GEOLOGY
Type 6.1 - Mopane/Mixed Open Woodland on Lithosols
Type 6.2 - Mixed Deciduous Woodland
Type 6.3 - Mixed Mopane/Miombo Woodland
TYPE 7: MIOMBO/OTHER UNITS ON NORTHERN BASEMENT GEOLOGY
Type 7.1 - Open Woodland on Dry Lithosols
Type 7.2 - Denser Woodland on Moister Lithosols
Type 7.3 - Western Miombo Open Woodland
Type 7.4 - Southern Miombo Open Woodland
Type 7.5 - Central Miombo Closed Woodland
Type 7.6 - Northern Miombo Closed Woodland
Type 7.7 - Bamboo Thickets
Type 7.8 - Serpentine Grasslands

Table 3.2: Numbers of samples, woody species per plot and total woody species for vegetation units identified to the south of Lake Cabora Bassa.

Type	No. of Samples	Species per Plot	Total Species
TYPE 1: VEGETATION ON ALLUVIUM/COLLUVIUM			
1.1	5	20, 20, 21, 27, 36	76
1.2	3	32, 37, 39	74
1.3	8	19, 34, 34, 39, 44, 47, 47, 48	107
1.4	2	11, 26	32
TYPE 2: DRY FOREST, THICKET AND WOODLAND TYPES ON UNCONSOLIDATED SANDS			
2.1	3	27, 29, 31	50
2.2	10	28, 30, 37, 37, 38, 38, 44, 49, 51, 59	136
2.3	2	14, 15	22
2.4	2	29, 49	51
TYPE 3: UNITS ON KAROO AND BASALT FORMATIONS			
3.1	7	41, 45, 46, 48, 50, 55, 63	124
3.2	8	18, 22, 25, 29, 31, 33, 37, 39	92
3.3	2	20, 24	27
3.4	9	25, 31, 31, 33, 34, 37, 37, 39, 53	120
3.5	5	5, 20, 24, 26, 34	70
TYPE 4: AQUATIC UNITS			
4.1	-	not sampled	-
4.2	-	not sampled	-
TYPE 5: UNITS ON BASEMENT GEOLOGY			
5.1	1	56	56
5.2	-	not sampled	
5.3	-	not sampled	
TOTAL	67	Range = 5-63	301

Table 3.3: Species identified as being of particular interest, from 67 plots recorded to the south of Lake Cabora Bassa, June 2000.

FAMILY **Species**	**Sample Nos.**	**Notes**
ACANTHACEAE		
Anisotes bracteatus	31	New record for Mozambique, uncommon in Zimbabwe
Anisotes formosissimus	64	One other record from Tete Province, none from northern Zimbabwe
ASTERACEAE		
Psiadia punctulata	45a	New record for Mozambique
Tarchonanthus camphoratus	45a	New record for Mozambique
BURSERACEAE		
Commiphora zanzibarica	65	Near southern extent of range
CAPPARACEAE		
Maerua buxifolia	45a	Possible new record for Mozambique
CELASTRACEAE		
Maytenus pubescens	56, 58	Northern extent of range, not common
COMBRETACEAE		
Combretum goetzei	30	Southern extent of range
Combretum kirkii	10, 14, 32, 44	Southern extent of range
DIPTEROCARPACEAE		
Monotes katangensis	01a	Southern extent of range
FABACEAE: MIMOSOIDEAE		
Mimosa mossambicensis	64	Also occurs further north, but endemic to Mozambique
Newtonia hildebrandtii	01a	Few records from this area
FABACEAE: PAPILIONOIDEAE		
Crotalaria monteiroi	45	Second record from this area
Rhynchosia wildii	45a, 56	Third record from this area, endemic to the Zambezi valley
MALPIGHIACEAE		
Caucanthus auriculatus	03, 45a	Near southern extent of range
MELIACEAE		
Trichilia capitata	61, 62, 64	Near southern extent of range, only recorded from Luia system where it is common, single record from Zimbabwe
Turraea zambesica	02, 03, 07, 30	Endemic along Zambezi River
OCHNACEAE		
Brackenridgea zanguebarica	04, 08	Significant extension of range (if correct), occurs southern Zimbabwe and adjacent portion of Mozambique
Ochna multiflora	08	Significant extension of range (if correct), occurs in higher rainfall areas of NW Zambia
RHAMNACEAE		
Ziziphus pubescens	05, 16, 17	Present but uncommon
POACEAE		
Elytrophorus globularis	20	New record for Mozambique
RUBIACEAE		
Psydrax martinii	45a	Possible new record for Mozambique

Table 3.4: Species identified as being relatively unusual occurrences, uncommon, or of uncertain status, from 67 plots recorded to the south of Lake Cabora Bassa, June 2000.

FAMILY **Species**	**Sample Nos**	**Present in Zim. (/)**	**Notes**
ACANTHACEAE			
Barleria albostellata	46	-	Not expected from here, elsewhere common in hills
ASTERACEAE			
Tarchonanthus trilobus	45a	-	Questionable identification
BALANITACEAE			
Balanites maughamii	05, 46	/	Not that common
BIGNONIACEAE			
Markhamia obtusifolia	46, 47	-	Usually associated with more mesic conditions
BURSERACEAE			
Commiphora ugogensis	02, 06, 44a	/	Not that common
CAPPARACEAE			
Cladostemon kirkii	31, 32 52	-	Not particularly common
CELASTRACEAE			
Elaeodendron matabelicum	45a	/	Uncertain status
Elaeodendron schlechterianum	40, 51, 56	/	Uncertain status
Gymnosporia putterlickioides	55	/	Not that common
Pleurostylia africana	01, 42, 53	/	Not common in valley
COMBRETACEAE			
Terminalia sambesiaca	31, 32, 59	/	Occurs but never common
EBENACEAE			
Euclea racemosa	40	-	Usually associated with higher rainfall
EUPHORBIACEAE			
Croton menyhartii	29	/	Not that common
Excoecaria bussei	09, 32	/	Southern extent of range
CAESALPINIOIDEAE			
Brachystegia longifolia	39	-	Southern limit
Brachystegia manga	43, 44, 52	-	Southern limit
Burkea africana	46	-	Not expected from here
Peltophorum africanum	45a, 49	-	Not expected from here

FAMILY **Species**	**Sample Nos**	**Present in Zim. (/)**	**Notes**
PAPILIONOIDEAE			
Eminia antennulifera	06	-	Not expected from here
Ormocarpum trichocarpum	41	/	Not common
MIMOSOIDEAE			
Acacia eriocarpa	01a, 21, 44	/	Relatively common, but endemic to middle Zambezi valley
Acacia polyacantha	50	-	Occurs as scattered individuals
Acacia xanthophloea	60, 63	-	Unusual, confined to the Luia system
Entada chrysostachys	52	-	Not common
LINACEAE			
Hugonia orientalis	09	-	Not common here
LOGANIACEAE			
Strychnos decussata	07, 17, 52	/	Not common
Strychnos usambarensis	31, 31a, 32	-	Uncertain status, occurs in hills
MALVACEAE			
Hibiscus seineri	29, 59	-	Uncertain status
MELIACEAE			
Entandrophragma caudatum	09	/	Not that common
MORACEAE			
Ficus bussei	50	-	Not that common, occurs as scattered individuals
RANUNCULACEAE			
Clematis viridiflora	05a	-	Not common
RUBIACEAE			
Hymenodictyon parvifolium	52	-	Uncertain status
Lagynias dryadum	31, 52	-	Not common
Pavetta klotzschiana	35, 37, 39	-	Not common
RUTACEAE			
Zanthoxylum leprieurii	07	/	Not common
TILIACEAE			
Grewia praecox	30	/	Uncertain status

Sample Nos. correspond to those in Annex 3.1. The letter "a" after any sample number indicates a species record from close proximity to, but not part of, the sample.

/ indicates that the species was recorded from among 175 similar samples from the adjacent Zambezi Valley area of Zimbabwe (Cunliffe, 1997a,b; Timberlake and Cunliffe, 1997; Timberlake et al., 1998).

Table 3.5: Conservation importance of the 30 vegetation units identified for the study area around Lake Cabora Bassa.

Unit	Species Composition	Extent		Level of Threat	Conservation Interest
	L = low M = moderate H = high	Area (km^2)	L = large M = moderate H = small	L = low M = moderate H = high	1 = high 2 = moderate 3 = low
Type 1: Vegetation on alluvium/colluvium					
1.1	M		H	M	1
1.2	H	1,144	M	H	1
1.3	H	474	M	H	1
1.4	L	31	H	M	1
Type 2: Dry forest, thicket and woodland types on unconsolidated sands					
2.1	H	175	H	M	1
2.2	H	1,113	M	M	2
2.3	L	478	M	L	2
2.4	L	98	M	L	2
2.5	L	218	M	L	2
Type 3: Units on Karoo and basalt formations					
3.1	H	676	M	L	1
3.2	M	4,738	L	L	3
3.3	L	2,202	L	L	3
3.4	M	4,895	L	M	3
3.5	L	2,167	L	H	2
Type 4: Aquatic units					
4.1	L	55	H	H	1
4.2	L	89	H	L	2
Type 5: Southern units on basement geology					
5.1	M	406	M	M	2
5.2	L	46	H	L	3
5.3	M	672	M	L	2
Type 6: Mopane/mixed units on basement geology					
6.1	M	1,370	L	L	3
6.2	M	1,284	L	L-M	3
6.3	M	1,394	L	L-M	3

Unit	**Species Composition**	**Extent**		**Level of Threat**	**Conservation Interest**
	L = low M = moderate H = high	Area (km^2)	L = large M = moderate H = small	L = low M = moderate H = high	1 = high 2 = moderate 3 = low
Type 7: Northern miombo units on basement geology					
7.1	L	1,149	L	L	3
7.2	M	3,865	L	L	3
7.3	L	1,380	L	L	3
7.4	L	1,127	L	L	3
7.5	M	4,629	L	M	3
7.6	M	4,556	L	H	2
7.7	L	154	H	H	1
7.8	H	114	H	L	1

Table 3.6: Vegetation types identified to the south of Lake Cabora Bassa, together with their equivalents from Timberlake et al. (1993).

Vegetation Type	**Equivalent**
1.1 - River Beds and Lowest Alluvial Terraces	B3
1.2 - Riparian Forest	B2 Subtype A/C
1.3 - Mixed Woodland on Sandy Alluvium and Colluvium	B2 Subtype A
1.4 - Seasonally Inundated Grassland on Clay Alluvium	J7 (but no specific match)
2.1 - *Xylia* Dry Forest	C2 Subtype A
2.2 - Mixed Dry Thicket and Woodland	C3
2.3 - *Terminalia brachystemma* Thicket to Wooded Bushland	C1
2.4 - *Julbernardia*/*Terminalia* Woodland on Comboio	- No match
3.1 - Mixed Woodland on Sandstone Ridges and Hills	- No match
3.2 - *Diospyros*/*Combretum*/Mopane Low Open Woodland on Shallow Sandstone Soils	E4 Subtype A
3.3 - *Mopane/Combretum/Terminalia* Low Open Woodland on Shallow Basalt Soils	E4 Subtype B
3.4 - Mopane/Mixed Woodland	F2
3.5 - Mopane Woodland on Deeper Depositional Soils	F3 Subtype A
4.1 - *Phragmites* Reedbeds on Sandbanks	- No match
4.2 - Floating Aquatic Vegetation	- No match
5.1 - Mixed Miombo Woodland on Songo Gneiss	- No match
5.2 - *Brachystegia allenii* Escarpment Open Woodland on Gneiss	D8
5.3 - Mixed Dry Thicket on Gneiss	D? (Insufficient information)

Table 3.7: Occurrence of 58 species of interest within the 14 vegetation types sampled to the south of Lake Cabora Bassa.

Vegetation Type	Number of Species of Interest
1.1	1
1.2	7
1.3	9
1.4	-
2.1	7
2.2	10
2.3	2
2.4	4
3.1	22
3.2	4
3.3	-
3.4	9
3.5	4
5.1	6

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ANNEXES

Annex 3.1: Details of sample plots for Cabora Bassa vegetation survey, June 2000.

Sample No.	Date	UTM Grid Reference	Location	Vegetation Type
01	June 03	2250.82688	Near Bawa Camp	2.2
02	June 03	2414.82678	Kafakudzi Camp (c. 20 km E of Bawa)	3.4
03	June 03	2378.8267	Kafakudzi to Bawa	2.2
04	June 04	2252.8243	Bawa to Kapesa (c. 40 km S of Bawa)	3.2
05	June 04	2237.82338	Near Kapesa	1.2
06	June 04	2237.82343	Near Kapesa	2.2
07	June 04	2241.8235	Near Kapesa	2.1
08	June 04	2240.8237	Near Kapesa	2.3
09	June 04	2240.82366	Near Kapesa	2.1
10	June 05	2241.82359	Near Kapesa	3.5
11	June 05	2240.82381	Near Kapesa	3.2
12	June 05	2262.82538	Kapesa to Bawa	2.3
13	June 05	2291.82634	Kapesa to Bawa	3.5
14	June 06	2423.82371	Near Chintopo	3.5
15	June 06	2436.82423	Near Chintopo	1.1
16	June 06	2446.82420	Near Chintopo	1.3
17	June 06	2451.82409	Near Chintopo	2.1
18	June 06	2446.82402	Near Chintopo	1.4
19	June 07	2441.82534	N of Chintopo	3.4
20	June 07	2453.82564	N of Chintopo	3.5
21	June 07	2433.82446	Near Chintopo	2.2
22	June 07	2652.82435	Chintopo to R. Funumoe	3.2
23	June 07	2747.82462	R. Funumoe, E bank	2.2
24	June 08	2978.82408	Messenguezi inlet	1.1
25	June 08	2894.82439	W of Messenguezi inlet	3.2
26	June 08	2938.82417	W of Messenguezi inlet	3.2
27	June 08	2959.82407	W of Messenguezi inlet	2.2
28	June 10	4083.82541	Near Daque Camp	2.2
29	June10	4135.82573	NE of Mt. Bungue	3.4

Sample No.	Date	UTM Grid Reference	Location	Vegetation Type
30	June 10	4090.82530	Daque Camp to main road	3.4
31	June 11	4108.82550	Mt. Bungue, W slope	3.1
32	June 11	4114.82547	Mt. Bungue, on top	3.1
33	June 11	4090.82455	R. Daque, S of Daque village	1.1
34	June 11	4093.82458	R. Daque, S of Daque village	1.1
35	June 12	4105.82383	S of Daque village	1.3
36	June 12	4166.82228	Powerline SW of Jeke	3.3
37	June 12	4145.82199	Powerline SW of Jeke	3.1
38	June 13	4112.82156	Powerline SW of Jeke	3.3
39	June 13	4122.82171	Powerline SW of Jeke	3.1
40	June 13	4120.82165	Powerline SW of Jeke	1.2
41	June 13	4559.82638	Powerline E of Nyakapiri	3.2
42	June 13	4742.82628	Chitima to Songo	3.2
43	June 15	3679.82513	E of Magoe	3.1
44	June 15	3584.82543	W of Magoe	2.2
45	June 15	3628.82326	W of Comboio	3.2
46	June 16	3695.82338	On top of Comboio	2.4
47	June 16	3700.82323	On top of Comboio	2.4
48	June 17	3815.82495	E of Magoe	3.1
49	June 17	3811.82495	E of Magoe	1.3
50	June 17	4706.82616	W of Chitima	1.3
51	June 18	4876.82581	Powerline, W of Songo junction	3.4
52	June 18	4801.82676	S of Songo boom	5.1
53	June 18	4934.82545	Songo to Tete	3.4
54	June 18	4960.82499	Songo to Tete	3.4
55	June 18	5082.82391	Songo to Tete	2.2
56	June 18	5261.82166	Songo to Tete	3.4
57	June 19	5245.81807	E of Mt.Changundue	3.4
58	June 19	5130.81814	Base of Mt.Changundue	3.5
59	June 19	5130.81810	On top of Mt.Changundue	3.1
60	June 19	4828.81860	E of Chioco	1.2
61	June 19	4827.81856	E of Chioco	1.3

Sample No.	Date	UTM Grid Reference	Location	Vegetation Type
62	June 20	4770.81890	R. Metangua, NW of Chioco	1.3
63	June 20	4779.81895	R. Metangua, NW of Chioco	1.4
64	June 20	4774.81887	R. Metangua, NW of Chioco	1.3
65	June 20	4626.81978	R. Metangua, NW of Chioco	1.3
66	June 20	4980.81835	R. Luia, E of Chioco	2.2
67	June 20	4935.81847	R. Luia, E of Chioco	1.1

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Annex 3.2: List of plant species from 67 plots recorded to the south of Lake Cabora Bassa, Tete Province, Mozambique, June 2000. (Nomenclature follows that in current use at the National Herbarium, Harare).

DICOTYLEDONS

Acanthaceae
Anisotes bracteatus *Milne-Redh.*
Anisotes formosissimus *(Klotzsch) Milne-Redh.*
Barleria albostellata *C.B.Clarke*
Barleria kirkii *T.Anderson*
Barleria rogersii *S.Moore*
Barleria senensis *Klotzsch*
Crabbea hirsuta *Harv.*
Duosperma crenatum *(Lindau) P.G.Mey.*
Duosperma quadrangulare *(Klotzsch) Brummitt*
Megalochlamys hamata *(Klotzsch) Vollesen*
Peristrophe paniculata *(Forssk.) Brummitt*

Anacardiaceae
Lannea schweinfurthii *(Engl.) Engl.*
Ozoroa insignis *Delile.* subsp. reticulata *(Baker f.) J.B.Gillett*
Rhus tenuinervis *Engl.*
Sclerocarya birrea *(A.Rich.) Hochst.* subsp. caffra *(Sond.) Kokwaro*

Annonaceae
Artabotrys brachypetalus *Benth.*
Cleistochlamys kirkii *(Benth.) Oliv.*
Friesodielsia obovata *(Benth.) Verdc.*
Monodora junodii *Engl. & Diels*

Apiaceae (= Umbelliferae)
Steganotaenia araliacea *Hochst.*

Apocynaceae: Apocynoideae (= Apocynaceae)
Diplorhynchus condylocarpon *(Müll.Arg.) Pich.*
Holarrhena pubescens *(Buch.-Ham.) G.Don*
Strophanthus kombe *Oliv.*
Strophanthus petersianus *Klotzsch*

Apocynaceae: Asclepiadoideae (= Asclepiadaceae)
Calotropis procera *(Aiton) W.T.Aiton*
Dregea macrantha *Klotzsch*
Pergularia daemia *(Forssk.) Chiov.*

Apocynaceae: Periplocoideae (= Periplocaceae)
Cryptolepis obtusa *N.E.Br.*
Stomatostemma monteiroae *(Oliv.) N.E.Br.*
Tacazzea apiculata *Oliv.*

Asteraceae (= Compositae)
Psiadia punctulata *(DC.) Vatke*
Tarchonanthus camphoratus *L.*
Tarchonanthus trilobus *DC.* var. galpinii *(Hutch. & E.Phillips) Paiva*
Vernonia glabra *(Steetz) Vatke*

Balanitaceae
Balanites aegyptiaca *(L.) Delile*
Balanites maughamii *Sprague* subsp. maughamii

Bignoniaceae
Kigelia africana *(Lam.)Benth.*
Markhamia obtusifolia *(Baker) Sprague*
Markhamia zanzibarica *(DC.) K.Schum.*
Stereospermum kunthianum *Cham.*

Bombacaceae
Adansonia digitata *L.*

Boraginaceae
Cordia goetzei *Gürke*
Cordia mukuensis *Taton*
Cordia pilosissima *Baker*
Ehretia amoena *Klotzsch*
Trichodesma zeylanicum *(Burm. f.) R.Br.*

Buddlejaceae
Nuxia oppositifolia *(Hochst.) Benth.*

Burseraceae
Commiphora africana *(A.Rich.) Engl.*
Commiphora caerulea *B.D.Burtt*
Commiphora edulis *(Klotzsch) Engl.*
Commiphora glandulosa *Schinz*
Commiphora karibensis *Wild*
Commiphora marlothii *Engl.*
Commiphora mollis *(Oliv.) Engl.*
Commiphora mossambicensis *(Oliv.) Engl.*
Commiphora ugogensis *Engl.*
Commiphora zanzibarica *(Baill.) Engl.*

Capparaceae
Boscia angustifolia *A.Rich.* var. corymbosa *(Gilg) DeWolf*
Boscia matabelensis *Pestal.*
Boscia mossambicensis *Klotzsch*
Cadaba kirkii *Oliv.*
Capparis tomentosa *Lam.*
Cladostemon kirkii *(Oliv.) Pax & Gilg*
Maerua angolensis *DC.*
Maerua buxifolia *(Oliv.) Gilg & Gilg-Ben.*
Maerua decumbens *(Brongn.) De Wolf* (= Courbonia glauca)
Maerua juncea *Pax* subsp. juncea
Maerua parvifolia *Pax*
Maerua prittwitzii *Gilg & Gilg-Ben.*
Thilachium africanum *Lour.*

Celastraceae
Elachyptera parvifolia *(Oliv.) N.Hallé* (= Hippocratea parvifolia)
Elaeodendron matabelicum *Loes*. (= Cassine matabelica)
Elaeodendron schlechterianum *(Loes.) Loes.*
Gymnosporis putterlickioides *Loes.* (= Maytenus putterlickioides)
Gymnosporia senegalensis *(Lam.) Loes.* (= Maytenus senegalensis)
Loeseneriella africana *(Willd.) N.Hallé* var. richardiana *(Cambess.) N.Hallé*
Maytenus pubescens *N. Robson*
Mystroxylon aethiopicum *(Thunb.) Loes.*
Pleurostylia africana *Loes.*

Reissantia buchananii *(Loes.) N. Hallé* (= Hippocratea buchananii)
Reissantia indica *(Willd.) N. Hallé* var. orientalis *N.Hallé & B. Mathew* (= Hippocratea indica)

Clusiaceae (= Guttiferae)
Garcinia livingstonei *T.Anderson*
Combretaceae
Combretum adenogonium *A.Rich.* (= Combretum fragrans)
Combretum apiculatum *Sond.* subsp. apiculatum
Combretum celastroides *C.Lawson*
Combretum collinum *Fresen.*
Combretum eleagnoides *Klotzsch*
Combretum goetzei *Engl. & Diels*
Combretum hereroense *Schinz*
Combretum imberbe *Wawra*
Combretum kirkii *C.Lawson*
Combretum microphyllum *Klotzsch*
Combretum mossambicense *(Klotzsch) Engl.*
Combretum obovatum *F.Hoffm.*
Combretum padoides *Engl. & Diels*
Combretum paniculatum *Vent.*
Combretum zeyheri *Sond.*
Meistemon tetrandus *(Exell) Exell & Stace* subsp. australis *Exell*
Pteleopsis anisoptera *(C.Lawson) Engl. & Diels*
Pteleopsis myrtifolia *(C.Lawson) Engl. & Diels*
Terminalia brachystemma *Hiern* subsp. brachystemma
Terminalia prunioides *C.Lawson*
Terminalia sambesiaca *Engl. & Diels*
Terminalia sericea *DC.*
Terminalia stenostachya *Engl. & Diels*
Terminalia stuhlmannii *Engl.*

Convolvulaceae
Ipomoea eriocarpa *R.Br.*
Jacquemontia tamnifolia *(L.) Griseb.*

Crassulaceae
Kalanchoe lanceolata *(Forssk.) Pers.*

Dipterocarpaceae
Monotes katangensis *(De Wild.) De Wild.*

Ebenaceae
Diospyros kirkii *Hiern*
Diospyros mespiliformis *A.DC.*
Diospyros quiloensis *(Hiern) F.White*
Diospyros senensis *Klotzsch*
Diospyros squarrosa *Klotzsch*
Euclea divinorum *Hiern*
Euclea racemosa *Murr.* subsp. schimperi *(A. DC.) F.White*

Erythroxylaceae
Erythroxylum zambesiacum *N.Robson*

Euphorbiaceae
Alchornea laxiflora *(Benth.) Pax & K.Hoffm.*
Antidesma venosum *Tul.*
Bridelia cathartica *G.Bertol.*
Bridelia mollis *Hutch.*
Croton gratissimus *Burch.* var gratissimus
Croton longipedicellatus *J.Léonard* var. longipedicellatus

Croton megalobotrys *Müll.Arg.*
Croton menyhartii *Pax*
Drypetes mossambicensis *Hutch*
Erythrococca menyhartii *(Pax) Prain*

(Euphorbiaceae continued)
Euphorbia espinosa *Pax*
Euphorbia ingens *Boiss*
Euphorbia matabelelensis *Pax*
Excoecaria bussei *(Pax) Pax*
Flueggea virosa *(Willd.) Voight*
Margaritaria discoidea *(Baill.) G.L.Webster* var. nitida *(Pax) Radcl.-Sm.*
Phyllanthus pinnatus *(Wight) G.L.Webster*
Phyllanthus reticulatus *Poir.*
Pseudolachnostylis maprouneifolia *Pax*
Ricinus communis *L.*

Fabaceae: Caesalpinioideae
Afzelia quanzensis *Welw.*
Bauhinia petersiana *Bolle* subsp. petersiana
Bauhinia thonningii *Schumach.* (= Piliostigma thonningii)
Bauhinia tomentosa *L.*
Brachystegia allenii *Burtt Davy & Hutch*
Brachystegia glaucescens *Burtt Davy & Hutch*
Brachystegia longifolia *Benth.*
Brachystegia manga *De Wild.*
Burkea africana *Hook.*
Cassia abbreviata *Oliv.*
Colophospermum mopane *(Benth.) J.Léonard*
Julbernardia globiflora *(Benth.) Troupin*
Peltophorum africanum *Sond.*
Senna obtusifolia *(L.) Irwin & Barneby*
Senna singueana *(Delile) Lock*
Tamarindus indica *L.*
Tylosema fassoglense *(Schweinf.) Torre & Hillc.*

Fabaceae: Faboideaeae (Papilionoideae)
Abrus precatorius *L.* subsp. africanus *Verdc.*
Abrus schimperi *Baker* subsp. africanus *(Vatke) Verdc.*
Baphia massaiensis *Taub.* subsp. obovata *(Schinz) Brummitt*
Bolusanthus speciosus *(Bolus) Harms*
Cordyla africana *Lour.*
Crotalaria monteiroi *Baker f.*
Dalbergia arbutifolia *Baker*
Dalbergia martinii *F.White*
Dalbergia melanoxylon *Guill. & Perr.*
Dalbergiella nyasae *Baker f.*
Eminia antennulifera *(Baker) Taub.*
Indigofera trita *L. f.* var. subulata *(Poir.) Ali*
Mundulea sericea *(Willd.) A.Chev.*
Ormocarpum kirkii *S.Moore*
Ormocarpum trichocarpum *(Taub.) Engl.*
Philenoptera bussei *(Harms) Schrire* (= Lonchocarpus bussei)
Philenoptera violacea *(Klotzsch) Schrire* (= Lonchocarpus capassa)
Pterocarpus angolensis *DC.*
Pterocarpus antunesii *(Taub.) Harms*
Pterocarpus brenanii *Barbosa & Torré*
Pterocarpus rotundifolius *(Sond.) Druce*
Rhynchosia wildii *Verdc.*

Sesbania tetraptera *Baker* subsp. rogersii *(E.Phillips & Hutch.) G.P.Lewis*
Tephrosia purpurea *(L.) Pers.* subsp. leptostachya *(DC.) Brummitt*
Tephrosia rhodesica *Baker f.* subsp. rhodesica
Xanthocercis zambesiaca *(Baker) Dumaz-le Grand*
Xeroderris stuhlmannii *(Taub.) Mendonça & E.C.Sousa*

Fabaceae: Mimosoideae
Acacia ataxacantha *DC.*
Acacia eriocarpa *Brenan*
Acacia galpinii *Burtt Davy*
Acacia nigrescens *Oliv.*
Acacia nilotica *(L.) Delile* subsp. kraussiana *(Benth.) Brenan*
Acacia polyacantha *Willd.*
Acacia robusta *Burch. s*ubsp. clavigera *(E.Mey.) Brenan*
Acacia schweinfurthii *Brenan & Exell*
Acacia senegal *(L.) Willd.* var. leiorhachis *Brenan*
Acacia sieberiana *DC.* var. woodii *(Burtt Davy) Keay & Brenan*
Acacia tortilis *(Forssk.) Hayne* subsp. spirocarpa *(A.Rich.) Brenan*
Acacia xanthophloea *Benth.*
Albizia anthelmintica *Brongn.*
Albizia brevifolia *Schinz*
Albizia harveyi *Fourn.*
Albizia tanganyicensis *E.G.Baker*
Dichrostachys cinerea *(L.) Wight & Arn.*
Elephantorrhiza goetzei *(Harms) Harms* subsp. goetzei
Entada chrysostachys *(Benth.) Drake*
Faidherbia albida *(Delile) A.Chev.* (= Acacia albida)
Mimosa mossambicensis *Brenan*
Mimosa pigra *L.*
Newtonia hildebrandtii *(Vatke) Torre*
Xylia torreana *Brenan*

Flacourtiaceae
Flacourtica indica *(Burm.f.) Merr.*
Xylotheca tettensis *(Klotzsch) Gilg*

Kirkiaceae (= Simaroubaceae)
Kirkia acuminata *Oliv.*

Lamiaceae (= Labiatae, including part of Verbenaceae)
Karomia tettensis *(Klotzsch) R.Fern.*
Leonotis nepetifolia *(L.) W.T.Aiton*
Premna senensis *Klotzsch*
Tinnea rhodesiana *S.Moore*
Vitex mombassae *Vatke*
Vitex payos *(Lour.) Merr.*
Vitex petersiana *Klotzsch*
Vitex schliebenii *Moldenke*

Linaceae
Hugonia orientalis *Engl.*

Loganiaceae
Strychnos decussata *(Pappe) Gilg*
Strychnos innocua *Delile*
Strychnos madagascariensis *Poir.*
Strychnos potatorum *L.f.*
Strychnos spinosa *Lam.*
Strychnos usambarensis *Gilg*

Malpighiaceae
Caucanthus auriculatus *(Radlk.) Niedenzu*

Malvaceae
Abutilon angulatum *(Guill. & Perr.) Mast.*
Azanza garckeana *(F.Hoffm.) Exell & Hillc.*
Hibiscus seineri *Engl.*
Pavonia burchellii *(DC.) R.A.Dyer*

Meliaceae
Entandrophragma caudatum *(Sprague) Sprague*
Trichilia capitata *Klotzsch*
Trichilia emetica *Vahl*
Turraea nilotica *Kotschy & Peyr.*
Turraea zambesica *Styles & F. White*

Menispermaceae
Cissampelos mucronata *A.Rich.*
Cocculus hirsutus *(L.) Diels*

Moraceae
Ficus bussei *Mildbr. & Burret*
Ficus capreifolia *Delile*
Ficus cordata *Thunb.* subsp. salicifolia *(Vahl) C.C.Berg*
Ficus sansibarica *Warb.*
Ficus soldanella *Warb.*
Ficus sycomorus *L.*
Maclura africana *(Bureau) Corner*

Nyctaginaceae
Commicarpus plumbagineus *(Cav.) Standl.*

Ochnaceae
Brackenridgea zanguebarica *Oliv.*
Ochna multiflora *DC.*

Olacaceae
Olax dissitiflora *Oliv.*
Ximenia americana *L.*
Ximenia caffra *Sond.* var. caffra

Oleaceae
Jasminum fluminense *Vell.*
Jasminum stenolobum *Rolfe*
Schrebera trichoclada *Welw.*

Opiliaceae
Opilia amentacea *Roxb.*

Ranunculaceae
Clematis viridiflora *Bertol.*

Rhamnaceae
Berchemia discolor *(Klotzsch) Hemsl.*
Helinus integrifolius *(Lam.) Kuntze*
Ziziphus mauritiana *Lam.*
Ziziphus mucronata *Willd.*
Ziziphus pubescens *Oliv.*

Rubiaceae
Canthium glaucum *Hiern* subsp. frangula *(S.Moore) Bridson* (= Canthium frangula)
Carphalea pubescens *(Klotzsch) Verdc.*
Catunaregam spinosa *(Thunb.) Tirveng.* subsp. taylorii *(S.Moore) Verdc*.
Crossopteryx febrifuga *(G.Don) Benth*.
Feretia aeruginescens *Stapf*
Gardenia resiniflua *Hiern*
Hymenodictyon parvifolium *Oliv.* subsp. scabrum *(Stapf) Verdc*.
Lagynias dryadum *(S.Moore) Robyns*.
Paederia bojeriana *(A.Rich.) Drake* subsp. foetens *(Hiern) Verdc*.
Pavetta cataractarum *S.Moore*
Pavetta klotzschiana *K. Schum*.
Psydrax livida *(Hiern) Bridson*
Psydrax martinii *(Dunkley) Bridson*
Tarenna zygoon *Bridson*
Tricalysia junodii *(Schinz) Brenan* var. kirkii *(Hook. f.) Robbr.*
Vangueria infausta *Burch.*

Rutaceae
Vepris zambesiaca *S. Moore*
Zanthoxylum chalybeum *Engl.*
Zanthoxylum leprieurii *Guill. & Perr.*

Salvadoraceae
Salvadora persica *L.*

Sapindaceae
Allophylus rubifolius *(A.Rich.) Engl.*
Deinbollia xanthocarpa *(Klotzsch) Radlk.*
Haplocoelum foliolosum *(Hiern) Bullock*
Lecaniodiscus fraxinifolius *Baker*
Pappea capensis *Eckl. & Zeyh*.

Sapotaceae
Manilkara mochisia *(Baker) Dubard*

Solanaceae
Solanum incanum *L.*
Solanum tettense *Klotzsch*

Sterculiaceae
Dombeya kirkii *Mast.*
Melhania acuminata *Mast.*
Sterculia africana *(Lour.) Fiori*
Sterculia appendiculata *K.Schum.*
Sterculia quinqueloba *(Garcke) K.Schum.*

Tiliaceae
Grewia bicolor *Juss.*
Grewia flavescens *Juss.* var. flavescens
Grewia flavescens *Juss.* var. olukondae *(Schinz) Wild*
Grewia pachycalyx *K.Schum.*
Grewia praecox *K. Schum.*

Vitaceae
Ampelocissus africana *(Lour.) Merr.*
Cissus cornifolia *(Baker) Planch.*
Cissus integrifolia *(Baker) Planch.*
Cissus quadrangularis *L.*

MONOCOTYLEDONS

Arecaceae (= Palmae)
Hyphaene petersiana *Mart.*

Asparagaceae
Asparagus sp.

Dracaenaceae
Sansevieria sp.

Poaceae (= Gramineae)
Aristida sp.
Dactyloctenium giganteum *B.S.Fisher & Schweick.*
Digitaria milanjiana *(Rendle) Stapf*
Elytrophorus globularis *Hack*
Eragrostis sp.
Heteropogon contortus *(L.) Roem. & Schult.*
Heteropogon melanocarpus *(Ell.) Benth.*
Ischaemum afrum *(J.F.Gmel.) Dandy*
Loudetia sp.
Panicum maximum *Jacq.*
Phragmites mauritianus *Kunth*
Pogonarthria squarrosa *(Roem. & Schult.) Pilg.*
Schmidtia pappophoroides *Steud.*
Setaria incrassata *(Hochst.) Hack.*
Sorghum bicolor *(L.) Moench* subsp. arundinaceum *(Desv.) d*e *Wet & J.R.Harlan*

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BIRD SURVEY ON THE SOUTHERN SIDE OF LAKE CABORA BASSA, MOZAMBIQUE

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Consultancy Report Prepared For
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1. INTRODUCTION

Popular interest in protecting the world's plant and animal species has intensified during the last 20 years. Both scientists and the general public have realised that we are living in a time of unprecedented mass extinction. Around the globe, biological communities that took millions of years to develop are being devastated by human actions. The main cause of the present extinctions is habitat destruction stemming from human activities, such as the indiscriminate chopping down of old-growth forests, over-grazing grasslands, draining wetlands and polluting inland freshwater and ocean ecosystems. The second major cause of extinctions is over-harvesting of animals and plants, especially when it is done using modern technology, to meet national and international interests.

In general, humans enjoy seeing biological diversity. The hundreds or thousands of visitors each year to national parks, botanical gardens, zoos and other recreational sites world wide are a testimony to the general public's interest in biological diversity. At a local level, home gardeners pride themselves on how many types of plants they have in their gardens, while birdwatchers compete to see how many species they can see in one day or in their lifetimes.

There are several good reasons why we worry about birds. Possibly the most basic reason is that birds are an integral part of our environment and, as such, deserve to be conserved in their own right. On the brighter side of things, it is worth reflecting on how much joy birds give us every day. Birds are very often the group that first attracts a person's interest in the natural environment. From a childhood delight in birds, their nests or eggs, very often grows a lifelong interest in the broader issues of the environment and its conservation. People should not doubt that birdwatching is the fastest growing natural history hobby in Africa, let alone the whole world.

At least 678 species of birds occur in Mozambique, with about 500 of them nesting (Dowsett 1993). Among these, 21 are globally threatened (Collar *et al*. 1994), eight of which could possibly occur within the study area.

The Mozambique Direccao Provincial de Agricultura e Pecuaria (DPAP), Tete Province, in collaboration with the Zambezi Society/Biodiversity Foundation for Africa, wishes to examine biological diversity in part of Tete Province. The target area is along both sides of Lake Cabora Bassa from Tchuma Tchato Bawa camp (Kanyemba) in the west to Songo, in the east, and extending south to the Mozambique border almost to the Mazowe/Luia confluence.

This report is part of a joint evaluation exercise that was carried out in the field from 3rd to 20th June 2000, aimed at gaining a useful understanding of probable vegetation and bird diversity, sufficient for planning purposes.

For the birds, the project was aimed at addressing the following seven issues -

a) provide a checklist of species for the study area, based on personal observations,

b) the checklist was to be broken down by habitat in a manner which related to the preliminary ecological classification of the area,

c) provide an indication of relative abundance for each species,

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d) the identification and description of any habitats, areas or sites of particular interest for conservation,

e) the identification and description of any bird species or areas with potential for utilisation of bird species,

f) make recommendations concerning the future development of the region that would serve to minimise impacts to any sites of high biodiversity or conservation value, and

g) recommend and prioritise any necessary and/or desirable further work, particularly as regards addressing any perceived limitations of this study.

2. STUDY AREA AND METHODS

This report is based on inland birds, both terrestrial and aquatic species.

This project was supposed to cover both the northern and southern sides of Lake Cabora Bassa, but unfortunately this was not achieved. Only the southern portion of the lake, comprising an area situated between latitudes 15°S and 16°30'S, and longitudes 30°35'E and 33°E, which is within the Zambezi Valley, was surveyed. This was partly due to the limited time (18 days) that had been allocated for the whole field work, and partly due to logistical problems.

An initial preliminary aerial survey conducted by R. Cunliffe, together with some satellite imagery colour pictures, were used as the basis for the identification of the sample sites. Sites were selected on the basis of vegetation types rather than in terms of suitable habitats for birds.

The project occupied 20 days comprising 18 days' field work and two days of travelling (2 - 21 June 2000). A total of 61 sites were sampled covering 16 Quarter Degree Squares (QDS)(Table 4.1). Daylight observation time for each site ranged between 25 minutes and four hours, with the overall time totalling 94 hours. The birds were identified by eye and ear while walking randomly within a defined habitat type. For security reasons, I was always accompanied by a scout, who also assisted in spotting birds. Two people only was ideal, so as to minimise the disturbances to birds as we walked in the bush. A pair of 8x42 Nikon binoculars was used to identify birds, with the aid of *Newman's Birds of Southern Africa* (Newman 1993) and *Roberts' Birds of Southern Africa* (Maclean 1985) as guide books.

Each day and night were divided into four sections as follows:

I. Dawn to 0900 hrs - watching small birds in the bush and searching for bird parties,
II. 0900 - 1400 hrs - watching medium to large birds in the sky (aerial birds and raptors) as I walked in the bush,
III. 1500 till dusk - any other birds,
IV. During the night - night birds (through hearing).

However, all species were recorded at all times.

The vegetation and habitat types were noted for each site, with a total of 12 habitat types being recognised. This is less than the number of vegetation types recognised by Cunliffe in his

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preliminary survey, since some types have been grouped together. For example, mopane woodland and mixed mopane woodland were classified here as one general habitat.

The abundance of individual species was scored through counting or estimating total numbers of birds and the number of sightings within the species' preferred habitat. The following categories were used: rare - for very restricted species ; uncommon - for birds with less than 4 sightings, or if seen once or twice outside their geographical range; common - for species seen more than ten times within their preferred habitat; and abundant - those species recorded in almost every Quarter Degree Square (QDS), or in large flock sizes.

3. RESULTS AND DISCUSSION

Despite the fact that most of the migrants (both Palaearctic and Intra-African) had long gone, and also that, away from the lake, most of the major drainage systems (from where many bird species could be sighted) were dry, altogether 251 species were recorded. The species master list is shown in Annex 4.1, and lists by individual QDS in Annex 4.2. Additional notes on certain families and species are provided in Annex 4.3, and a preliminary list of Chikunda bird names in Annex 4.4.

The highest bird diversity was concentrated along the Cabora Bassa Lake shore, especially within a five kilometre belt, and also along flowing river courses (Annex 4.2, 4.2). Very few mammals were seen inland and away from the main water courses. This is indeed a good indication of the importance of water to both animals and birds. With the high concentration of human settlement along almost all the major drainage systems in the study area, this means that the accessibility of water, particularly during the dry seasons, is becoming very restricted to fewer and fewer isolated sections.

3.1 Species of Interest

A number of species of interest were recorded in the study area. Some of the species recorded were outside their known distribution ranges. These included the Long-toed Plover (two sightings of two birds each) and the Little Spotted Woodpecker (one sighting of two birds) (Annex 4.3). The distribution and abundance of hornbills was also interesting. The Red-billed and Crowned Hornbills were more common to the west of 32^{o}E longitude, while the Grey and Yellow-billed Hornbills were commonly seen to the east of this line. Another interesting species was Arnot's Chat. Despite the fact that the whole study area was dominated by mopane woodland, which comprises the preferred habitat for this species, it was only recorded (in good family sizes) to the west of the 30^{o}45'E longitude line. Other species of interest included vultures (four species) and sunbirds (seven species), most of which were quite common (Annex 4.3). Annex 4.3 also provides brief notes on additional species.

Of the 21 Globally Treatened bird species that occur in Mozambique, eight species may possibly occur within the study area (Table 4.3). However, none of them were recorded during this survey; five species in any case are Palaearctic migrants, and had already left the study area.

The trapping of Carmine Bee-eaters along river banks during their breeding season is of great concern. This should be stopped immediately by Mozambique's Law enforcement agents. The

trapping activities that are going on pose a great threat to the continued survival of the species in this region.

3.2 Habitats/Areas of Interest

It was not easy to identify priority bird habitats for conservation purposes, mainly because the study area was not covered in whole, and also because little time was spent per each sample site. In order to arrive at a clear description of habitats for birds, the study area needs to be visited at least three times, that is, during the hot-wet, cold-dry and hot-dry seasons. This would give a very clear picture, which could then be used to determine the 'hot-spots' for birds in the study area. Some natural pans, like Nyadehwe, Mbirira and Chinsanga, were not surveyed, but are possibly important breeding sites of waterfowl, and so deserve good protection. In this survey, the highest bird diversity was concentrated along the Cabora Bassa Lake shore, especially within a five kilometre belt, and also along flowing river courses.

3.3 Potential for Utilization

The results of this survey showed that some game birds (Helmeted Guineafowls, francolins and doves, and Double-banded Sandgrouse) and some parrots (Meyer's and Cape parrots, and Lilian's Lovebirds) still had healthy populations throughout the study area. Good numbers of young birds were also recorded for most of these species. I therefore think that these species could be utilised sustainably through an annual quota system, particularly under the Tchuma-Tchato natural resource management programme. Selected waterfowl species (ducks) could also be utilised under the same programme.

3.4 Human Settlement and Poaching

Human settlements in the study area were in the form of clustered compounds, at very high densities, especially along the Cabora Bassa Lake shore (fishing camps), drainage systems, and along the major roads. This pattern of settlement with extensive bush in between, was necessitated, in the first place, by political instability, lawlessness, and civil unrest that forced rural farmers off their land and into remote, undeveloped areas where they felt safer. The large concentration of people in these areas has displaced plants and animals that lived there previously and, has given rise to problems unique to such crowded conditions.

Since the end of the civil war settlements have not resulted from careful planning. Most of them have developed haphazardly, with attendant problems. Crime, unemployment, poor housing, depletion of water supplies and contamination by domestic waste disposal, energy (fuel wood) consumption, transport costs, and land-use sprawl, are among the serious problems facing contemporary settlements in the study area.

People are faced with many important choices concerning how and where they will live. The government is being challenged by many of these people who are now leaving these settlements for better areas inland, bringing some of the same problems with them that encouraged them to leave the clustered way of settlement. New communities - large and small - are being developed. Some are the result of individual families moving into previously unsettled areas, while in some, re-developments are taking place to try to improve the habitability of the old and dying neighbourhoods.

The Mozambican government should know that any development or re-development of an area has an impact on the plants and animals who do and can live there, as well as on any people who might live there. Sometimes the development can be of benefit, and sometimes of long-term harm. When such decisions are made, it seems prudent to plan for the impact of your people's actions as carefully and thoughtfully as possible. Time is moving fast and now is the right time to act.

Whenever an area of land is divided and excavated for homes for people, ploughed to grow crops - small animals lose their homes, and frequently their sources of food and water. As these small animals disappear, so too do the larger animals that previously depended upon the smaller animals in the food chain as a source of food. This is what is going to happen in Mozambique's Tete Provice.

Some rural people destroy biological communities and hunt endangered or threatened species to extinction because they are poor and have no land of their own. Most of them live in remote and undeveloped areas where they attempt to eke out a living through shifting cultivation. In this kind of subsistence farming, sometimes referred to as 'slash-and-burn' agriculture, plots of natural vegetation are burned away and the cleared patches are farmed for two or three seasons after which their fertility usually diminishes to a point where adequate crop production is no longer possible. The patch is abandoned and more natural vegetation must be cleared. This kind of shifting cultivation is becoming a common thing in Mozambique because the farmers are unwilling to spend the time and money necessary to develop more permanent forms of agriculture on land that they do not own and may not occupy for very long.

As a result of the above-mentioned activities going on in Tete Province, wildlife poaching (both domestic and commercial) is greater than people think.

A female elephant was shot and the ivory removed about a kilometre away from where we were camped in the Kapesa area on June 4th. Many snares (52 wire and 38 fibre) for both animals (hares to duikers) and birds (doves to guineafowls) were encountered and removed, particularly along the major drainage systems. Duty Bhibho, a young boy (12 years old) of Kamonyongo Village, Chitete (QDS 1531 C3) was apprehended with a Red-billed Hornbill he had caught with a fibre snare. The bird was still alive but it had been defeathered and its wings broken so that it could not fly away. Twenty-six snares were removed from a burnt area where hornbills, together with other bird species, were foraging on grass seeds at that open space. Actually the burning had been done by this same boy for the purpose of snaring birds. He told me that he was able to catch about 40 to 50 birds per day. One wonders by what degree such activities are taking place throughout the Tete Province, let alone Mozambique as a whole.

The scouts I worked with told me about how other birds like Carmine Bee-eaters, lovebirds and parrots were being trapped both for food and also for trade.

Trapping of Carmine Bee-eaters

Carmine Bee-eaters breed in colonies. They make nesting holes on sandy 'cliff' banks along rivers. It is at these breeding colonies where the birds are trapped, particularly along the Angwa, Manyame and Panyame (after the confluence of Manyame and Angwa) Rivers. The trappers are said to use gill-nets with 2,5 cm to 4 cm (1" to 1,5") mesh-sizes to catch the birds right at the nest entrances. The trappers hide a few metres away from the birds' breeding colony, from where they run and quickly cover with the gill-nets the birds already in the nesting holes, thereby catching the departing birds. The nets are then removed and taken to the hiding place, and the

same process is repeated again and again. The trappers work individually or in groups, helping each other to spread the gill-net in front of the colony.

Snares set right at the entrances to the nesting holes are also used to catch the birds by those who do not have access to gill-nets.

Trapping of Lilian's Lovebirds

The trapping of this species takes place during its breeding season and when the maize crops start to ripen. The trappers locate the lovebirds' nests in trees, particularly during July and August. They then set limed sticks nearby and at the top of the nesting tree so that the birds get caught by the lime when they visit the nests. They usually first catch one of the parent birds with the use of a snare set by the nest entrance, and then put it in a wire-mesh cage, which is left by the nest entrance. The alarm calls made by the bird in the cage attracts its mate or family group to come and investigate, which in turn get caught by the baited lime set around the nesting hole.

The culprits then get the chicks from the nest, usually through chopping down and opening the nesting tree-trunk in order to have access to them in the cavity.

The lovebirds are similarly caught in fields. One bird is caught with the use of a snare, set by a maize cob that has partly been eaten by the birds or deliberately slightly opened by the trapper. Once a single bird is caught, it is put in a cage. A number of limed sticks are then tied high up so that the other birds get caught as they come to investigate the alarm call from their mate. The birds in the cage are left in the maize fields until many lovebirds are caught with the bird lime.

A few of the birds caught are for food, particularly in those areas where it is too remote (very far away from potential market places or client routes), while the rest are sold to tourists by the main roads, the main market being in Tete, the Province's capital. Most of the buyers are said to be South Africans and Zimbabweans, plus a few locals. The previous year's black market price for one lovebird was 15 000 Meticals (US$1).

3.5 Future Developments

Human pressure on wildlife in general is becoming worse in the study area than most people think. The Mozambican Government should initiate a proper resettlement programme immediately so as to reduce the accelerating environmental degradation going on in much of the Tete Province. It is suggested that much of the initial conservation work be targeted on the protection of major drainage systems, particularly along the lake shore where wildlife and humans are seriously competing for space. The Mozambican Government should know that some rural people are destroying biological communities and hunting certain species to extinction because they are unaware of the implications of their activities. Hence the need to act right now before it is too late.

3.6 Limitations of the Study

The results of this study should be taken as a base for a more detailed survey. The next survey should include natural pans like Nyadehwe, Mbirira and Chansanga, between Panyame and Fundumwa Rivers, that were not covered now, but are presumably important breeding sites of waterfowl and deserve good protection. I was also informed that some of these natural pans

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never dry up in the dry season, which means that they should also be oases for other birds and mammals.

The survey period should allow extra time, say four to six days, so as to accommodate unforeseen matters that might arise, be they logistical or accidental. This should reduce unnecessary panic that may be caused by trying to finish the job in a stipulated time-frame, during which important sites may be overlooked or neglected.

On this survey birds were identified through eyes and ears only. Because of the secretive behaviour of some bird species, while others are mimics, certain species may have been overlooked. I therefore suggest that equipment such as mist nets and bird-call tapes be used to counter this drawback.

Two experienced observers should do the work together when covering such large areas if time is limited. This would allow more effective coverage and more consideration of the bird communities at the time.

The Mozambican 'Tchuma-Tchato' officials, to which this project was affiliated, need to improve their communication skills so as not to confuse the planning of the field work when researchers are already in the field. The initial plan was to cover both the northern and southern sides of Lake Cabora Bassa, but we were later informed that we could not go to the north due to security reasons and other problems that had not been discussed prior to the start of the field work.

3.7 Further Work

The results of the bird survey in this report should be taken as a base for a more detailed survey. Two more surveys (for the hot-wet and hot-dry seasons) need to be carried out so as to produce a 'complete' checklist of birds in the study area. The next survey should include natural pans like Nyadehwe, Mbirira and Chansanga, that were not covered during this study.

Two experienced observers will have to do the work together. This would allow more effective coverage and more consideration of the bird communities at the time.

4 ACKNOWLEDGEMENTS

My sincere gratitude goes to the coordinator of this project, Rob Cunliffe who, despite many problems we faced during the field work, was equal to any situation that arose. I sincerely admire his leadership qualities. The Mozambique 'Tchuma-Tchato' programme, to which this project was affiliated, is thanked for its support during the field work. We also acknowledge our friends and colleagues at Bawa and Daque, including the Tchuma-Tchato scouts who participated in this project (some of whom helped me to produce the 'Chikunda' bird list of Annex 4.4).

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TABLES

Table 4.1: List of sites sampled for birds in the study area.

Site No.	Locstat	QDS	Habitat	Time
001	UTM 02250.82688	1530 C2	Open Combretum	0625-0935
002	UTM 02414.82678	1530 D1	Deciduous woodland	1440-1530
003	UTM 02378.8267	1530 D1	Mopane mixed	1600-1650
004	UTM 02252.8243	1530 C4	Mixed Acacia	0900-1130
005	UTM 02237.8234	1530 C4	Mixed mopane	1300-1430
006	UTM 02241.8235	1530 C4	Combretum mixed	1500-1550
007	UTM 02240.8237	1530 C4	Combretum mixed	1605-1705
008	UTM 02240.82366	1530 C4	Terminalia mixed	0640-0740
009	UTM 02241.82359	1530 C4	Jesse thicket	0800-0900
010	UTM 02240.82381	1530 C4	Mopane/Terminalia	1045-1100
011	UTM 02436.82423	1530 D3	Mopane	0545-0730
012	UTM 02451.82409	1530 D3	Acacia	0730-0900
013	UTM 02446.82402	1530 D3	Clumped/mixed	1100-1500
014	UTM 02441.82534	1530 D3	Clumped/mixed	1500-1525
015	UTM 02453.82564	1530 D3	Mopane mixed	1700-1745
016	UTM 02433.82446	1530 D3	Mopane	0710-0815
017	UTM 02652.82434	1530 D4	Combretum mixed	0815-0905
018	UTM 02747.82462	1530 D4	Combretum/mopane mixed	1200-1315
019	UTM 02978.82408	1531 C3	Acacia mixed	0545-0925
020	UTM 02959.82407	1531 C3	Acacia mixed	1155-1425
021	UTM 04090.82530	1532 C3	Mopane mixed	0715-0815
022	UTM 04114.82547	1532 C3	Acacia mixed	0815-1117
023	UTM 04090.82454	1532 C3	Clumped mixed	1117-1400
024	UTM 04122.82547	1532 C3	Acacia	1400-1415
025	UTM 04105.82383	1532 C3	Acacia	1630-1740
026	UTM 04166.82288	1632 A1	Acacia mixed	0600-0855
027	UTM 04145.82199	1632 A1	Mopane mixed	
028	UTM 04112.82156	1632 A1	Mixed woodland	
029	UTM 04122.82171	1632 A1	Combretum	
030	UTM 04459.82638	1532 D1	Clumped mixed	

Site No.	Locstat	QDS	Habitat	Time
031	UTM 04706.82616	1532 D1	Mopane mixed	
032	UTM 03679.82518	1531 D4	Combretum mixed	
033	UTM 03584.82543	1531 D3	Combretum mixed	
034	UTM 03679.82326	1531 D4	Mopane mixed	
035	UTM 04742.82628	1532 D2	Mopane	
036	UTM 03815.82495	1531 D4	Combretum	
037	UTM 04876.82581	1532 D4	Combretum	
038	UTM 04934.82545	1532 D4	Mopane mixed	
039	UTM 04960.82499	1532 D4	Combretum mixed	
040	UTM 05082.82391	1533 C3	Acacia mixed	
041	UTM 05261.82166	1633 A1	Combretum mixed	
042	UTM 05245.81807	1633 A1	Mopane	
043	UTM 05130.81814	1633 A1	Combretum	
044	UTM 04960.81828	1632 B4	Mopane	
045	UTM 04828.81852	1632 B4	Mopane	
046	UTM 04764.81852	1632 B4	Mopane mixed	
047	UTM 04742.82628	1532 D2	Mopane	

Note: An additional fourteen localities were sampled but unfortunately not marked.

Table 4.2: Numbers of species recorded in the seven main habitat types that were identified in the survey area.

Habitat	**No. of Species**
Riverine evergreen forest and lake shore	173
Mopane/mixed mopane	144
Acacia/mixed acacia	119
Grassland/wooded grassland	103
Mountain/Hills (sandstone/basalt)	98
Combretum/thickets and mixed woodland	77
Terminalia clumped to mixed woodland	69
Total	**251**

Notes:
1. This is a **winter** checklist only.
2. These seven habitats can be divided further into 12 categories. For example, "Riverine evergreen forest and lake shore" could be divided into aquatic and land (riverine forest) birds.

Table 4.3: Globally threatened species that occur in Mozambique (from Collar et al. 1994), with those that may occur in the survey area indicated by *.

Species	Threat Category	Status in Mozambique
Lesser Flamingo	Near threatened	nomad
Cape Griffon	Vulnerable	breeding resident
Southern Banded Snake Eagle	Near threatened	breeding resident
Pallid Harrier*	Near threatened	Palaearctic migrant
Lesser Kestrel*	Vulnerable	Palaearctic migrant
Taita Falcon*	Vulnerable	breeding resident (?)
Wattled Crane	Vulnerable	breeding resident
Corncrake*	Vulnerable	Palaearctic migrant
Great Snipe*	Near threatened	Palaearctic migrant
Stierling's Woodpecker	Near threatened	breeding resident
Blue Swallow	Vulnerable	intra-African migrant
Thyolo Alethe	Vulnerable	breeding resident
Swynnerton's Robin	Vulnerable	breeding resident
East Coast Akalat	Vulnerable	breeding resident
Dappled Mountain Robin	Vulnerable	breeding resident
Basra Reed Warbler*	Near threatened	Palaearctic migrant
Long-billed Tailorbird	Critically endangered	breeding resident
Namuli Apalis	Vulnerable	breeding resident
White-winged Apalis*	Vulnerable	breeding resident
Plain-backed (Blue-thr.) Sunbird*	Near threatened	breeding resident
Neergaard's Sunbird	Near threatened	breeding resident

Note:
Intra-African migrant = August - April, and Palaearctic migrant = October - March.

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ANNEXES

Annex 4.1: Species Master List

This is a complete list of all species seen in the project area, with an overall assessment of their relative abundance, and an indication of their habitat. The order of bird families and the common (without hyphens) and scientific names follow Maclean (1993). Note that most alternative common names are not included in this list.

The following symbols are used for relative abundance and habitat.

Relative Abundance:

AB	abundant (present in almost every QDS, or in large flock sizes)
C	common (recorded more than 10 times in preferred habitat)
UNC	uncommon (less than four sightings)
R	rare (very restricted species)

Habitat:

A	Aquatic
Ac	*Acacia* woodland
Ah	All habitats
B	Basalt area
C	*Combretum* woodland
Cf	Crop fields
G	Grassland
H	Human settlement
M	Mopane woodland
Mo	Mountain/Hills
R	Riverine forest
T	*Terminalia*/Clumped

Common name/Scientific name	**Relative Abundance**	**Habitat**
Reed Cormorant *Phalacrocorax africanus*	AB	A
African Darter *Anhinga melanogaster*	C	A
Grey Heron *Ardea cinerea*	C	A
Blackheaded Heron *Ardea melanocephala*	UNC	A/G
Goliath Heron *Ardea goliath*	C	A
Purple Heron *Ardea purpurea*	C	A
Great White Egret *Egretta alba*	C	A
Little Egret *Egretta garzetta*	C	A
Yellowbilled Egret *Egretta intermedia*	C	A
Black Egret *Egretta ardesiaca*	C	A
Cattle Egret *Bubulcus ibis*	C	A/G/Ac
Squacco Heron *Ardeola ralloides*	C	A
Greenbacked Heron *Butorides striatus*	C	A
Little Bittern *Ixobrychus minutus*	UNC	A
Hamerkop *Scopus umbretta*	C	A/R
Black Stork *Ciconia nigra*	R	R

Common name/Scientific name	**Relative Abundance**	**Habitat**
Openbilled Stork *Anastomus lamelligerus*	AB	A
Saddlebilled Stork *Ephippiorhynchus senegalensis*	C	A
Marabou Stork *Leptoptilos crumeniferus*	UNC	T
Sacred Ibis *Threskiornis aethiopicus*	C	A
Hadeda Ibis *Bostrychia hagedash*	UNC	A
African Spoonbill *Platalea alba*	C	A
Whitefaced Duck *Dendrocygna viduata*	C	A
Egyptian Goose *Alopochen aegyptiacus*	C	A/R
Redbilled Teal *Anas erythrorhyncha*	C	A
Knobbilled Duck *Sarkidiornis melanotos*	C	A/R
Spurwinged Goose *Plectropterus gambensis*	UNC	A
Hooded Vulture *Necrosyrtes monachus*	C-UNC	Ah
Whitebacked Vulture *Pseudogyps africanus*	C-UNC	Ah
Lappetfaced Vulture *Torgos tracheliotos*	C-UNC	Ah
Whiteheaded Vulture *Trigonoceps occipitalis*	C-UNC	Ah
Blackshouldered Kite *Elanus caeruleus*	C	G/Cf
Cuckoo Hawk *Aviceda cuculoides*	UNC	R/C
African Hawk Eagle *Hieraaetus spilogaster*	C	Ah
Martial Eagle *Polemaetus bellicosus*	C	Ah
Crowned Eagle *Stephanoaetus coronatus*	UNC	R/Mo
Brown Snake Eagle *Circaetus cinereus*	C	Ah
Blackbreasted Snake Eagle *Circaetus pectoralis*	C	G/M/Mo
Western Banded Snake Eagle *Circaetus cinerascens*	UNC	R
Bateleur *Terathopius ecaudatus*	AB	Ah
African Fish Eagle *Haliaeetus vocifer*	AB	A/R
Augur Buzzard *Buteo augur*	UNC	Mo
Lizard Buzzard *Kaupifalco monogrammicus*	C	Ah
Little Sparrowhawk *Accipiter minullus*	C	Ah
Black Sparrowhawk *Accipiter melanoleucus*	C-UNC	R/M
Little Banded Goshawk *Accipiter badius*	C	Ah
African Goshawk *Accipiter tachiro*	C	R/M/Mo
Gabar Goshawk *Micronisus gabar*	C	Ah
Dark Chanting Goshawk *Melierax metabates*	C	Ah
Gymnogene *Polyboroides typus*	C	Ah
Peregrine Falcon *Falco peregrinus*	UNC	Mo
Lanner Falcon *Falco biarmicus*	C	Ah
Rock Kestrel *Falco tinnunculus*	C	Mo/M/C
Dickinson's Kestrel *Falco dickinsoni*	UNC	G/Cf/M
Coqui Francolin *Francolinus coqui*	C	Ah
Crested Francolin *Francolinus sephaena*	AB	Ah
Shelley's Francolin *Francolinus shelleyi*	UNC	C/T
Natal Francolin *Francolinus natalensis*	C	Ac/R/Mo
Swainson's Francolin *Francolinus swainsonii*	C	Ah
Common Quail *Coturnix coturnix*	C	G/A/T
Harlequin Quail *Coturnix delegorguei*	UNC	Ac/G
Helmeted Guineafowl *Numida meleagris*	AB	Ah
Crested Guineafowl *Guttera pucherani*	UNC	T
Kurrichane Buttonquail *Turnix sylvatica*	C-UNC	G/Ac
African Jacana *Actophilornis africanus*	AB	A
Kittlitz's Plover *Charadrius pecuarius*	C	R/A

Common name/Scientific name	**Relative Abundance**	**Habitat**
Threebanded Plover *Charadrius tricollaris*	C	R/A
Crowned Plover *Vanellus coronatus*	UNC	G
Blacksmith Plover *Vanellus armatus*	C	A/R
Whitecrowned Plover *Vanellus albiceps*	C	A
Wattled Plover *Vanellus senegallus*	C	A
Longtoed Plover *Vanellus crassirostris*	R	A
Water Dikkop *Burhinus vermiculatus*	C	A
Temminck's Courser *Cursorius temminckii*	C	G
Threebanded Courser *Rhinoptilus cinctus*	UNC	G
Doublebanded Sandgrouse *Pterocles bicinctus*	C	Ah
Feral Pigeon *Columba livia*	C	Ah
Rock Pigeon *Columba guinea*	C	R/Cf
Redeyed Dove *Streptopelia semitorquata*	C	Ah
Mourning Dove *Streptopelia decipiens*	AB	R/Ac
Cape Turtle Dove *Streptopelia capicola*	AB	Ah
Laughing Dove *Streptopelia senegalensis*	AB	Ah
Namaqua Dove *Oena capensis*	C-UNC	G/Cf
Emeraldspotted Dove *Turtur chalcospilos*	AB	Ah
Green Pigeon *Treron calva*	C	R
Cape Parrot *Poicephalus robustus*	C-UNC	Ah
Brownheaded Parrot *Poicephalus cryptoxanthus*	UNC	M/Mo
Meyer's Parrot *Poicephalus meyeri*	C	Ah
Lilian's (Nyasa) Lovebird *Agapornis lilianae*	C	Ah
Purplecrested Lourie *Tauraco porphyreolophus*	C	Mo/R
Grey Lourie *Corythaixoides concolor*	C	Ah
Striped Cuckoo *Clamator levaillantii*	UNC	Ac
Senegal Coucal *Centropus senegalensis*	C-UNC	R/G
Burchell's Coucal *Centropus superciliosus*	AB	R/G
Barn Owl *Tyto alba*	C	Ah
Marsh Owl *Asio capensis*	C-UNC	G/Ac
Scops Owl *Otus senegalensis*	C	M/G/B
Whitefaced Owl *Otus leucotis*	UNC	R
Pearlspotted Owl *Glaucidium perlatum*	AB	Ah
Barred Owl *Glaucidium capense*	C	M/B
Spotted Eagle Owl *Bubo africanus*	C	Ah
Giant Eagle Owl *Bubo lacteus*	C	Ah
Freckled Nightjar *Caprimulgus tristigma*	C(?)	Mo/G
Mozambique Nightjar *Caprimulgus fossii*	C(?)	Mo/G/B
Black Swift *Apus barbatus*	UNC	Mo
Palm Swift *Cypsiurus parvus*	AB	Ah
Mottled Spinetail *Telecanthura ussheri*	UNC	R/Ac
Bohm's (Batlike) Spinetail *Neafrapus boehmi*	UNC	R
Redfaced Mousebird *Colius indicus*	C	R/Ac
Pied Kingfisher *Ceryle rudis*	AB	R/A
Giant Kingfisher *Ceryle maxima*	C-UNC	R/A
Malachite Kingfisher *Alcedo cristata*	UNC	R
Brownhooded Kingfisher *Halcyon albiventris*	C	Ah

Common name/Scientific name	**Relative Abundance**	**Habitat**
Greyhooded Kingfisher *Halcyon leucocephala*	UNC	T/Cf
Striped Kingfisher *Halcyon chelicuti*	C	Ah
Carmine Bee-eater *Merops nubicoides*	C-UNC	Ah
Whitefronted Bee-eater *Merops bullockoides*	C-UNC	R
Little Bee-eater *Merops pusillus*	AB	Ah
Swallowtailed Bee-eater *Merops hirundineus*	C	T/C/R
Lilacbreasted Roller *Coracias caudata*	AB	Ah
Racket-tailed Roller *Coracias spatulata*	C-UNC	M/Mo/T
Purple Roller *Coracias naevia*	UNC	M/Mo
Hoopoe *Upupa epops*	C	Ah
Redbilled Woodhoopoe *Phoeniculus purpureus*	C	Ah
Scimitarbilled Woodhoopoe *Phoeniculus cyanomelas*	C	Ah
Trumpeter Hornbill *Bycanistes bucinator*	C	Mo/R
Grey Hornbill *Tockus nasutus*	C-AB	Ah
Redbilled Hornbill *Tockus erythrorhynchus*	AB	Ah
Yellowbilled Hornbill *Tockus flavirostris*	C-UNC	M/G/R/A
Crowned Hornbill *Tockus alboterminatus*	AB	Ah
Ground Hornbill *Bucorvus leadbeateri*	C	Ah
Blackcollared Barbet *Lybius torquatus*	C	Ah
Yellowfronted Tinker Barbet *Pogoniulus chrysoconus*	C	M/Ac/B
Crested Barbet *Trachyphonus vaillantii*	C	M/C/Ac/T
Greater Honeyguide *Indicator indicator*	C	Ah
Lesser Honeyguide *Indicator minor*	UNC	T/Ac
Sharpbilled Honeyguide *Prodotiscus regulus*	UNC	T
Slenderbilled Honeyguide *Prodotiscus zambesiae*	UNC	C/M
Bennett's Woodpecker *Campethera bennettii*	C	M/Ac
Goldentailed Woodpecker *Campethera abingoni*	C	M/C
Little Spotted Woodpecker *Campethera cailliautii*	R	M
Cardinal Woodpecker *Dendropicos fuscescens*	C	Ah
Bearded Woodpecker *Thripias namaquus*	C	Ah
Flappet Lark M*irafra rufocinnamomea*	C-UNC	M/G/A
Chestnutbacked Finchlark *Eremopterix leucotis*	C-UNC	G/M
Wiretailed Swallow *Hirundo smithii*	C	R
Mosque Swallow *Hirundo senegalensis*	C-UNC	Ah
Rock Martin *Hirundo fuligula*	C-UNC	Mo
Greyrumped Swallow *Pseudhirundo griseopyga*	C-UNC	G/R
Brownthroated Martin *Riparia paludicola*	C-UNC	R
Whitebreasted Cuckooshrike *Coracina pectoralis*	C	M/Ac/B
Forktailed Drongo *Dicrurus adsimilis*	AB	Ah
African Golden Oriole *Oriolus auratus*	AB	R/Mo
Blackheaded Oriole *Oriolus larvatus*	C	Ah
Pied Crow *Corvus albus*	C-UNC	H
Whitenecked Raven *Corvus albicollis*	UNC	Mo
Southern Black Tit *Parus niger*	C	Ac/M/C/T
Grey Penduline Tit *Anthoscopus caroli*	UNC	C/R/B

Common name/Scientific name	**Relative Abundance**	**Habitat**
Arrowmarked Babbler *Turdoides jardineii*	C	Ah
Blackeyed Bulbul *Pycnonotus barbatus*	AB	Ah
Terrestrial Bulbul *Phyllastrephus terrestris*	AB	R
Yellowbellied Bulbul *Chlorocichla flaviventris*	AB	R/B
Yellowspotted Nicator *Nicator gularis*	UNC	R
Kurrichane Trush *Turdus libonyana*	C	R/C
Groundscraper Thrush *Turdus litsitsirupa*	UNC	G/M/C/B
Capped Wheatear *Oenanthe pileata*	UNC	G/B
Familiar Chat *Cercomela familiaris*	UNC	Ac
Mocking Chat *Thamnolaea cinnamomeiventris*	C-UNC	Mo
Arnot's Chat *Thamnolaea arnoti*	C-UNC	M
Stonechat *Saxicola torquata*	UNC	R
Heuglin's Robin *Cossypha heuglini*	C	R
Natal Robin *Cossypha natalensis*	UNC	R/C/B
Whitebrowed Scrub Robin *Erythropygia leucophrys*	AB	Ah
Bearded Robin *Erythropygia quadrivirgata*	C	R/C
Cape Reed Warbler *Acrocephalus gracilirostris*	C	R
Barthroated Apalis *Apalis thoracica*	C	R/Ac
Yellowbreasted Apalis *Apalis flavida*	UNC	Ac/R/C
Longbilled Crombec *Sylvietta rufescens*	C	Ah
Yellowbellied Eremomela *Eremomela icteropygialis*	C	R/C
Greencapped Eremomela *Eremomela scotops*	C	R/C/Ac
Burntnecked Eremomela *Eremomela usticollis*	UNC	Ac
Grey-backed Bleating Warbler *Camaroptera brachyura*	AB	Ah
Stierling's Barred Warbler *Calamonastes stierlingi*	UNC	G
Fantailed Cisticola *Cisticola juncidis*	C	G/Ac
Rattling Cisticola *Cisticola chiniana*	C	Ac/G
Redfaced Cisticola *Cisticola erythrops*	C	G/Ac
Croaking Cisticola *Cisticola natalensis*	C-UNC	G/Ac
Neddicky *Cisticola fulvicapilla*	C	G/Ac/T
Tawnyflanked Prinia *Prinia subflava*	C	Ah
Spotted Flycatcher *Muscicapa striata*	UNC	M/Ac
Dusky Flycatcher *Muscicapa adusta*	UNC	Ac/M/T
Bluegrey Flycatcher *Muscicapa caerulescens*	UNC	C/T/R
Black Flycatcher *Melaenornis pammelaina*	UNC	M/Ac
Mousecoloured Flycatcher *Melaenornis pallidus*	UNC	Ac/M
Chinspot Batis *Batis molitor*	C	M/Ac/C/T
Paradise Flycatcher *Terpsiphone viridis*	UNC	R/C/M
African Pied Wagtail *Motacilla aguimp*	C	R/A
Longbilled Pipit *Anthus similis*	UNC	G
Tropical Boubou *Laniarius aethiopicus*	C	Ah
Puffback *Dryoscopus cubla*	C	Ac/M/R/T
Brubru *Nilaus afer*	C	M/Ac/C/T
Threestreaked Tchagra *Tchagra australis*	C	Ah
Blackcrowned Tchagra *Tchagra senegala*	C	Ah
Orangebreasted Bush Shrike *Telophorus sulfureopectus*	C	C/G/Ac
Greyheaded Bush Shrike *Malaconotus blanchoti*	C	C/Mo/R
White Helmetshrike *Prionops plumatus*	AB	Ah
Redbilled Helmetshrike *Prionops retzii*	C	Ah
Wattled Starling *Creatophora cinerea*	C-UNC	R/Ac
Plumcoloured Starling *Cinnyricinclus leucogaster*	C-UNC	Mo/Ac/M
Longtailed Starling *Lamprotornis mevesii*	AB	Ah

Common name/Scientific name	**Relative Abundance**	**Habitat**
Greater Blue-eared Starling *Lamprotornis chalybaeus*	UNC	Ac/Cf/C
Redwinged Starling *Onychognathus morio*	UNC	Mo/B
Redbilled Oxpecker *Buphagus erythrorhynchus*	C-UNC	Ah
Coppery Sunbird *Nectarinia cuprea*	UNC	C/Mo/R/Ac
Purplebanded Sunbird *Nectarinia bifasciata*	UNC	Ac/C
Yellowbellied Sunbird *Nectarinia venusta*	C	C/R
Whitebellied Sunbird *Nectarinia talatala*	AB	Ah
Scarletchested Sunbird *Nectarinia senegalensis*	C	Ah
Black Sunbird *Nectarinia amethystina*	UNC	R/Ac
Collared Sunbird *Anthreptes collaris*	UNC	R/Ac/C
Yellow White-eye *Zosterops senegalensis*	C-UNC	R
Whitebrowed Sparrow-weaver *Plocepasser mahali*	AB	M/Ac
House Sparrow *Passer domesticus*	C	H
Greyheaded Sparrow *Passer griseus*	C	Ac/M/Mo
Yellowthroated Sparrow *Petronia superciliaris*	C	M/Mo
Spectacled Weaver *Ploceus ocularis*	C	R
Spottedbacked Weaver *Ploceus cucullatus*	C	R
Masked Weaver *Ploceus velatus*	C	R
Redheaded Weaver *Anaplectes rubriceps*	C	Ah
Redbilled Quelea *Quelea quelea*	AB	Ah
Yellowrumped Widow *Euplectes capensis*	C	R
Whitewinged Widow *Euplectes albonotatus*	C	R
Goldenbacked Pytilia *Pytilia afra*	UNC	R/Ac
Melba Finch *Pytilia melba*	C	Ah
Jameson's Firefinch *Lagonosticta rhodopareia*	C	Ac/G/R
Redbilled Firefinch *Lagonosticta senegala*	C	Ac/G/R
Blue Waxbill *Uraeginthus angolensis*	AB	Ah
Common Waxbill *Estrilda astrild*	C-UNC	R
Cutthroat Finch *Amadina fasciata*	C	Ac/Cf
Bronze Mannikin *Spermestes cucullatus*	UNC	Ac/G/Cf
Redbacked Mannikin *Spermestes bicolor*	UNC	Ac
Pintailed Whydah *Vidua macroura*	C-UNC	R/Cf/G
Paradise Whydah *Vidua regia*	AB	R/Ac/G/Cf
Broadtailed Paradise Whydah *Vidua obtusa*	UNC	Ac/R/G/Cf
Purple Widowfinch *Vidua purpurascens*	UNC	Ac/G
Steelblue Widowfinch *Vidua chalybeata*	C	Ah
Yelloweyed Canary *Serinus mozambicus*	C	Ah
Bully Canary *Serinus sulphuratus*	C-UNC	G/Cf
Blackeared Canary *Serinus mennelli*	C	G/Cf
Goldenbreasted Bunting *Emberiza flaviventris*	C	M/Mo/B
Rock Bunting *Emberiza tahapisi*	C	Mo/M/B

TOTAL NUMBER OF SPECIES = 251

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Annex 4.2: List of Bird Species by Quarter Degree Squares

SPECIES	1530					1531			1532				1533	1632		1633
	C2	C4	D1	D3	D4	C3	D3	D4	C3	D1	D2	D4	C3	A1	B4	A3
Reed Cormorant			x	x		x			x							
African Darter						x			x							
Grey Heron	x		x	x		x			x							
Black-headed Heron			x						x							
Goliath Heron			x													
Purple Heron			x						x							
Great White Egret			x			x			x							
Little Egret			x						x							
Yellow-billed Egret			x						x							
Black Egret			x						x							
Cattle Egret			x	x		x			x	x		x				
Squacco Heron			x			x										
Green-backed Heron			x	x		x										
Little Bittern									x							
Hamerkop	x		x	x		x		x	x				x		x	
Black Stork									x							
Open-billed Stork	x		x			x			x							
Saddle-billed Stork	x		x													
Marabou Stork	x	x	x													
Sacred Ibis			x			x			x							
Hadeda Ibis			x													
African Spoonbill				x					x							
White-faced Duck			x	x		x			x							
Egyptian Goose			x			x			x							
Red-billed Teal			x													
Knob-billed Duck	x								x						x	
Spur-winged Goose									x							
Hooded Vulture		x														
White-backed Vulture		x	x			x									x	

SPECIES	1530					1531			1532				1533	1632		1633
	C2	C4	D1	D3	D4	C3	D3	D4	C3	D1	D2	D4	C3	A1	B4	A3
Lappet-faced Vulture		x														
White-headed Vulture		x														
Black-shouldered Kite			x												x	
Cuckoo Hawk														x		
African Hawk Eagle	x	x	x						x					x		
Martial Eagle					x		x	x	x					x		
Crowned Eagle		x						x								
Brown Snake Eagle	x	x						x	x	x			x	x	x	
Black-breasted Snake Eagle		x		x			x								x	x
Western Banded Snake Eagle	x	x	x	x												
Bateleur		x	x	x		x	x	x	x	x				x	x	x
African Fish Eagle	x		x	x		x		x	x					x		
Augur Buzzard											x					
Lizard Buzzard		x		x					x	x		x			x	x
Little Sparrowhawk				x			x	x				x		x	x	
Black Sparrowhawk															x	
Little Banded Goshawk	x	x		x		x		x	x	x				x	x	
African Goshawk	x	x	x	x		x			x					x	x	x
Gabar Goshawk	x			x		x			x			x		x	x	
Dark Chanting Goshawk	x	x		x					x	x				x		
Gymnogene									x						x	
Peregrine Falcon											x					
Lanner Falcon								x								
Rock Kestrel														x		
Dickinson's Kestrel										x						
Coqui Francolin								x	x	x					x	x
Crested Francolin	x	x	x	x	x	x		x	x	x		x		x	x	x
Shelley's Francolin		x			x											
Natal Francolin	x	x	x	x		x			x	x				x	x	x
Swainson's Francolin	x	x	x	x	x	x			x	x				x	x	
Common Quail	x								x							
Harlequin Quail																

SPECIES	1530					1531			1532				1533	1632		1633
	C2	C4	D1	D3	D4	C3	D3	D4	C3	D1	D2	D4	C3	A1	B4	A3
Helmeted Guineafowl	x	x	x	x		x			x	x			x	x	x	x
Crested Guineafowl		x														
Kurrichane Buttonquail	x	x					x							x		
African Jacana			x			x			x							
Kittlitz's Plover															x	
Three-banded Plover				x											x	
Crowned Plover			x													
Blacksmith Plover			x	x		x			x							
White-crowned Plover			x													
Wattled Plover			x													
Long-toed Plover			x			x										
Water Dikkop	x			x		x										
Temminck's Courser																
Three-banded Courser				x												
Double-banded Sandgrouse	x	x	x	x	x	x			x			x		x	x	x
Feral Pigeon	x			x		x	x	x	x	x					x	
Rock Pigeon							x	x								
Red-eyed Dove	x	x		x		x	x		x	x		x		x	x	x
Mourning Dove	x		x	x	x	x		x	x	x					x	
Cape Turtle Dove	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Laughing Dove	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Namaqua Dove			x	x						x				x		x
Emerald-spotted Dove	x	x	x	x		x	x	x	x	x		x	x	x	x	x
Green Pigeon		x							x	x				x	x	x
Cape Parrot		x		x	x	x	x		x					x	x	
Brown-headed Parrot								x								
Meyer's Parrot	x	x	x	x	x	x		x	x	x		x	x	x	x	x
Lilian's Lovebird	x		x	x		x			x							
Purple-crested Lourie		x		x				x	x							
Grey Lourie	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
Striped Cuckoo				x												
Senegal Coucal									x					x	x	x

SPECIES	1530					1531			1532				1533	1632		1633
	C2	C4	D1	D3	D4	C3	D3	D4	C3	D1	D2	D4	C3	A1	B4	A3
Burchell's Coucal	x		x	x		x			x	x						
Barn Owl	x	x		x				x	x						x	x
Marsh Owl															x	
Scops Owl	x		x	x										x		
White-faced Owl	x															
Pearl-spotted Owl	x	x		x	x	x		x	x	x					x	x
Barred Owl				x				x	x					x		x
Spotted Eagle Owl	x			x				x		x						
Giant Eagle Owl				x	x	x		x	x	x						
Freckled Nightjar	x													x		
Mozambique Nightjar	x			x										x		
Black Swift											x					
Palm Swift	x		x	x	x	x		x	x			x			x	
Mottled Spinetail			x													
Bohm's Spinetail	x	x	x						x						x	
Red-faced Mousebird				x		x		x	x	x		x	x	x	x	x
Pied Kingfisher	x		x	x		x			x							
Giant Kingfisher														x		x
Malachite Kingfisher															x	
Brown-hooded Kingfisher	x			x										x	x	
Grey-hooded Kingfisher															x	
Striped Kingfisher	x	x	x					x	x			x		x	x	
Carmine Bee-eater				x		x										
White-fronted Bee-eater					x	x			x					x		
Little Bee-eater	x	x	x	x		x		x	x	x		x	x	x	x	
Swallow-tailed Bee-eater		x		x				x								x
Lilac-breasted Roller	x	x	x	x	x	x	x	x	x	x		x		x	x	x
Racket-tailed Roller		x		x		x		x						x	x	x
Purple Roller								x				x				
Hoopoe	x	x	x	x				x	x	x					x	x
Red-billed Wood Hoopoe	x	x		x	x	x	x	x	x	x		x				x
Scimitar-billed Wood Hoopoe	x	x		x		x	x	x	x	x		x			x	x

SPECIES	1530					1531			1532				1533	1632		1633
	C2	C4	D1	D3	D4	C3	D3	D4	C3	D1	D2	D4	C3	A1	B4	A3
Trumpeter Hornbill	x	x		x			x	x						x		
Grey Hornbill		x				x		x		x		x		x	x	x
Red-billed Hornbill	x	x	x	x	x	x		x	x	x		x	x	x	x	x
Yellow-billed Hornbill									x			x	x		x	x
Crowned Hornbill	x	x	x	x	x	x	x	x	x						x	
Ground Hornbill	x	x	x	x				x						x	x	
Black-collared Barbet	x			x				x	x							
Yellow-fronted Tinker Barbet								x	x	x		x		x	x	x
Crested Barbet	x	x	x	x	x	x			x			x			x	
Greater Honeyguide		x		x				x	x	x					x	x
Lesser Honeyguide									x							
Sharp-billed Honeyguide					x	x										x
Slender-billed Honeyguide								x								
Bennett's Woodpecker	x		x					x		x		x			x	
Golden-tailed Woodpecker		x				x			x					x	x	
Little Spotted Woodpecker									x							
Cardinal Woodpecker	x	x		x		x		x	x	x		x		x	x	x
Bearded Woodpecker	x	x	x	x	x	x		x	x			x	x	x	x	
Flappet Lark				x	x			x						x	x	
Chestnut-backed Finchlark										x				x	x	
Wire-tailed Swallow		x		x	x	x			x						x	
Mosque Swallow				x		x			x							
Rock Martin							x	x								
Grey-rumped Swallow						x			x						x	
Brown-throated Martin															x	
White-breasted Cuckooshrike							x									
Fork-tailed Drongo	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
African Golden Oriole	x	x	x	x	x	x	x		x						x	
Black-headed Oriole		x													x	x
Pied Crow										x	x	x	x			
White-necked Raven																
Southern Black Tit	x	x		x		x		x	x			x		x	x	x

SPECIES	1530					1531			1532				1533	1632		1633
	C2	C4	D1	D3	D4	C3	D3	D4	C3	D1	D2	D4	C3	A1	B4	A3
Grey Penduline Tit									x					x		
Arrow-marked Babbler		x	x	x	x	x			x	x				x	x	
Black-eyed Bulbul	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Terrestrial Bulbul	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
Yellow-bellied Bulbul	x	x	x	x		x		x	x	x	x	x		x	x	x
Yellow-spotted Nicator								x	x						x	
Kurrichane Thrush	x	x								x		x	x		x	x
Groundscraper Thrush	x	x														
Capped Wheatear																
Familiar Chat								x								
Mocking Chat							x	x								
Arnot's Chat		x	x													
Stonechat								x								
Heuglin's Robin		x		x	x			x		x					x	
Natal Robin															x	
White-browed Scrub Robin		x		x	x	x		x	x	x		x	x	x	x	x
Bearded Robin		x		x											x	
Cape Reed Warbler						x			x							
Bar-throated Apalis	x		x												x	
Yellow-breasted Apalis															x	
Long-billed Crombec		x		x				x	x	x		x	x		x	x
Yellow-bellied Eremomela								x						x		x
Green-capped Eremomela		x		x												
Burnt-necked Eremomela															x	
Grey-backed Bleating Warbler	x	x	x	x	x	x		x	x	x		x	x	x	x	x
Stierling's Barred Warbler															x	
Fan-tailed Cisticola															x	
Rattling Cisticola				x	x	x		x	x	x	x				x	
Red-faced Cisticola			x	x	x	x			x							
Croaking Cisticola															x	
Neddicky		x		x	x	x			x	x	x			x	x	x
Tawny-flanked Prinia	x	x		x	x	x		x	x	x		x	x	x	x	x

SPECIES	1530					1531			1532				1533	1632		1633
	C2	C4	D1	D3	D4	C3	D3	D4	C3	D1	D2	D4	C3	A1	B4	A3
Spotted Flycatcher			x													
Dusky Flycatcher	x															
Blue-grey Flycatcher		x							x						x	
Black Flycatcher	x	x	x													
Mouse-coloured Flycatcher		x			x	x										
Chinspot Batis	x	x	x	x				x	x	x		x		x	x	
Paradise Flycatcher		x				x			x						x	
African Pied Wagtail	x					x			x						x	
Long-billed Pipit										x						
Tropical Boubou	x	x	x	x	x	x		x	x	x	x	x	x	x	x	
Puffback	x	x	x	x	x	x		x	x	x			x	x	x	x
Brubru		x		x		x			x	x					x	x
Three-streaked Tchagra	x	x	x	x				x	x	x		x	x	x	x	x
Black-crowned Tchagra	x	x		x	x	x		x	x	x	x	x	x	x	x	x
Orange-breasted Bush Shrike	x		x	x		x			x					x	x	
Grey-headed Bush Shrike		x		x				x	x			x			x	
White Helmet Shrike	x	x	x	x		x	x	x	x	x		x		x	x	
Red-billed Helmet Shrike	x	x	x	x			x	x	x	x					x	
Wattled Starling				x		x										
Plum-coloured Starling							x	x				x				
Long-tailed Starling	x	x	x	x	x	x		x	x	x		x			x	x
Greater Blue-eared Starling			x							x						
Red-winged Starling								x						x		
Red-billed Oxpecker	x	x	x													
Coppery Sunbird		x						x								
Purple-banded Sunbird						x										
Yellow-bellied Sunbird	x	x		x					x				x		x	
White-bellied Sunbird	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x
Scarlet-chested Sunbird	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Black Sunbird						x										
Collared Sunbird										x						
Yellow White-eye															x	

SPECIES	1530					1531			1532				1533	1632		1633
	C2	C4	D1	D3	D4	C3	D3	D4	C3	D1	D2	D4	C3	A1	B4	A3
White-browed Sparrow-weaver	x	x	x	x	x	x		x	x	x				x	x	x
House Sparrow	x									x						
Grey-headed Sparrow	x			x	x	x		x	x			x	x		x	x
Yellow-throated Sparrow				x	x	x	x	x	x	x		x		x	x	
Spectacled Weaver									x							
Spotted-backed Weaver								x	x	x		x			x	x
Masked Weaver				x												
Red-headed Weaver	x	x	x	x		x		x	x	x		x		x	x	x
Red-billed Quelea	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
Yellow-rumped Widow	x	x													x	
White-winged Widow				x		x		x						x		
Golden-backed Pytilia	x								x							
Melba Finch	x	x		x		x			x	x		x	x	x	x	x
Jameson's Firefinch	x	x		x		x		x	x	x				x	x	x
Red-billed Firefinch	x	x	x	x	x	x		x	x	x	x		x	x	x	
Blue Waxbill	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x
Common Waxbill				x	x	x		x	x						x	x
Cut-throat Finch						x			x	x					x	
Bronze Mannikin				x						x						
Red-backed Mannikin		x							x							
Pin-tailed Whydah	x														x	
Paradise Whydah		x		x			x	x	x	x		x		x	x	x
Broad-tailed Paradise Whydah			x	x												x
Purple Widowfinch									x							
Steel-blue Widowfinch				x				x	x						x	
Yellow-eyed Canary	x	x	x	x			x	x	x	x			x	x		x
Bully Canary				x	x	x			x		x				x	
Black-eared Canary								x	x	x			x	x		
Golden-breasted Bunting	x	x		x	x		x	x	x	x		x	x	x	x	x
Rock Bunting							x	x	x			x		x		x
Total Species	**99**	**105**	**92**	**122**	**52**	**104**	**36**	**98**	**142**	**83**	**18**	**58**	**37**	**85**	**126**	**70**

SPECIES	1530					1531			1532				1533	1632		1633
	C2	C4	D1	D3	D4	C3	D3	D4	C3	D1	D2	D4	C3	A1	B4	A3
No. of samples	2	8	2	6	2	2	1	3	5	2	1	3	1	4	4	2
Total sample time (hours)	3.8	8.0	1.7	11.6	1.4	6.2	3.5	12.1	4.0	4.1	1.1	3.9	1.8	6.8	8.9	2.7
QDS with lakeshore frontage/flowing rivers	y	y	y	y	-	y	-	-	y	-	-	-	-	-	y	-

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Annex 4.3: Notes on Certain Bird Families and Species

Aquatic Birds

The following notes are a supplement to the list produced by Gary Douglas (2000). A few additional species were seen along rivers inland. The lake was close to full and still rising, due to the opened flood gates at Kariba Dam wall, causing most of the lake shore's sandy banks to be covered in water. This made it hard for wading birds to find suitable foraging in shallow waters. Away from the lake most of the drainage systems were already dry when this survey was carried out. The concentration of human settlements and farming practices along the rivers and lake shore is also having a negative impact on many of the waterbird species.

Reed Cormorant: the most common species along the shores of Lake Cabora Bassa. It was the only species seen along inland flowing rivers -Manyame and Msengezi Rivers.

Blackheaded Heron: only one sighting was made, just below Bungue Hill, perched in a dead tree.

Goliath Heron: only one sighting was made, about 8 km east of Bawa Tchuma-Tchato Camp.

Purple Heron: only one sighting was made, at Daque Tchuma-Tchato Camp.

Great White Egret: single birds were common along the lake shore. Two birds were seen at Manyame River (QDS 1530 D3) and one bird was seen standing by a pool of water in the Luia River, next to Chioco Administrative Offices (QDS 1632 B4).

Little Egret: only one sighting was made, next to a fishing camp just below Bungue Hill, Daque area (QDS 1532 C3).

Yellowbilled Egret: fairly common along the lake shore. None was recorded at inland waters.

Black Egret: only one sighting was made, next to a fishing camp just below Bungue Hill (QDS 1532 C3).

Cattle Egret: fairly common, it was most often seen wherever there were domestic animals, particularly cattle, donkeys and goats, and along the lake shore, swamps and rivers.

Greenbacked Heron: seen at all the lake shore sampled sites, suggesting that it is a common species at Cabora Bassa.

Hamerkop: fairly widely distributed throughout the project area (rivers, lake shore and swampy areas), and recorded in eight QDS.

Black Stork: only one sighting of an adult bird, by Nhantuta River (west of Bungue Hill - QDS 1532 C3).

Openbilled Stork: the most common species of the stork group.

Saddlebilled Stork: three separate sightings of single birds (all males) were seen foraging in shallow waters between Kafakudzi and Bawa Tchuma-Tchato Camps.

Marabou Stork: seen twice, both adults - one bird on the ground, 8 km east of Bawa Tchuma-Tchato Camp (QDS 1530 C2), and another one soaring in a thermal over Daque Tchuma-Tchato Camp.

African Spoonbill: 5 were seen just below Bungue Hill, and 2 were foraging at a swampy area next to Manyame River.

Sacred Ibis: seen several times along the lake shores. Many were also seen foraging along the river passing through Chitima Village (QDS 1532 D2).

Whitefaced Duck: flocks of 8-38 birds were sighted along the lake shores. There were no sightings inland. There were plucked feathers of this species by the lake shore at Msengezi River mouth and near Daque Tchuma-Tchato Camp.

Egyptian Goose: a common species along the lake shore. A few flocks were also seen along the Manyame and Luia Rivers.

Spurwinged Goose: one sighting of four birds (3 adults and one immature) next to Bungue Hill.

Redbilled Teal: five sightings of various flock sizes (3 - 9) were recorded along the lake shore.

Knobbilled Duck: six sightings of flock sizes 3-9 along the lake shore, and single sightings along Manyame River (6 birds), Msengezi River ('pair') and Luia River (4 birds).

Longtoed Plover: two pairs were seen at different places along the lake shore. The rising lake water by-passed the reeds into cultivated fields and gardens along the shores. This is where one pair was seen foraging. (These two sightings were exciting because there has been a distribution gap of this species along the Zambezi River).

Crowned Plover: only one sighting of six birds at an overgrazed/degraded area at Chitima Village, by the turn-off to Songo (QDS 1532 D2). It was surprising to see this species only once because there were many ideal habitats for it, especially close to the villages. Neither did we hear its calls during the nights.

Water Dikkop: heard once and seen twice along the lake shore, flushed twice along rivers.

Vultures

Only 5 sightings of this group were made. The scarcity of game and limited livestock through most of the surveyed area could be their major constraint. Only a few people had cattle and donkeys. The most common domestic animals were goats.

Whitebacked Vulture: - 61 birds (including 7 immatures) at two buffalo carcasses (female and calf) that had been killed by lions the previous night (4th June) (QDS - 1530 C4). Over 300 birds, with a few young, that got attracted (together with three other vulture species) to a female elephant that had been shot by poachers in the Kapesa area (QDS 1530 C4) on 4th June, less than 2km from where we were camped. Unfortunately I failed to get close to that carcass in fear of victimization by the armed poachers. The two armed scouts who went to investigate afterwards said they saw more than 300 vultures perched in trees next to the carcass. The other sightings were 3 adult birds soaring over the Mozambique Hunters' Camp, Kafakudzi area (QDS 1530 D1); 4 birds (1 ad. + 3imm) gliding eastwards over Msengezi River mouth (QDS 1531 C3); and a lonely immature seen soaring in a thermal over Luia River by Chioco Village (QDS 1632 B4).

Hooded Vulture: 5 adults seen perched in a tree at the carcasses of buffalos; 13 birds seen flying towards the female elephant carcass.

Whiteheaded Vulture : 4 adults at the buffalo carcasses; and 11 (9ad. + 2juv.) at the elephant carcass, an unusually high number.

Lappetfaced Vulture:three adults and 2 immatures were seen coming down to the elephant carcass.

Raptors

In addition to the four vulture species mentioned above, a total of 23 other diurnal raptor species were recorded. Certainly this was a good variety of birds of prey although, in terms of abundance, there were more sightings of hawks and snake eagles than the other groups. Many sightings of young birds were also made.

Western Banded Snake Eagle: 8 sightings were made to the west of Fundumwe River, and only one to the east (QDS 1532 D1). Almost all the sightings (all single birds) were in riverine forests and were always perched (still-hunting) either in leafless or dead trees.

Bateleur: the most common of the larger raptors. Sixty-three sightings were made in 12 of the 16 QDSs surveyed. The classifications were 28 adult males, 19 adult females and 16 juvenile/immature birds. The proportion of young birds to adults indicates that the population is healthy (Watson 1990). This is one of those species that were recorded in any habitat, but preferred hunting over sparse mopane woodland.

Blackbreasted Snake Eagle: 9 sightings were made - 7 in settled areas (over crop fields and open grazed lands); one adult hovering over a hill range, at an unusually high altitude (over 1500 ft a.g.l.); one adult over mature mopane woodland. Only one young bird, a sub-adult, was seen hunting in QDS1633 A3.

Brown Snake Eagle: 27 sightings were made in 9 QDSs. Half of the sightings were along powerlines - from Songo area going south and eastwards. They were usually seen perched on the powerline towers. We can say that it is a species that has been blessed by such an environmental change (powerlines) caused by man.

African Hawk Eagle: only seven sightings were made in 4 QDSs. This survey was carried out in June - its peak breeding season (Irwin 1981). Five of the sightings were of single birds while the other two were in pairs (i.e. nine birds).

Crowned Eagle: two sightings of individual adult birds were made, both of which were in well wooded areas. The first was on 4th June at Kapesa Camp (QDS 1530 C4) - an individual bird was seen doing territorial displays (pendulum displays and calling continuously at the same time) over our campsite (locstat UTM 02237.8234). The second sighting was at the gap between Gerama and Massapa areas, along Ribeira Banha River, Magoe area (loc. UTM 03815.882500). The impact on most of the major riverine forests due to human settlement was so intense that it could have a strong negative impact on this species in the very near future.

African Fish Eagle: it is doing extremely well especially along the lake shore. Five occupied nests were located within a stretch of approximately 2 km at Daque Tchuma-Tchato Camp (QDS 1532 C3), which is indeed one of the highest densities of the species recorded so far. At the Msengezi River mouth (QDS 1531 C3), 17 young birds (11 first-year juveniles, completely brown with faint white markings on the breast, and 6 immatures, with the head almost white, though with a few brown markings) were attracted to a veld fire, together with two adults, on 8th June. This was indeed an unusual incident. I couldn't tell what they were after over the fire because none of the birds was seen catching or feeding on any insects or rodents that were fleeing from the fire. The birds could be seen flying in and out of the smoke over the fire without any problem. This fire was about a kilometre away from the river. These figures suggest that the species is quite healthy at the lake.

Martial Eagle: seven sightings of individual adult birds were made in 5 QDSs. One of the sightings was right over human settlement (Magoe Village) where the bird flew around for over 30 minutes before it left the village without a catch.

Augur Buzzard: only one sighting, made over the hills to the north of Chitima Village.

Lizard Buzzard: more often heard than seen. Most of the sightings were in mopane woodland and on the verges of harvested crop fields still-hunting.

Blackshouldered Kite: a very common species close to human settlements, particularly in the Chioco area where 21 sightings were made. Most of the sightings were made during the evenings as they hunted over harvested crop fields and grasslands.

Little Sparrowhawk: 9 sightings were made in 6 of the 16 QDSs surveyed. Young birds were recorded on four of these sightings.

Little Banded Goshawk: seen in 10 QDSs. There were 7 sightings of young birds.

Gabar Goshawk: only six sightings were made, 2 of which were in mopane woodland and the rest in acacia vegetation where they were usually in pursuit of Red-billed Queleas.

African Goshawk: most of the sightings were made early in the mornings as they did territorial displays. It was also seen a few times in pursuit of queleas.

Dark Chanting Goshawk: well spread out and a fairly common species.

Black Sparrowhawk: only one sighting was made within a well wooded riverine forest, by Luia River, next to Chioco Village (QDS 1632 B4). This is another species that may end up being affected by the impact of man along riverine forests.

Gymnogene: three young birds (brown) seen around Chioco area (QDS 1632 B4) may suggest that the species is still doing well within its preferred habitats.

Cuckoo Hawk: only one sighting of an adult bird was made in an open and mixed acacia woodland close to a riverine forest. The bird was about 4 km north of Jeke Village (QDS 1632 A1).

Peregrine Falcon: two sightings comprising a pair each were made next to some sandstone cliffs, between Chitima and Songo Villages. Fresh mutes on the cliff-faces next to both sightings indicated that they could be breeding residents. This is the only place with tall cliffs throughout the area surveyed.

Lanner Falcon: recorded at all the hilly areas.

Dickinson's Kestrel: two sightings of individual birds were made. The first one was perched in a Baobab tree, in the middle of a harvested crop field on 13 June, in the Nyakapiriri area (QDS 1532 D1). The other sighting was near Daque Village, also perched in a Baobab tree (QDS 1532 C3).

Rock Kestrel: only one sighting made of a single bird in the Jeke hilly area (QDS 1632 A1). It was seen perched on top of a powerline tower.

Ground Birds

Common Quail: fairly common in the Chioco area (QDS 1632 B4). Individuals and pairs were flushed in grasslands, sparse acacia woodlands, and harvested maize fields.

Coqui Francolin: quite common from the Mkumbura area eastwards. On one occasion (9th June), five family groups (pairs with 3 - 5 chicks) were seen crossing the Mkumbura/Magoe Road.

Crested Francolin: recorded throughout the area and in a variety of vegetation types. In most cases it was heard rather than seen. Many pirs had 2 - 4 young. This species was heard calling throughout the nght.

Swainson's Francolin: second in abundance to the Crested Francolin. Pairs with young were recorded in 9 of the 16 QDSs.

Shelley's Francolin: seen only three times, all of which were to the west of Msengezi River - near Bawa Tchuma-Tchato camp (QDS 1530 C2), Kapesa (QDS 1530 C4) and Fundumwe River (QDS 1530 D4). I think it is rare in this section of its range.

Natal Francolin: a well-distributed species, being recorded in 10 of the 16 QDSs, but only individuals or pairs were seen.

Kurrichane Buttonquail: fairly common in grasslands with sparse vegetation and also in harvested crop fields.

Helmeted Guineafowl: 21 sightings in 11 of the 16 QDSs. All the flocks (sizes 11 - 46) had young. Unfortunately the species is being over-hunted for food. The local people are snaring/trapping guineafowls and francolins heavily throughout the surveyed area. A lot of fibre snares were removed, with many scattered feathers being seen both in the hunting grounds and around villages.

Crested Guineafowl: One sighting of about 30 birds, with 4 young in a thicket of Ziziphus alluvial woodland with tall trees in the Kapesa area (Locstat UTM 02237.8234).

Temminck's Courser: two sightings of a pair each, in the clearing below the powerline between Jeke Village and where the powerline crosses the Daque/Chitima Villages (QDS 1632 A1).

Threebanded Courser: only one sighting was made at a grassland in the Kamponyongo area (QDS 1530 D3).

Sandgrouse and Doves

Only **Double-banded Sandgrouse** were recorded throughout the surveyed area, usually seen or heard calling as they flew to and from water points at dusk. Some were also flushed along the roads.
The doves were well represented throughout, the most common being the **Cape Turtle Dove. Mourning Doves** were very common along the lake shore and all major rivers (Angwa, Manyame, Msengezi and Luia). Very few sightings were made of the **Namaqua Dove**. Both **pigeon** species were seen in good flock sizes.

Parrots and lovebirds

Four parrot species were recorded. The **Meyer's Parrot** and **Lilian's Lovebird** were the most commonly sighted (42 and 36 sightings respectively), with flock sizes of 2 to 8 for the Meyer's, and 3 to 65 for the lovebirds. The **Cape Parrot** was recorded in 7 of the 16 QDSs, with flock sizes of 2 to 6, while only one sighting of two birds was made for the **Brown-headed Parrot** just below Kalomocahue Hill, Magoe (QDS 1531 D4). Bird trapping could be a cause of concern for all these species.

Louries

Both the **Grey** and **Purplecrested Louries** were seen throughout the surveyed area, with the former being more abundant.

Cuckoos and Coucals

Only one sighting of 2 **Striped Cuckoos** was made by the Panyame River, in the Chintopo area (QDS 1530 D3). This was one of the few Intra-African migrants that had overstayed in this region.
Sightings of **Senegal Coucals** were quite common in the Chioco area, along the Luia River, while those for the **Burchell's Coucal** were mainly along the Zambezi River. Thirty-two sightings were made of the Burchell's Coucal, of which 9 of these were young birds

Owls

Eight owl species were recorded in the surveyed area, with the Pearlspotted being the most common. Almost all were heard during the night rather than seen. They were recorded as follows -

Barn Owl: heard 11 times in 8 QDSs

Marsh Owl: flushed in tall grass in one QDS (1632 B4)

Scops Owl: heard 5 times in 5 QDS

White-faced Owl: heard only once in QDS 1530 C2

Pearlspotted Owl: seen twice in acacia woodland, and heard 23 times in 10 QDSs.

Barred Owl: heard 7 times in 5 QDSs.

Spotted Eagle Owl: heard twice and seen 3 times in 5 QDSs.

Giant Eagle Owl: flushed 3 times and heard 6 times in 7 QDSs in thickly wooded water courses.

Nightjars

The nightjars were very quiet during the month of June. Only four times did I hear two of the species: the **Mozambique Nightjar** heard 3 times, and the **Freckled Nightjar** heard only once.

Swifts

Palm Swift: associated with palm trees. It was recorded in 10 QDSs from 26 sightings.

Black Swift: seen flying around (many birds) in front of very tall cliff-faces between Chitima and Songo Villages, along the short-cut tarred road (QDS 1532 D2).

Mottled Spinetail: only one sighting of 5 birds was made in QDS 1530 D1 (Kafakudzi Camp). A couple of Baobab Trees were close by.

Bohm's (Batlike) Spinetail: nine sightings were made in 5 QDSs, all in broad-leafed woodlands. The flock sizes were 5 to 11 birds.

Kingfishers

Three terrestrial and three aquatic species were recorded, the most common being the **Striped** and **the Pied Kingfishers.**

Brownhooded Kingfisher: fairly common, sighted 7 times in 4 QDSs.

Giant Kingfisher: recorded once - a pair along a flowing river in the hilly area near Jeke Village (QDS 1632 A1).

Greyhooded Kingfisher: the most exciting sighting of all, because it is an Intra-African migrant that was supposed to have gone north already. One bird was seen perched in a dead acacia tree within a cultivated maize field near Luia River, next to Chipembere Village (QDS 1632 B4).

Malachite Kingfisher: seen once by the Luia River, next to Chipembere Village.

Bee-eaters

Little Bee-eater: the most common, being recorded in 13 of the 16 QDSs surveyed. All of the sightings of this species were in close proximity to rivers (either flowing or dry) or swampy areas.

Swallowtailed Bee-eater: an uncommon species. Six sightings with flock sizes of 2 to 5 birds made in 4 QDSs were all in jesse thickets.

Carmine Bee-eater: two sightings. The first was in the Chintopo area (QDS 1530 D3) where 17 birds were seen flying west towards the Angwa River. The second was at Msengezi River mouth where over 150 birds had been attracted to a veld fire.

Whitefronted Bee-eater: sighted along or close to dry water courses, with flock sizes of 5 to 6 birds. It was present in 4 QDSs.

Rollers

Lilacbreasted Roller: the most common. It was sighted 46 times in 15 of the 16 QDSs surveyed.

Racket-tailed Roller: eleven sightings were made in 7 QDSs, most of them in mixed mopane woodland.

Purple Roller: only two sightings, both by the road side.

I noticed that in areas where all the dead trees had been collected, many species of hoopoes, hornbills, barbets and woodpeckers were rare, which suggests that the insects found in dead wood are very important to the survival of these birds.

Hoopoes

The **Redbilled** and the **Scimitarbilled Woodhoopoes** were commonly seen in bird parties in any vegetation type, but mostly in mature mopane woodland. The **Hoopoe** was also widespread, being sighted 13 times in 7 QDSs. All of the sightings were in mopane woodland.

Hornbills

The most common and widespread species in this group were the **Redbilled** and the **Crowned Hornbills**. These two species could be found in any habitat. They were recorded in 15 and 10 QDSs respectively. Twenty-two sightings were made of the **Trumpeter Hornbill** in 6 QDSs. No sighting was made of the **Yellowbilled Hornbill** to the west of the 32^{o} 05'E latitude. All the sightings (16 in 5 QDSs) were from Daque River going eastwards. The **Grey Hornbill** was more common from Msengezi River going eastwards. Nineteen sightings, with flock sizes of not less than 5 birds, were made in 8 QDSs to the east of Msengezi River. Once, 69 birds were counted in one flock (0715 hrs) in the Nyakapiriri area (QDS 1532 D1). These birds were foraging in harvested maize and sorghum crop fields next to a dry water course. Generally speaking, the Redbilled and the Crowned Hornbills were more common to the west of the 32^{o} E latitude, while the Grey and Yellowbilled Hornbills were commonly seen to the east of this line.

Ground Hornbill: only heard (and not seen) in seven QDSs. Therefore group compositions and sizes could not be established. I think that this species is still quite safe because much of the forests have not yet been disturbed by humans.

Barbets

All three species were quite widespread. The **Yellowfronted Tinker Barbet** was often in association with bird parties in any vegetation type, while the **Crested Barbet** was commonly recorded in mopane woodland. The **Blackcollared Barbet** was often seen in riverine forests and hilly outcrops.

Woodpeckers

A pair of **Little Spotted Woodpeckers** was seen in a mature and undisturbed mopane woodland, close to Nhantuta River, on June 10th, at 1642 hrs (QDS 1532 C3). Twelve minutes were spent watching this pair as they foraged - first pecking on a dead mopane branch before flying off to another mopane tree. The outstanding identification features were the fairly large and almost rounded heavy spots from the chest down to the belly on both sexes and a dark forehead with white spots on the female. Neither sex had moustachial streaks. The distribution of this species is from just below the confluence of Luia/Mazoe Rivers going southwards. It has never previously been recorded to the west of the 32^{o}30'E latitude line.

All sightings of **Bennett's Woodpeckers** were on the ground.

Honeyguides

The **Greater Honeyguide** was the most common and also widespread, being sighted 23 times in 8 QDSs. The other three were seen only once each.

Larks, Pipits and Wagtails

Both the **Flappet Lark** and the **Chestnutbacked Finchlark** were common in the dry hilly basalt area around Jeke (QDS 1632 A1). The Flappet Lark revealed its presence by its wing-clapping displays, usually during the evenings. The **Longbilled Pipit** was recorded twice between Nyakapiriri and Chitima Villages. They were foraging in some degraded and overgrazed (short grass) areas. The **African Pied Wagtail** was recorded twice, in the Zambezi River (by Bawa Tchhuma-Tchato) and in the Luia River (by Chioco Village).

Swallows and Martins

Mosque Swallow: recorded in three QDSs with flock sizes of 5, 7, and 9 birds. All the sightings were in close proximity to baobab trees.

Wiretailed Swallow: very common along the lake shore and at all the major rivers sampled. It was present in 6 QDSs.

Greyrumped Swallow: recorded in 3 QDSs, all in association with water bodies. It was quite common along the lake shores, Msengezi and Luia Rivers.

Brownthroated Martin: seen once (7 birds) in the Luia River, near Chioco Village (QDS 1632 B4).

Rock Martin: recorded in 2 QDSs, both sightings being along the sandstone ridge immediately to the northern side of Magoe Village.

Various

Forktailed Drongo: very common throughout. At the Msengezi River (QDS 1531 C3) over 200 birds were attracted to a veld fire together with many other species. I had never seen so many drongos at one time in my life !

Whitebreasted Cuckooshrike: seen once just below Calomocahue Mountain in the Magoe area.

Southern Black Tit: very common and widespread, being associated with bird parties in most cases.

Arrowmarked Babbler: very common, with group sizes of 13-27 birds.

Orioles and Corvids

African Golden Oriole: was the more common, especially along the lake shore belt (up to about 5 km inland). They could be seen in any habitat, particularly along evergreen riverine forests.

Blackheaded Oriole: was also widespread. Both species were often recorded in bird parties.

Pied Crow: not as widespread as I had anticipated. It was seen in three areas only - Chitima Village, Songo and Tete - all of which had some brick-walled housing with asbestos or galvanized sheet metal roofs. With the way people are settling along the major roads, it is only a matter of time, I think, before it is present in all the villages.

Whitenecked Raven: seen twice along the sandstone ridge between Chitima and Songo Villages.

Bulbuls

Three sightings of a **Yellowspotted Nicator** were made in some tangled vine by Nhantuta River, near Bungue Hill (QDS 1530 C3), and in some evergreen riverine forest by Luia River, near Chioco Village (QDS 1632 B4). The **Yellowbellied**, **Terrestrial** and **Blackeyed Bulbuls** were present in large numbers throughout.

Thrushes etc.

Kurrichane Thrush: fairly common compared to the **Groundscraper Thrush**. Both birds were seen along dry and wet water courses, and also in any vegetation type inland.

Mocking Chat: only recorded along the sandstone ridge by Magoe Village.

Arnot's Chat: quite common in mature mopane woodland to the west of Panyame River, with group sizes of 2 to 9. Six young were present in 3 (2 young per sighting) of the 14 sightings made. None was seen to the east of the 30°45'E longitude line, although there were quite ideal and undisturbed habitats (mopane woodlands) for them.

Capped Wheatear: only one sighting of 3 birds was made between Nyakapiriri and Chitima villages. They were in some degraded and overgrazed (short grass) areas.

Familiar Chat: two sightings made, 2 birds near Magoe Village and another two near Chitima Village.

Stonechat: seen once by a wet water course in the Magoe area.

Robins

Whitebrowed Scrub Robin: the most common and widespread of the robins. This was followed (in abundance) by the **Heuglin's Robin**. The **Natal** and the **Bearded Robins** were uncommon. The former was recorded only once in some clustered vegetation in grassland in the Chioco area, while the latter was recorded twice in the Kapesa area.

Warblers

Most of the nine species were commonly seen in association with bird parties, with the exception of **the Cape Reed Warbler** which was quite common along the lake shore. **Barthroated Apalis** (fairly common); **Yellowbreasted Apalis** (single sighting of 2 birds that had been attracted to a snake with other birds); **Longbilled Crombec** (common and widespread); **Burntnecked Eremomela** (recorded once in some acacia woodland); **Yellowbellied Eremomela** (3 sightings in 3 QDSs); **Greencapped Eremomela** (2 sightings in 2 QDSs); **Stierling's Barred Warbler** (1 sighting in grassland on the verge of a thicket); and **Bleating Warbler** (grey-backed form) the most common and widespread (63 sightings in 14 QDSs, in any habitat).

Flycatchers

All the four species were scarce (probably because of the time of the year - winter).

Spotted Flycatcher: seen once in acacia woodland;

Dusky Flycatcher: 2 birds seen once in *Combretum* woodland;

Mousecoloured Flycatcher: 2 sightings in 2 QDSs, on the outskirts of jesse thickets;

Bluegrey Flycatcher: seen in three QDSs, widespread but uncommon.

Chinspot Batis: quite common and widespread. Almost all of the sightings were in association with bird parties.

Paradise Flycatcher: widespread especially close to the lake shore.

Shrikes

These were fairly well represented. The **Brubru** and the **Puffback** were quite common, with pairs being often seen in any vegetation type, particularly mopane woodland. On three occasions and within the same area, four birds that resembled Puffbacks (plumage and body size), but with black eyes, buffy breast and white wing coverts, were seen

gleaning by a dry water course to the west side of Bungue Hill. The final assumption was that these were young Puffbacks that were still within their home ground.

The **Tropical Boubou** and the two **tchagras, Threestreaked** and **Blackcrowned**, were very common. The **Orangebreasted Bush Shrike** and the **Greyheaded Bush Shrike** were fairly common and widespread. Family groups of **Redbilled Helmetshrikes** and **White Helmetshrikes** were very common and widespread. Group sizes for the White Helmetshrikes ranged between 6 and 17 birds from 47 sightings, while that of the Redbilled Helmetshrikes were between 4 and 9 birds out of 32 sightings.

Starlings

Longtailed Starling: the most common of all the five species recorded. Wattled Starling: seen five times, all the sightings being to the west of the 31°15' E longitude line.

Redwinged Starling: only two sightings were made - 7 birds seen flying along a river within the Jeke Hills (QDS 1632 A1) and another 5 birds were seen feeding on fruits in a *Commiphora* tree along the sandstone ridge to the north of Magoe Village.

Plumcoloured Starling: very common from Magoe going eastwards.

Greater Blue-eared Starling: very uncommon, even rare. Only two sightings were made - a flock of 11 birds seen foraging around by the lake shore, next to Kafakudzi Hunting Camp (QDS 1530 D1), and the other sighting was of 7 birds feeding on ripe Masawu fruits on the ground in a harvested crop field in the Nyakapiriri area (QDS 1532 D1).

Of the **oxpeckers**, only the **Redbilled** was seen: 5 adults foraging on 11 Hippopotamus by the Zambezi River near Kafakudzi Hunting Camp (QDS 1530 D1), and 8 (unaged) on 60 or more Buffalo in the Kapesa area (QDS 1530 C4).

Sunbirds

Whitebellied Sunbird: sighted 69 times and recorded in all 16 QDSs surveyed, was the most common.

Scarletchested Sunbird: common and widespread. Most of the sightings of these two species were in any habitat where they were foraging on flowering parasitic plants in large trees;

Yellowbellied Sunbird: 17 sightings in 6 QDSs.

Sparrows, Weavers and Widows

House Sparrow: restricted to human settlements - Bawa, Chitima and Tete town;

Redbilled Quelea: abundant throughout the whole surveyed area, with flock sizes of 5 to 200 birds. Most of the sightings were in harvested crop fields, grasslands and along rivers. All the birds sighted were non-breeders. No breeding site was located either;
Spottedbacked Weaver: very common along the lake shore and major rivers where flocks of 8 to 30 birds were seen.

Waxbills and Mannikins

Melba Finch: fairly common and widespread;

Goldenbacked Pytilia: uncommon, 2 sightings of pairs;

Redbilled Firefinch: common and widespread;

Jameson's Firefinch: common and widespread;

Blue Waxbill: abundant and widespread, also seen in association with bird parties on many occasions;

Bronze and Redbacked Mannikins: both uncommon, 2 sightings each only.

Whydahs

Paradise Whydah: commonest, 36 sightings.

Pintailed Whydahs and **Broadtailed Paradise Whydahs** were uncommon - 3 sightings for the former and 2 sightings for the latter.

Purple Widowfinch: One sighting of 12 birds, most of them moulting out of the breeding dress, with the exception of 3 males that were still in full breeding plumage.

Steelblue Widowfinches were very common and widespread throughout the surveyed area.

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Annex 4.4: List of Local (Chikunda) Bird Names

This is a preliminary list based on information provided by Tchuma Tchato scouts during the field work. It is hoped that additional names will be obtained over the next few months.

ENGLISH	CHIKUNDA
Reed Cormorant	Kanyurira
Grey Heron	Nyakojora
Great White Egret	Kakowakakuru
Cattle Egret	Kakowa
Hamerkop	Kondo
Openbill Stork	Kononga
Egyptian Goose	N'ango
Knob-billed Duck	Chipula
Spurwinged Goose	Tsekwe
African Fish Eagle	Kwazi
Coqui Francolin	Kwari
Crested Francolin	Kwari
Shelley's Francolin	Kwari
Natal Francolin	Kwari
Swainson's Francolin	Kwari
Common Quail	Tsenzeresi
Helmeted Guineafowl	Hanga
African Jacana	Kukuruzi
Longtoed Plover	Njonjo
Water Dikkop	Mwaora
Redeyed Dove	Gukuta
Mourning Dove	Svibirakugotsi
Cape Turtle Dove	Svibirakugotsi
Laughing Dove	Wanditeereyi paukuka
Senegal Coucal	Nyakuta
Burchell's Coucal	Nyakuta
Barn Owl	Zizi
Pearl-spotted Owl	Tsvororo
Spotted Eagle Owl	Zizi
Giant Eagle Owl	Zizi
Freckled Nightjar	Dahwa
Mozambique Nightjar	Dahwa
Red-faced Mousebird	Njiwapopo
Swifts	Nyacamembe
Pied Kingfisher	Kanobatahove
Giant Kingfisher	Batahove
Carmine Bee-eater	Gurekure
Lilac-breasted Roller	Geyakeya
Racket-tailed Roller	Geyakeya
Purple Roller	Geyakeya
Trumpeter Hornbill	Banguwangu
Grey Hornbill	Banguwangu
Redbilled Hornbill	Goto wemuromo mutsvuku
Yellowbilled Hornbill	Goto wemuromo weYero
Crowned Hornbill	Goto
Ground Hornbill	Nyan'omba
Greater Honeyguide	Tsoro
Bennett's Woodpecker	Gogodza
Goldentailed Woodpecker	Gogodza
Little Spotted Woodpecker	Gogodza
Cardinal Woodpecker	Kagogodza kadiki
Bearded Woodpecker	Gogodza (is this the same name for all woodpeckers?)

Crested Barbet	Utete
Swallows	Nhakaremwa
Forktailed Drongo	Nhengure
Blackheaded Oriole	Nyachiro
Pied Crow	Gunguo
Southern Black Tit	Suzaarendo
Arrowmarked Babbler	Nyachiocha
Blackeyed Bulbul	Botwe
Tawnyflanked Prinia	Dhimba
African Pied Wagtail	Kambarami Kagombe
Longtailed Starling	Mwanzeya
Oxpeckers	Tsande
Whitebellied Sunbird	Dzonyo (this is for all sunbirds)
Masked Weaver	Shonkho
Blue Waxbill	Sirisiri

Names were provided by Naison (?) and Aniceto Williamo, both of whom were with Tchuma Tchato based at Bawa Camp.

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VOLUME 11
TECHNICAL REPORTS

VEGETATION AND PLANT SURVEY OF LAKE CABORA BASSA SHORELINE

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July 2000

Consultancy Report Prepared For
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SUMMARY

A plant survey of the shoreline of Lake Cabora Bassa in Tete Province, Mozambique was carried out in June 2000. This forms part of a broader ecological zonation study for the Tchumo Tchato project of the Direcção Provincial de Agricultura e Pecuaria (DPAP) of Tete. A further objective was to identify particular species or areas of conservation interest.

The shoreline was divided into six vegetation units: Gorge and cliffs, Mopane woodland, Riparian woodland, Alluvial flats, Sandbanks, and Aquatic vegetation. Mopane woodland was the most widespread. The gorges and cliffs of the eastern end of the lake are perhaps the most species-rich. However, for biodiversity conservation sandbanks and aquatic vegetation are of particular significance for their bird diversity and importance for fish breeding.

A total of 175 plant species were recorded. Most of them are of wide distribution, although one species is of particular interest as it has not been recorded previously from the Middle Zambezi.

Eight potential conservation areas were identified. Of major significance are river mouths which support a larger habitat diversity.

The importance of proper planning and zonation of the lakeshore is discussed. This will keep options for fishing and tourism activities open, and ensure wilderness quality.

Eight recommendations are given including:

- zonation of the lakeshore, including for tourism and wilderness,
- fish survey of the lake,
- protection of river mouths for fish breeding and other biodiversity,
- the implementation of an integrated monitoring programme,
- the importance of exposed sandbanks for bird diversity,
- further biodiversity survey work.

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1. INTRODUCTION

The Biodiversity Foundation for Africa/Zambezi Society (BFA/ZamSoc) partnership was requested by Direcção Provincial de Agricultura e Pecuaria (DPAP), Tete Province, Mozambique, in collaboration with the Ford Foundation, to develop an ecological zonation for the Tchumo Tchato project area on the north and south sides of Lake Cabora Bassa. The purpose of this zonation will be to provide an ecologically sound basis for developmental planning that will maintain maximum biological diversity within the area, and also to provide an indication of potential areas for biodiversity and/or wilderness-based tourism.

In order to produce the required zonation the partnership was requested to:

- Create a broad ecological map of the area
- Identify broad areas of particular biodiversity conservation value
- Identify areas of particular wilderness value
- Make a preliminary identification of specific sites of high biodiversity importance
- Provide recommendations enabling developmental planning agencies to minimize impacts on areas and sites of high biodiversity and/or wilderness value.

The purpose of the present survey was to provide information on shoreline vegetation present around Lake Cabora Bassa and the plant species present. Full Terms of Reference are given as Annex 5.1. This report forms part of a larger study looking at vegetation and birds of the broader study area.

In addition to an annotated checklist of species, an indication and description of the variety of lakeshore vegetation types was required. Conclusions on the diversity, importance and particular sites or species of conservation interest are given, along with some general recommendations on lakeshore development.

2. PREVIOUS WORK

Lake Cabora Bassa is a relatively new lake – formed after the closing of the Cabora Bassa dam at Songo in 1975. Prior to this period there does not appear to have been any plant checklist or recorded plant collections from the area, although there are likely to be numerous specimens in various herbaria.

The only significant work on the plants of the dam area is that by Bond & Roberts (1978) which records the spread of aquatic weeds on the lake, principally *Salvinia* and *Eichhornia*. An account of some possible ecological effects of the dam, including the spread of aquatic weeds, was given by Davies, Hall & Jackson (1975) and Macedo (1974), while Jackson & Davies (1976) highlighted the infestation by aquatic weeds in the first year of lake formation.

Significant plant collections of the Tete area and the area around where the lake would be were made by J.M. de Aguiar Macêdo in 1972. Collections from the broader area were also made in 1972 by A. Pereira and M.F. Correia. Results from these and earlier collections from Tete Province that are housed in herbariums in Coimbra, Lisbon and Maputo were compiled into an annotated species list by A.E. Gonçalves in 1978-1982 (Gonçalves 1978, 1980, 1981, 1982).

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Recently, similar studies to this one have been carried out of the shoreline vegetation of southern Lake Kariba in Zimbabwe (Mhlanga & Mapaure 2000a) and the vegetation of a series of islands in that same lake (Mhlanga & Mapaure 2000b).

The Flora Zambesiaca vegetation map (Wild & Barbosa 1967) shows the Lake Cabora Bassa area as dry early-deciduous savanna woodland (*Colophospermum mopane*) on the south bank, with inclusions of dry deciduous thicket (*Commiphora* and *Combretum*) on some Karoo grits and sandstones. While to the north of the lake margin deciduous dry miombo savanna woodland (*Julbernardia globiflora*) is widespread.

Cunliffe (1999) has presented a preliminary classification of the vegetation of the Tchumo Tchato project area. Fieldwork to check this was being done concurrently with the present lakeshore survey. This report also gives some preliminary indications of four areas of conservation interest which abut the lake, and five possible wilderness areas. Other than this, no publications have been noted on the ecological zonation or biological characterisation of the lake.

3. METHODS

The survey was carried out over 11 days from 7 to 18 June 2000. At this time the lake level was very high (about 1.8 m below spilling), thus the majority of the foreshore was flooded. Total extent of the lake, as determined from the May 1998 satellite image, was around 2484 km^2. A significant proportion of the shoreline vegetation was also leafless or in an advanced state of leaf-fall or drying out.

The survey was done together with a bird survey, which is presented as a separate report (G. Douglas 2000).

The fisheries research vessel "Pende" (12 tons, 30 m long) was used to cruise along the south bank from Caliote harbour below Songo westwards to Zumbo/Bawa. The return trip eastwards went along the north bank. Visits to shore were made using a smaller boat. Places visited were primarily chosen using two standard 1:250,000 scale Landsat false-colour images (scenes 169/071 and 170/071, dated 6 June and 28 May 1998, respectively) so as to cover a representative range of landscape or vegetation units.

At each of the 27 sampling points a list was made of those herbaceous plants floating or on the immediate foreshore. The shoreline vegetation, with particular emphasis on the woody species, was recorded from the foreshore to about 50 m inland. Herbarium specimens were collected as vouchers and to confirm identification in some instances. A GPS reading (Garmin 12, WGS 84 datum) was taken at each point. Bird species present were also recorded at most sites (see Douglas 2000).

4. RESULTS

Results fall into three categories – vegetation units, plant species and sites of interest. These are given separately below.

4.1 Vegetation Units

Twenty seven sites were recorded (see Annex 5.2 for positions and vegetation type). Coupled with additional observations, six broad shoreline vegetation units were identified (see Map 5):

i. Gorge and cliffs
ii. Mopane woodland
iii. Riparian woodland
iv. Alluvial flats
v. Sandbanks
vi. Aquatic vegetation.

These are each briefly described below.

i. *Gorge and Cliffs*

This unit is found from the dam wall upstream for about 35 km in the area known as the "Cabora Bassa gorge". It comprises towering cliffs of ancient gneiss. Some of the steep slopes are cultivated. Burning is widespread and regular.

The vegetation is mostly open woodland, with some denser patches verging on thickets in gullies or pockets of colluvium. Typical trees are *Kirkia acuminata*, *Lannea schweinfurthii*, *Sterculia africana*, *Sterculia quinqueloba*, *Adansonia digitata* (often the only tree remaining in cultivated fields), *Commiphora* species, *Gyrocarpus americanus*, *Pteleopsis* ?*anisoptera*, *Terminalia prunioides*, *Tamarindus indica* and *Ficus* species. Mopane is absent. The grass layer consists of tall species and is not well developed.

Although not comprehensively surveyed, it appears that this unit is not of great biodiversity significance. However, it has enormous scenic value and because of this the gorge is an important tourist attraction, perhaps greater than any other single unit round the lake. Bird diversity is low, but the unit is important for raptors. The wilderness value is greatly reduced by the widespread cultivation and clearance on slopes and by frequent burning.

ii. *Mopane Woodland*

This very variable unit is found around the great majority of the lake's perimeter on various substrates ranging from basalt and rhyolite to various strata of Karoo sandstone, as well as gneiss.

The vegetation is mostly woodland dominated by *Colophospermum mopane* with some areas comprising low open woodland, typically with *Combretum apiculatum*. Other areas are a denser woodland of tall mopane tress (12-16 m high) typically with *Terminalia prunioides*, *Kirkia acuminata* and *Commiphora* species. On some of the Karoo sandstone strata a semi-thicket vegetation is found in the shrub layer comprising typical dry forest (or jesse bush) species such as *Combretum elaeagnoides*, *Karomia tettensis*, *Diospyros quiloensis* and *Grewia* species. The grass layer is normally poorly developed. On the foreshore there is often a narrow band of the grasses *Sorghum bicolor*. Around the sites of old fishing camps low trees of *Ziziphus mauritiana* and *Acacia tortilis* subsp. *spirocarpa* are common.

This unit is not only widespread in the Tchumo Tchato project area but also in Zimbabwe and around Lake Kariba. It has no particular biodiversity significance as regards the plant species present. In a few places Karoo sandstone cliffs come down to the shoreline, particularly in flooded gorges (e.g. 15°44'S, 31°37'E), and are quite spectacular. These scenic spots are potential tourist attractions. Fossil wood was also found in one locality (CV 10; 15°44'S, 31°39'E).

iii. *Riparian Woodland*

This unit is found on alluvium laid down by the Zambezi River at the top end or western extremity of the lake. It represents areas which have not been flooded by the lake, thus strictly-speaking it lies upstream of Lake Cabora Bassa. However, it is included here for the sake of completeness.

The vegetation is a fringing woodland of large tall trees such as *Tamarindus indica*, *Acacia robusta* subsp. *clavigera*, *Cordyla africana*, *Lonchocarpus capassa*, *Diospyros mespiliformis* and *Terminalia sambesiaca*. The dense shrub layer consists of *Lecaniodiscus fraxinifolius*, *Acacia schweinfurthii* and many lianas. *Mimosa pigra* is common on the waterline.

The unit is very limited in its extent, but is much more widespread upstream on the Zambezi. Owing to both its high diversity and geographically-limited extent it is of particular conservation interest. Bird life is also varied and different from that in other lakeshore units. The large size of the trees compared to most other places around the lake makes it attractive to tourists. In Zimbabwe, this unit is the setting for some lodges and camps.

iv. *Alluvial Flats*

This unit, which was only minimally sampled, is found on alluvium deposited by large rivers feeding into Lake Cabora Bassa. As the lower parts of these rivers are now flooded by the lake, the unit is restricted to the largest rivers such as the Musengezi and Panhame.

The vegetation comprises seasonally-flooded grassland with *Sorghum bicolor*, *Panicum coloratum*, *Eragrostis japonica*, *Pennisetum polystachion*, various *Cyperus* species and dense stands of *Phragmites mauritianus*. Herbs such as *Ricinus communis*, *Ageratum conyzoides*, *Pluchea dioscoroides* and *Heliotropum ovalifolium* are common, locally with *Sesbania* species.

As mentioned above, the unit is limited in extent and has no particular plant biodiversity interest, although some interesting bird species are found. The plant species present are generally widespread. A significant portion of the unit is disturbed by humans or livestock, and because of this it has little tourism potential.

v. *Sandbanks*

This unit is restricted to the 10-15 km stretch of the lake downstream from where the Zambezi River enters. It consists of low sandbanks, islands and reedbeds formed from recently deposited sand. Also included is a bank in the middle of the lake (CV 14; 15°43'S, 31°06'E) composed of gravel and rounded pebbles.

The vegetation comprises extensive beds of *Phragmites mauritianus* with scattered *Sesbania sesban* and occasional trees of *Faidherbia albida*, *Ficus capreifolia*, *Ficus sycomorus* and *Ziziphus mauritiana*. Other herbs and grasses include *Panicum coloratum*, *Pluchea dioscoridis*, *Ipomoea rubens*, *Cynodon dactylon*, *Echinochloa pyramidalis*, *Luffa cylindrica* and *Tacazzea apiculata*. The reed beds are fringed with aquatic vegetation such as *Vossia cuspidata*, *Persicaria senegalense*, *Sesbania cinerascens*, *Azolla filiculoides* and *Ludwigia leptocarpa*. The gravel bank supported, in addition, a number of *Tephrosia* and *Indigofera* species.

Although a very restricted unit it has limited interest from a botanical perspective, but is of great significance for bird diversity, particularly those sandbanks which are not vegetated. Many of the banks have been disturbed by humans and hippo grazing is widespread. The banks are also important for crocodiles.

vi. ***Aquatic Vegetation***

This vegetation unit is principally found floating just off the shoreline. It is generally restricted to sheltered east-facing bays where it builds up in the face of prevailing easterly winds. In places, such as the mouth of the Musengezi and Zambezi rivers, large beds are found in more open situations. The type is more extensive at the western end of the lake and along the southern margin.

The vegetation comprises floating or rooted mats of the grass *Vossia cuspidata* fringed by the free-floating fern *Azolla filiculoides*. The submerged species *Utricularia inflexa* and *Ceratophyllum demersum* are common. Other typical species are the emergents *Persicaria senegalense*, *Eclipta prostrata*, occasional rooted plants of *Typha* sp., *Mimosa pigra* and *Sesbania cinerascens*. The rooted aquatic water-lily *Nymphaea* was only noted once. Floating species include *Eichhornia crassipes*, *Pistia stratiotes* and, rarely, *Salvinia molesta*.

Although an interesting community, it is of no great importance from a plant biodiversity perspective, although it is important for the feeding of various waterbirds and, possibly, hippo. The floating mats are obviously mobile and looking at the satellite imagery it appears they can also rapidly expand.

4.2 Plant Species

The list of flowering plants and ferns recorded, totalling 175 species, is given in Table 5.1. The table is arranged alphabetically under family. Nomenclature follows that in current use at the National Herbarium in Harare (SRGH). An indication is given of which of the six habitats each species was found in.

Mopane woodland was the most intensively sampled unit (12 samples), and 84 species were recorded here. The next most species-rich unit was gorges and cliffs with 59 species.

4.3 Sites of Interest

Sites of particular interest for conservation or as tourist attractions were not easy to identify from the lakeshore during the survey. In addition the terrain was rather uniform with extensive areas of most habitats, not remnant patches. As settlement is mostly scattered, the conservation threat is diffuse rather than concentrated.

The following are a selection of possible areas/sites of interest, going from east to west.

(a) The Cabora Bassa gorge area has great scenic attraction, despite extensive cultivation on steep slopes. Such areas, therefore, may not readily be classified as wilderness. The vegetation composition is not of specific interest, but it is felt that a good example of this type, with high tourist appeal, should be managed for conservation.

(b) The gneiss islands in the middle of the eastern basin (around 15°38'S, 32°07'E, alt. 602 m), including Namhanga mountain (which was on the southern bank of the Zambezi pre-dam) are very scenic and relatively little disturbed by human activities. Although not of any particular significance for vegetation conservation, they are typical of a wide area and would benefit from conservation attention.

(c) A large hill on the south bank (15°47'S, 32°10'E, alt. 740 m) north east of Dacque appears (from a distance) to support a range of woodland vegetation types and be of potential interest for conservation. It is allegedly sacred and special permission is required to climb it.

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(d) The basalt peninsular, steep gorges and inlet to the east of Mague (around 15°44'S, 31°37'E) have a moderately high habitat diversity, spectacular gorges and are generally not settled or disturbed, particularly on the peninsular. However, there is a sizeable kapenta fishing camp at the entrance to the main gorge which greatly reduces its wilderness value and tourism potential. This is a good potential conservation area, typical of much of the lakeshore Karoo sandstone and rhyolite exposures. Fossil wood is also present.

(e) An isolated mountain (15°33'S, 31°46'E) on the north bank, set some distance back from the shoreline, looks as if it could be of particular conservation interest. There appears to be forest vegetation in southeast-facing gullies.

(f) The best and most extensive developments of aquatic vegetation were around the mouth of the Rio Musengezi on the south bank (around 15°55'S, 31°07'E) and on the Rio Zambezi (around 15°38'S, 30°40'E). Such areas should be looked at in more detail and a representative range of aquatic habitats conserved here. Such areas are also important for fish breeding and it would be desirable to conserve both fish and vegetation here.

(g) The bay into which the Rio Panhame runs (around 15°39'S, 30°40'E) is characteristic of a number of similar bays with a reasonable habitat and species diversity. Habitats range from those on alluvium to those on Karoo sandstone and floating vegetation. A possible alternative was noted on the north bank (CV16; 15o37'S, 30o38'E), but was not fully investigated.

(h) Some of the sandbanks at the mouth of the Zambezi, just downstream of Zumbo (15°39'S, 13°33'E) should be conserved. They are not species-rich but are the only examples of this habitat on the lake, and are particularly important for waterbirds (see Douglas 2000).

5. DISCUSSION

5.1 Vegetation

The most extensive shoreline vegetation type was mopane woodland (unit ii) of varying types, extending along 1730 km or 76.5% of the total shoreline. This was followed by open woodland on the steep gorges (unit i) extending 530 km (23.5%) along the shoreline. The extent of aquatic and semi-aquatic vegetation was 144 km^2, of which 89 km^2 comprised floating aquatics and 55 km^2 was mostly *Phragmites* vegetation on sandbanks. It is likely the figure for floating aquatics varies substantially through the season, and may well exceed this when lake nutrient levels are higher.

The vegetation types along the lakeshore were not particularly varied, nor were there any of especial plant conservation concern.

5.2 Plant Species A total of 175 species of flowering plants and ferns were recorded. This figure would be much higher except that (a) the foreshore was flooded, (b) grasses and sedges were dying off making identification difficult, and (c) little attempt was made to record herbaceous species in the woodland areas. The list can be considered reasonably comprehensive for aquatic species, species on sandbanks and woody species from mopane woodland, but is much less complete for other units as sampling intensity was low and diversity higher.

Of the species recorded, 84 can be regarded as wetland species, that is they are found in units iii, v and vi. Species that have previously been recorded from Cabora Bassa (according to the list of wetland plants given in Timberlake 2000) are indicated in Table 5.1, as are those species recorded from the lakeshore and islands of Kariba (Mhlanga & Mapaure 2000a, 2000b, communal lands vegetation survey). The previous list of only wetland plants from Cabora Bassa (Timberlake 2000) is particularly scant (eight species), although this number does not include any cited in Gonçalves (1978-82). Hence 150 of the records from the present survey can provisionally be regarded as new records. 108 species are found around both Cabora Bassa and Kariba, but from the literature 67 appear to be only found around Lake Cabora Bassa. It must be noted that the available lists are not comprehensive so these figures may change significantly.

The most species-rich vegetation unit is mopane woodland (unit ii), but this was also the by far the most extensively sampled. The next richest was the gorge and cliffs (unit i),although it was not extensively sampled. If all vegetation units were equally sampled it is likely that the gorges and cliffs would be the richest. Part of the reason is probably the multiplicity of microhabitats present. A number of species recorded from this unit are of relatively restricted distribution. But these are not confined to the shoreline and are widespread further inland.

The riparian unit is particularly species-poor, but this is an artefact of a very low sampling intensity. The alluvium unit has a total of 16 species, the sandbank unit 34 species and the aquatic vegetation unit 25 species.

Perhaps the most restricted vegetation type is the sandbanks with *Phragmites* (unit v), confined to the uppermost end of the lake. Although not unduly special as a type, or in its species composition, it is less common now than before owing to river regulation of the Zambezi. It is of particular significance for bird populations.

5.3 Species of Particular Interest

No particularly unusual or rare plant species were found during the survey. However, it is a characteristic of most wetland and shoreline species that they are widespread (Timberlake 2000). However, one species of particular interest was the legume *Sesbania cinerascens*. Although recorded from the Okavango/Chobe/Kwando system in the Upper Zambezi, and from N Zambia and Angola, it has not previously been recorded from the Middle Zambezi. It was relatively common on sandbanks at the western end of Lake Cabora Bassa.

The presence of the tall labiate weed *Hyptis suaveolens* represents a significant range extension from Chimoio. But this is probably an artefact of poor collecting in recent years.
A plant group of economic interest is aquatic weeds. In the first year after lake formation there was a moderate infestation of *Eichhornia crassipes* (Jackson & Davies 1976, Bond & Roberts 1978). This seems to have died down within a year or two and has been less problematic than similar invasions by *Salvinia molesta* on Lake Kariba. At present the major weed is *Azolla filiculoides*, confined to relatively small areas in sheltered bays. Larger beds of *Vossia cuspidata* and *Persicaria senegalense* are seen in all sheltered bays, but these can not be considered particularly problematic. Other known invasives such as *Eichhornia*, *Salvinia* and *Pistia stratioites* were seen, but in small numbers. A probable reason for the low level of infestation is that the waters are not eutrophic (nutrient enriched) due to high through-flow, although this may change with nutrient-enriched runoff from upstream agricultural activity in Zimbabwe and Zambia.

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5.4 Sites of Particular Interest

It proved difficult to identify obvious areas of particular conservation interest partly as the terrain was rather uniform with extensive areas of most habitats. In addition, developments are scattered and not particularly concentrated in any one area, making the threats diffuse.

5.5 Planning and Development

There would appear to be five principal economic activities that could be, or are being, carried out on Lake Cabora Bassa. They are:

- commercial kapenta fishing
- artesenal inshore fishing
- sport fishing
- recreational tourism
- crocodile farming.

Apart from concerns over the sustainable use of the fisheries resource and crocodile populations, there are concerns over the siting and impact of shoreline facilities, particularly of the kapenta fishing camps. At present there appears to be no zonation of these developments and little enforcement of regulations on their location or impacts. Developments are placed at the site most suitable in the eyes of the developer. This may not be ideal from an integrated development perspective and can preclude future utilization of areas for other purposes. For example, if a kapenta camp is sited in a suitable area for recreational or wilderness tourism this may foreclose these options in the future.

Concerns could also be raised on how sustainable utilization of the renewable resources is. There was no clear indication available of the extent, quantity and quality (e.g. individual fish sizes) of the fisheries, or of the crocodile population. But this aspect was not followed up and such data may exist elsewhere. There is an important need for a fisheries monitoring programme which would (a) determine trends in total catch, (b) determine recruitment status of the various species, and (c) record maximum sizes and trend of sport fishing species.

Fishing nets are often placed across bays and at an intensity which may rapidly reduce stocks. Also, it is not clear if there is any protection or regulation of fishing in the shallow eutrophic bays which are so important for breeding of many species.

6. LIMITATIONS OF STUDY

There were a number of limitations to this study.

(a) The survey was carried out during a high water level period (1.8 m below capacity) thus any foreshore or emergent vegetation which had developed in the preceding dry period was flooded. The lake waters abutted directly onto woodland in most cases.

(b) The terrestrial vegetation types were not well recorded. This was because the focus of the survey was on shoreline and aquatic vegetation, and because the vegetation survey of the whole project area was to cover such units more comprehensively.

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(c) The survey was carried out when many dryland grasses and sedges were dying back, and there were not many herbaceous species.

(d) The survey was necessarily rapid – 11 days to cover over 500 km of shoreline – and it was not possible to travel close inshore for much of this extent. Shore landings were only made at suitable points. The north bank was covered in much less detail than the south bank, principally as the south bank is more diverse and will be the main focus for development.

7. CONCLUSIONS

1. The shoreline vegetation of Lake Cabora Bassa can be usefully categorised into six broad types – gorge vegetation, mopane woodland, riparian woodland, alluvial flats, sandbanks and aquatic vegetation. The most extensive unit was mopane woodland, covering 76% of the shoreline with 24% of gorge vegetation. There was 89 km^2 of floating aquatic vegetation.

2. Two of these vegetation types – riparian woodland (not really present around the lake) and sandbanks – are of interest for conservation owing to their rather limited extent within the Zambezi Basin and their importance for birds. Their interest for plant conservation is less. The other types are of comparatively broad extent and distribution in the region as a whole.

3. Vegetation of the littoral zone, as at Kariba, is probably not that well developed owing to fluctuating water levels, hence unstable environmental conditions.

4. There is little exposed alluvium on the lakeshore, and no mud flats were seen. Both are important habitats for birds. This could be a result of the present high lake levels. Generally the shoreline is steeply sloping and rugged, not gently sloping.

5. The shoreline vegetation of Cabora Bassa appears to be similar, although perhaps less diverse, to that of Lake Kariba. Comparisons are difficult at present as much of the littoral zone is flooded. Of particular note on Cabora Bassa is the lack of extensive grassland of *Panicum repens*, so valuable for large herbivores.

6. The larger river mouths (e.g. Panhame, Metamboa) are the richest areas in terms of habitat diversity. They are also the most important areas for birds and fish.
7. Eight specific areas of interest for conservation for their plant species composition, scenic attributes or as habitat for other organisms were identified.

8. The extent of development on the lakeshore is not high, and is minimal on the north bank. Commercial enterprises with permanent structures are few. Developments are scattered and this can compromise possibilities for other tourist-related activities and for fisheries protection.

8. RECOMMENDATIONS

1. That the lakeshore is zoned for development so that future potential activities are not compromised and possible wilderness and tourism developments are not precluded.

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2. That there is a fish survey of the lake in order to determine (a) the types and abundance of fish species present, (b) the areas and species most suitable for promotion of sport fishing, and (c) that important breeding areas are identified. An institution such as the J.L.B. Smith Institute of Ichthyology in Grahamstown, South Africa, would be able to do this.

3. That major river mouths are given some sort of protection from excessive fishing, such as closed seasons.

4. That an integrated monitoring programme be implemented that looks at fisheries, fish species, birds, aquatic weeds and settlement. The fisheries research vessel "Pende" seems ideal for this task given some refurbishment. Any such monitoring programme should attempt to determine causation of change as well as measuring it.

5. That certain areas or stretches of shoreline be designated as wilderness areas or for tourism. Possible sites are described above.

6. That special attention be given to conservation of exposed sandbanks at the western extremity of the lake, particularly for birds.

7. A representative area (tens of square kilometres in size) of aquatic vegetation, perhaps in a sheltered bay, should be conserved for its plant life and for the important habitat it provides for some waterbirds and for fish.

8. That a more detailed ecological survey be carried out of sandbanks, areas of alluvium and beds of aquatic vegetation, including plant checklists. A similar study should be done of the diverse and species-rich gorge area.

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Table 5.1: List of plant species from lakeshore of Cabora Bassa, Tete Province, Mozambique - June 2000.

Family/species/authority	Habitat						Previous records		Notes
	gorge	mopane	alluv.	riparian	sandbank	aquatic	CB	Kariba	
PTERIDOPHYTA									
Azollaceae									
Azolla filiculoides *Lam.*					**X**	**X**			common
Marsiliaceae									
Marsilia sp. (CB21)						**X**			
Parkeriaceae									
Ceratopteris cornuta *(P.Beauv.) Lepr.*						**X**			v. local
Salviniaceae									
Salvinia molesta *D.S.Mitchell*						**X**	T	T	
MONOCOTYLEDONS									
Araceae									
Pistia stratiotes *L.*						**X**		T	
Arecaceae									
Hyphaene petersiana *Klotzsch*			**X**					T	
Commelinaceae									
Commelina diffusa *Burm.f.*					**X**	**X**			
Cyperaceae									
Cyperus alternifolius *L* subsp. Flabelliformis *Kük*			**X**						
Cyperus digitatus *Roxb.* subsp. Auricicormis *(Spreng.) Kük*			**X**						
Cyperus maculatus *Boeck*						**X**		T	
Pycreus flavescens *(L.) Rchb.*					**X**				
Pycreus mundii *Nees*						**X**			
Poaceae									
Aristida sp. (CB4)		**X**							
Cynodon dactylon *(L.) Pers.*					**X**			T	
Digitaria sp. (CB15)		**X**							
Digitaria sp. (CB4)		**X**							
Echinochloa pyramidalis *(Lam.) Hitchc.& Chase*					**X**	**X**			

Family/species/authority	**Habitat**						**Previous records**		**Notes**
	gorge	mopane	alluv.	riparian	sandbank	aquatic	CB	Kariba	
Enneapogon sp. (CB18)			**X**						
Enteropogon sp. (CB11)		**X**							
Eragrostis aethiopica *Chiov.*	**X**							T	
Eragrostis japonica *(Thunb.) Trin.*			**X**				T		
Eriochloa fatmensis *(Hochst.& Steud) Clayton*						**X**			
Eriochloa meyeriana *(Nees) Pilg*			**X**		**X**				
Hemarthria altissima *(Poir.) Stapf & C.E.Hubb.*			**X**						
Heteropogon contortus *(L.) Roem.& Schult.*		**X**						T	
Melinis repens *(Willd.) Zizka* subsp. repens *(Willd.) Zizka*		**X**						T	
Panicum coloratum *L.*			**X**		**X**				
Panicum maximum *Jacq.*			**X**					T	
Panicum subalbidum *Kunth*			**X**						
Pennisetum polystachion *(L.) Schult.*					**X**				
Pennisetum purpureum *Schumach.*			**X**						
Phragmites mauritianus *Kunth*			**X**		**X**	**X**		T	
Schmidtia pappohoroides *Steud.*	**X**							T	
Sorghum bicolor *(L.) Moench* subsp. arundinaceum *(Desv.) DeWet & Harlan*	**X**	**X**			**X**				common on shoreline
Urochloa mossambicensis *(Hack.) Dandy*		**X**						T	
Urochloa trichopus *(Hochst.) Stapf*	**X**							T	
Vossia cuspidata *(Roxb.) Griff.*					**X**	**X**			dominant aquatic
Pontederiaceae									
Eichhornia crassipes *(Mart.) Solms*						**X**		T	locally common
Typhaceae									
Typha sp.						**X**			
DICOTYLEDONS									
Acanthaceae									
Megalochlamys hamata *(Klotzsch) Vollesen*		**X**						T	
Elytraria acaulis *(L.f.) Lindau*		**X**						T	
Amaranthaceae									

Family/species/authority	Habitat						Previous records		Notes
	gorge	mopane	alluv.	riparian	sandbank	aquatic	CB	Kariba	
Alternanthera pungens *H.B.K.*	**X**								
Anacardiaceae									
Lannea schweinfurthii *(Engl.) Engl.* var. stuhlmannii *(Engl.) Kokwaro*	**X**	**X**						T	
Sclerocarya birrea *(A.Rich.) Hochst.* subsp. caffra *(Sond.) Kokwaro*	**X**	**X**						T	
Annonaceae									
Cleistochlamys kirkii *(Benth.) Oliv.*		**X**							
Apocynaceae									
Diplorhynchus condylocarpon *(Müll.Arg.) Pichon*	**X**							T	
Holarrhena pubescens *(Buch.-Ham.) G.Don*	**X**								
Strophanthus sp.		**X**						T	
Asclepiadaceae									
Calotropis procera *(Aiton) W.T.Aiton*		**X**			**X**			T	
Tacazzea apiculata *Oliv.*	**X**	**X**			**X**			T	
Asteraceae									
Ageratum conyzoides *L.*			**X**					T	
Eclipta prostrata *(L.) L.* (E. alba)						**X**		T	
Nidorella microcephala *Steetz*	**X**								
Pluchea dioscoridis *(L.) DC.*			**X**					T	
Tridax procumbens L.	**X**							T	
Vernonia glabra *(Steez) Vatke*					**X**				
Vernonia steetziana *Oliv.& Hiern*		**X**						T	
Bignoniaceae									
Markhamia zanzibarica *(DC.) K.Schum.*	**X**	**X**						T	
Bombacaceae									
Adansonia digitata *L.*	**X**	**X**					T	T	
Boraginaceae									
Cordia sinensis *Lam.*		**X**							
Heliotropium indicum *L.*		**X**						T	
Heliotropium ovalifolium *Forssk.*	**X**	**X**	**X**		**X**			T	
Burseraceae									
Commiphora africana *(A.Rich.) Engl.*		**X**						T	

Family/species/authority	**Habitat**						**Previous records**		**Notes**
	gorge	mopane	alluv.	riparian	sandbank	aquatic	CB	Kariba	
Commiphora caerulea *B.D.Burtt*		**X**						T	
Commiphora ?karibensis *Wild*		**X**						T	
Commiphora marlothii *Engl*	**X**							T	
Commiphora mollis *(Oliv.) Engl.*		**X**						T	
Capparaceae									
Boscia angustifolia *A.Rich.* var. corymbosa *(Gilg) DeWolf*		**X**						T	
Boscia mossambicensis *Klotzsch*		**X**						T	
Courbonia glauca *(Klotzsch) Gilg.& Bened.*		**X**							
Ceratophyllaceae									
Ceratophyllum demersum *L.*					**X**				locally common
Celastraceae									
Hippocratea buchananii *Loes.*		**X**						T	
Maytenus senegalensis *(Lam.) Exell*		**X**						T	
Clusiaceae									
Garcinia livingstonei *T.Anders.*				**X**			T		
Combretaceae									
Combretum apiculatum *Sond.*	**X**	**X**						T	
Combretum celastroides *C.Lawson*		**X**						T	
Combretum elaeagnoides *Klotzsch*	**X**	**X**						T	
Combretum goetzei *Engl.& Diels*		**X**							
Combretum imberbe *Wawra*	**X**							T	
Combretum mossambicense *(Klotzsch) Engl.*		**X**		**X**				T	
Combretum obovatum *F.Hoffm.*		**X**						T	
Pteleopsis myrtifolia *(C.Lawson) Engl.& Diels*	**X**							T	
Terminalia prunioides *C.Lawson*		**X**						T	
Terminalia sambesiaca *Engl.& Diels*	**X**			**X**					
Terminalia stuhlmannii *Engl.*		**X**						T	
Convolvulaceae									
Ipomoea aquatica *Forssk.*						**X**			
Ipomoea rubens *Choisy*					**X**				
Cucurbitaceae									

Family/species/authority	Habitat						Previous records		Notes
	gorge	mopane	alluv.	riparian	sandbank	aquatic	CB	Kariba	
Luffa cylindrica *(L.) M.Roem.*	**X**				**X**				
Ebenaceae									
Diospyros kirkii *Hiern*		**X**						T	
Diospyros mespiliformis *A.DC.*				**X**				T	
Diospyros quiloensis *(Hiern) F.White*	**X**	**X**						T	
Euphorbiaceae									
Croton menyhartii *Pax*		**X**						T	
Drypetes mossambicensis *Hutch.*		**X**							
Euphorbia cooperi *A.Berger*		**X**							
Euphorbia griseola *Pax*		**X**							
Flueggea virosa *(Willd.) Voigt*	**X**							T	
Jatropha gossypifolia *L.*	**X**								
Phyllanthus reticulatus *Poir.*	**X**				**X**			T	
Pseudolachnostylis maprounefolia *Pax*	**X**							T	
Ricinus communis *L.*			**X**					T	
Tragia breviceps *Pax*	**X**								
Hernandiaceae									
Gyrocarpus americanus *Jacq.*	**X**	**X**							
Lamiaceae									
Hyptis suaveolens *Poit.*	**X**								significant range extension
Leg: Caesalpinioideae									
Afzelia quanzensis *Welw.*	**X**	**X**						T	
Bauhinia petersiana *Bolle* subsp. Petersiana	**X**							T	
Colophospermum mopane *(Benth.) J.Léonard*		**X**		**X**				T	dominant on shore
Senna singueana *(Delile) Lock*	**X**								
Tamarindus indica *L.*	**X**	**X**		**X**				T	
Leg: Mimosoideae									
Acacia ataxacantha *DC.*		**X**						T	
Acacia nigrescens *Oliv.*	**X**	**X**						T	
Acacia nilotica *(L.) Delile*	**X**	**X**						T	
Acacia robusta *Burch.* subsp. clavigera *(E.Mey.) Brenan*		**X**		**X**				T	

Family/species/authority	**Habitat**						**Previous records**		**Notes**
	gorge	mopane	alluv.	riparian	sandbank	aquatic	CB	Kariba	
Acacia schweinfurthii *Brenan & Exell*				**X**				T	
Acacia tortilis *(Forssk.) Hayne* subsp. spirocarpa *(A.Rich.) Brenan*	**X**	**X**					T	T	
Albizia anthelmintica *(A.Rich.) Brogn.*		**X**						T	
Albizia harveyi *Fourn.*		**X**						T	
Dichrostachys cinerea *(L.) Wight & Arn.*		**X**			**X**			T	
Faidherbia albida *(Delile) A.Chev*		**X**			**X**		T	T	
Mimosa pigra *L.*					**X**		T	T	
Leg: Papilionoideae									
Cordyla africana *Lour.*	**X**			**X**				T	
Crotalaria podocarpa *DC.*		**X**			**(X)**			T	
Dalbergia melanoxylon *Guill.& Perr.*	**X**	**X**						T	
Indigofera astragalina *DC.*	**X**				**(X)**			T	
Indigofera tinctoria *L.* var. arcuta *J.B.Gillett*	**X**							T	
Lonchocarpus bussei *Harms*	**X**	**X**						T	
Lonchocarpus capassa *Rolfe*	**X**			**X**				T	
Pterocarpus brenanii *Barbosa & Torre*	**X**							T	
Pterocarpus lucens *Guill.& Perr.* subsp. antunesii *(Taub.) Rojo*	**X**	**X**						T	
Sesbania cinerascens *Baker*					**X**	**X**			new record for Moz. Prev. only Upper Zambezi
Sesbania greenwayi *J.B.Gillett*						**X**			
Sesbania sesban *(L.) Merr.* var. nubica *Chiov*		**X**			**(X)**				
Tephrosia euprepes *Brummitt*	**X**							T	
Tephrosia villosa *(L.) Pers.* ssp. ehrenbergiana *(Schweinf.) Brummitt* var. daviesii *Brummitt*					**(X)**				
Tephrosia uniflora *Pers.*					**(X)**				
Tephrosia sp.		**X**							
Vigna luteola *(Jacq.) Benth.*						**X**		T	
Xeroderris stuhlmannii *(Taub.) Mend.& E.C.Sousa*	**X**							T	
Lentibulariaceae									
Utricularia inflexa *Forssk.*						**X**			locally common
Loganiaceae									

Family/species/authority	**Habitat**						**Previous records**		**Notes**
	gorge	mopane	alluv.	riparian	sandbank	aquatic	CB	Kariba	
Strychnos madagascariensis *Poir.*		**X**						T	
Strychnos potatorum *L.f.*	**X**								
Malvaceae									
Sida acuta *Burm.f.*	**X**							T	
Urena lobata *L.*					**X**				
Moraceae									
Ficus capreifolia *Delile*					**X**				
Ficus sur *Forssk.*	**X**							T	
Ficus sycomorus *L.*					**X**		T	T	
Ficus tettensis *Hutch.*	**X**								
Nymphaeaceae									
Nymphaea nouchali *Burm.f.* var. caerulea *(Savigny) Verdc.*						**X**			
Olacaceae									
Ximenia americana *L.*		**X**						T	
Ximenia caffra *Sond.*		**X**						T	
Oleaceae									
Schrebera trichoclada *Welw.*	**X**							T	
Onagraceae									
Ludwigia leptocarpa *(Nutt.) Hara*						**X**		T	
Ludwigia stolonifera *(Guill.& Perr.) Raven*						**X**		T	
Papaveraceae									
Argemone mexicana *L.*	**X**								
Polygonaceae									
Persicaria attenuata *(R.Br.) Sojak* subsp. africana *K.L.Wilson* (Polygonum pulchrum)					**X**	**X**			
Persicaria senegalensis *(Meisn.) Sojak* (Polygonum senegalense)	**X**					**X**		T	locally abundant
Rhamnaceae									
erchemia discolor *(Klotzsch) Hemsl.*		**X**						T	
Ziziphus mauritiana *Lam.*	**X**	**X**			**X**				
Rubiaceae									
Carphalea pubescens *(Klotzsch) Verdc.*		**X**						T	

Family/species/authority	**Habitat**						**Previous records**		**Notes**
	gorge	mopane	alluv.	riparian	sandbank	aquatic	CB	Kariba	
Gardenia resiniflua *Hiern*		**X**						T	
Karomia tettensis *(Klotzsch) R.Fernandes* (Holmskioldia tettensis)		**X**						T	
Rutaceae									
Zanthoxylum chalybeum *Engl.*		**X**						T	
Sapindaceae									
Haplocoelum foliolosum *(Hiern) Bullock*		**X**							
Lecaniodiscus fraxinifolius *Baker*		**X**		**X**				T	
Sapotaceae									
Manilkara mochisia *(Baker) K.Schum.*		**X**						T	
Simbaroubaceae									
Kirkia acuminata *Oliv.*	**X**	**X**						T	
Sterculiaceae									
Sterculia africana *(Lour.) Fiori*	**X**	**X**						T	
Sterculia quinqueloba *(Garcke) K.Schum.*	**X**								
Waltheria indica *L.*		**X**							
Tiliaceae									
Grewia bicolor *Juss.*		**X**						T	
Grewia flavescens *Juss.* var. flavescens		**X**						T	
Grewia flavescens *Juss.* var. olukondae *(Schinz) Wild*					**X**		T	T	
Grewia monticola *Sond.*		**X**						T	
Grewia lepidopetala *Garke*		**X**							
Turneraceae									
Tricliceras glanduliferum *(Klotzsch) R.Fern.*	**X**							T	
Verbenaceae									
Vitex ferruginea *Schumach.& Thonn.* (V. amboniensis)		**X**							
TOTAL SPECIES	**59**	**84**	**16**	**11**	**34**	**25**	**9**	**108**	

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ANNEX 5.1

TERMS OF REFERENCE

The consultant will:

a) Provide a checklist of plant species and subspecies for the lake and lakeshore area based on personal observation. For each entry on the checklist, an indication should be provided for (i) habitat (in a manner which should relate to the preliminary ecological classification of the area), (ii) relative abundance, and (iii) locstats for particular sites and specimens. Uncertain determinations should be confirmed in a herbarium.

b) Provide brief descriptions of vegetation types for each of the major habitat types identified.

c) Provide a brief written report evaluating the survey findings. This should include a description as to how the data was recorded, a candid statement concerning any limitations of the survey, and a discussion of findings of interest. These findings should include: (i) identification and discussion of any species of special biological interest or conservation concern, (ii) the identification and description of any habitats, areas or sites of particular interest for conservation, (iii) the identification and description of any areas with high potential for wilderness and/or ecotourism developments, (iv) recommendations concerning lakeshore development that would serve to minimize impacts to any sites of high plant biodiversity or conservation value, and to any sites of high wilderness value, and (v) recommendations and prioritizations concerning any necessary and/or desirable further works, including those required to address any limitations of this study.

d) In carrying out the fieldwork, the consultant will be expected to work together with, one or more Mozambican counterparts, as seconded to him by Mr Marcelino Foloma of SPFFB, Tete.

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GPS Waypoints for Cabora Bassa Plant Survey (map datum WGS 84)

Sampl	date	GMT+2	S	E	map unit	notes
CV1	8 June 2000	10:51	15°37.081	32°42.159	1	Caliote harbour
CV2	8 June 2000	11:25	15°35.896	32°40.540	1	cliffs, CB gorge
CV3	8 June 2000	14:16	15°34.536	32°33.287	1	gneiss peninsular
CV4	9 June 2000	07:41	15°38.488	32°30.640	2	near flooded river bed
CV5	9 June 2000	-			6	flooded river floodplain
	9 June 2000	-	15°36.6	32°24.6		Nova Chicoa - kapenta camp
CV6	9 June 2000	12:26	15°39.049	32°25.301	2	flooded bay, fields
CV7	9 June 2000	15:36	15°41.946	32°14.003	2	basalt - mopane
CV8	10 June 2000	09:45	15°48.031	32°08.300	2/6	floating Vossia
CV9	10 June 2000	14:15	15°42.723	31°53.486	2/6	Karoo sandstone
CV10	11 June 2000	06:47	15°44.380	31°38.816	2	mopane - Karoo. Fossil wood
	11 June 2000	-	15°44.468	31°37.172		entry to Karoo gorge; kapenta
CV11	11 June 2000	12:10	15°41.443	31°19.382	2	mopane - Karoo
CV12	11 June 2000	15:51	15°49.159	31°12.902	6	floating Vossia
CV13	12 June 2000	07:15	15°55.304	31°07.844	6	large floating beds
CV14	12 June 2000	12:32	15°43.323	31°05.849	(5)	island in lake
CV15	12 June 2000	16:22	15°39.159	30°46.291	2/6	mopane - pebbly arkose
CV16	13 June 2000	-	15°36.591	30°38.006	6	mouth of river - N bank
CV17	13 June 2000	09:25	15°39.897	30°40.058	6	Panyame mouth
CV18	13 June 2000	10:49	15°40.760	30°39.722	4	boat stuck - Panyame
CV19	13 June 2000	11:30	15°40.988	30°39.691	4	alluvium + Phragmites
CV20	13 June 2000	16:02	15°38.228	30°30.024	5	sandbank in Zambezi
CV21	14 June 2000	06:46	15°38.383	30°32.106	5	sandbank in Zambezi
	15 June 2000	-	15°37.522	30°25.892		Bawa Camp
CV22	16 June 2000	06:34	15°41.541	30°53.343	2	overnight - Karoo
CV23	16 June 2000	08:22	15°39.091	30°54.053	2/6	small inlet - N bank
CV24	17 June 2000	07:01	15°36.624	31°19.874	2/6	mopane + jesse
	17 June 2000	-	15°38	31°36.5		Rio Mucumha bay
CV25	17 June 2000	14:00	15°37.544	31°37.812	2	bay, Rio Muamba
CV26	17 June 2000	15:16	15°37.240	31°37.540	1	Cabora Bassa gorge
	17 June 2000	-	15°37.445	32°02.491		kapenta camp, overnight
	18 June 2000	-	15°37.948	32°06.565		Namhanga mountain
	18 June 2000	-	15°34.533	32°30.819		Cabora Bassa gorge
CV27	18 June 2000	16:09	15°34.527	32°30.871	1	Cabora Bassa gorge
	18 June 2000	-	15°37.156	32°42.293		Caliote harbour

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VOLUME 11
TECHNICAL REPORTS

ORNITHOLOGICAL SURVEY OF LAKE CABORA BASSA

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July 2000

Consultancy Report Prepared For
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SUMMARY

An ornithological survey of Lake Cabora Bassa and the shoreline environment was carried out during June 2000. This forms part of a broader biodiversity evaluation and ecological zonation study for the Tchuma Tchato project of the Direcção Provincial de Agricultura e Pecuaria (DPAP) Tete Province. A further objective was to identify particular species or areas of conservation interest.

Field work was carried out using a fishing vessel supplied by the Mozambiquan authorities. A plant and vegetation survey was undertaken on the same trip, by Mr. Jonathan Timberlake, the results of which are reported separately.

Six ecological zones were recognized for the shoreline: Gorge and cliffs, Mopane woodland, *Phragmites* reedbeds, Alluvial flats, Aquatic vegetation and Riparian woodland. Mopane woodland accounts for the bulk of the shoreline environment, with the other five types being relatively restricted. Birds were recorded from 19 localities, covering four of the zones (other than Aquatic vegetation and Riparian woodland).

A total of 163 species were recorded. Of these, 55 species were classified as aquatic, on the basis of being specifically associated with water. Most migratory species were absent at this time of the year, although individuals of several species were observed which appear to be over-wintering here. A relatively high density of African Fish Eagle (*Haliaaetus vocifer*) were recorded, including a high proportion of juveniles. A number of other species of interest were noted.

The alluvial flats (associated with the mouths of the larger tributaries) and *Phragmites* reedbeds (particularly at the western extremity of the lake) were identified as being key bird areas, particularly for aquatic species. The occurrence of certain species was directly linked to the specific habitat provided by the gorge and cliffs at the eastern end of the lake. The greatest number of species was recorded from the Mopane woodland area (100 species), although none of these were considered to be of particular interest.

The lake was observed to have a relatively steep shoreline. Changes in water level are likely to have a marked impact on certain bird species, such as waders, that are dependent on the shoreline environment. At the time of the survey, the water level in the lake was relatively high (roughly 1.8 m below full supply level), such that mud flats were restricted to small areas principally in association with the major tributaries. Changes in water level are expected to have little impact as regards the occurrence of Aquatic vegetation.

The need to manage the future growth and expansion of both kapenta and inshore fishing operations is emphasized, particularly so as to avoid foreclosing options for the development of wildlife and tourism enterprises.

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1. INTRODUCTION

The Biodiversity Foundation for Africa/Zambezi Society (BFA/ZamSoc) partnership was requested by Direcção Provincial de Agricultura e Pecuaria (DPAP) Tete Province, Mozambique, in collaboration with the Ford Foundation, to develop an ecological zonation for the Tchuma Tchato project area on the north and south sides of Lake Cabora Bassa. The purpose of this zonation is to provide an ecologically sound basis for developmental planning that will maintain maximum biological diversity within the area, and to provide an indication of potential areas for biodiversity conservation and/or wilderness-based tourism.

In order to produce the required zonation the partnership was requested to:

- Create a broad ecological map of the area
- Identify broad areas of particular biodiversity conservation value
- Identify areas of particular wilderness value
- Make a preliminary identification of specific sites of high biodiversity importance
- Provide recommendations enabling developmental planning agencies to minimize impacts on areas and sites of high biodiversity and/or wilderness value.

The purpose of the present survey was to provide information on birds of the lake and lakeshore environs. Outline Terms of Reference are given as Annex 6.I. This report forms part of a larger study looking at vegetation and birds of the broader study area.

2. METHODS

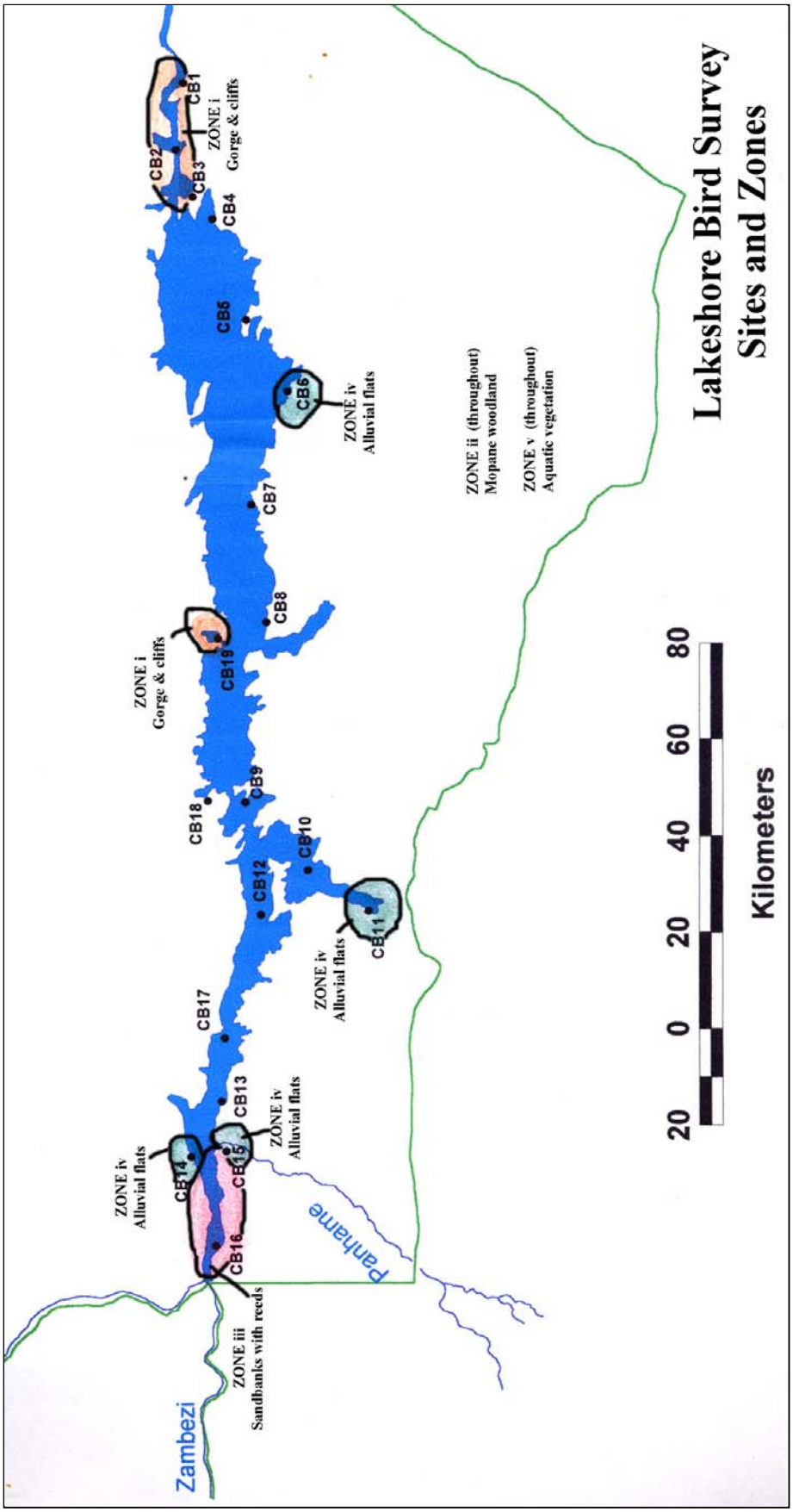
The survey was carried out over 11 days from 7-18 June 2000. The Mozambiquan Fisheries Department provided a fisheries research vessel. This was used to travel the lake from Caliote harbour (below Songo on the south bank), westwards to Zumbo/Bawa, and back again. The outward trip followed the south bank and the return trip was conducted along the north bank. Visits to the shore were made using a smaller boat.

The survey was carried out together with a plant and vegetation survey, which is presented as a separate report (Appendix 5 Timberlake, 2000).

Sampling was carried out so as to provide coverage of the various lakeshore ecological zones. The identification of zones was based on the interpretation of Landsat false colour images, as carried out by Timberlake (2000).

Species lists were recorded from 19 sample sites (Figure 1). Fourteen of these were located on the south bank, where it was discovered that the bulk of the area consisted of Mopane dominated woodland with no real littoral zone. Within the Mopane type, survey sites were repeated at spaced intervals, so as to provide an overall coverage. Only four samples were taken from the north shore, partly because the ecological stratification was interpreted as being very similar to that of the southern shore (and confirmed from the four samples taken). The remaining sample was taken from a shallow flooded island dominated by *Sesbania* sp. This was quite different from most of the islands, whose terrain and vegetation appeared largely the same as for the adjacent shoreline.

Figure 6.1: Cabora Bassa lakeshore bird survey sites and zones



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Each site was given an appellation, photographed, and Global Positions System fixed with a Garmin 12 XL using WGS 84 for the map datum (Table 6.1). The time of recording and weather conditions were also noted, as certain species may be less vocal at midday as well as under adverse and inclement conditions. Weather conditions are indicated using the standard aeronautical procedure of degrees of 8's cover. The rule of 8's depicts percentages of clear sky, with 0/8 being completely clear, 4/8 being half cloud and half clear, and 8/8 being totally overcast.

Species of birds were noted through scanning the immediate environs using Swarovski 8 x 35 SLB binoculars, and complemented by identification of calls by ear, whilst doing short shoreline walks or moving in the small tender boat. All species of birds were recorded, although some of them are not necessarily associated with aquatic or littoral zones, and may have been nearby in mixed bird parties or drinking on the lake edge. The nomenclature used follows Roberts' Birds of Southern Africa – Sixth edition (Maclean, 1993).

In addition to a checklist of species, some indication is provided as regards abundance and distribution. For each of the ecological zones, key species are identified and recommendations provided concerning their future conservation and development.

3. RESULTS

The identification of ecological zones is based on that of Timberlake (2000), who provides details on vegetation types and plant species composition. Samples were taken from four of these, excluding the aquatic vegetation and the riparian woodland (Figure 1 and Map 5). Brief details of these zones are as follows.

Zone i: Gorge and Cliffs
Steep rocky gorge with no littoral zone, and slopes dominated by White Syringa (*Kirkia acuminata)*, Large-leaved Sterculia (*Sterculia quinqueloba*) and Boabab *(Adansonia digitata*). Occurs from the dam wall upstream for 35 km. Sample sites CB1, CB2, CB3 and CB19.

Zone ii: Mopane Woodland
Mature Mopane (*Colophospermum mopane*) woodland with mixed *Combretum*/*Terminalia* and other species. Occupies the central portion and major part of the lakeshore. Sample sites CB4, CB5, CB7, CB8, CB9, CB10, CB13, CB17 and CB18.

Zone iii: Sandbanks with *Phragmites* Reedbeds
Phragmites sp. dominated sandbeds. Found at the entrance to the Rio Panhame and where the Zambezi River fans out into the lake. Sample site CB16.

Zone iv: Alluvial Flats
River mouths with alluvial and sand beds, particularly the Musengezi and Panhame Rivers. Sample sites CB6, CB11, CB14 and CB15.

Zone v: Aquatic Vegetation
Aquatic vegetation bands dominated by *Vossia* grass and other emergent water weeds. Bands are largest in river mouths and leeward sides of bays. No samples.

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Zone vi: Riparian Woodland
Tall riverine trees with a dense shrub understorey. Extreme western end of the lake only. No samples.

Species records are presented in the form of a checklist (Table 6.2). Species specifically associated with water are identified as "aquatic" species. However, it should be noted these aquatic birds range from lacustrine species (eg. Whitewinged Tern, *Chlidonias leucopterus*), to those associated with rank vegetation types occurring in association with water (eg. Orangebreasted Waxbill, *Sporaeginthus subflavus*). Of the total 163 species recorded, 55 fall within this aquatic category.

Species of particular interest, together with interesting observations of aquatic species, are listed in Table 6.3.

4. DISCUSSION

Zone i: Gorge and Cliffs
The largest number of species (100) were recorded from the gorge, although densities are typically low. This zone is of particular importance for some of the larger raptors, in that it is the only portion to provide suitable nesting sites. Most of the hill slopes drop steeply onto the deep waterline. There is substantial cultivation and most tree lines, even though apparently only accessible with great difficulty, had evidence of human activities.

Very little overhanging vegetation occurs, which would normally provide suitable habitat for secretive species that are averse to disturbance, such as the Pel's Fishing Owl and Whitebacked Night Heron. Riparian vegetation would provide suitable alternative habitat for these relatively rare piscivorous species, but is virtually absent from the lakeshore.

Key species identified
A possible pair of Taita Falcons (*Falco fasciinucha*) were noted late one evening on one of the craggy peaks, whilst nearby Black Storks and Black Eagles were sighted. These records attest to the significance of this zone for rarer and habitat specific species.

Recommendations for conservation or development
The propensity for villagers to clear the higher slopes should be discouraged, and fallow areas should be left to regrow.

Zone ii: Mopane Woodland
Dominating the Cabora Bassa shoreline, the Mopane woodland areas are sparsely inhabited by people. However, mopane is a favoured fuel-wood wherever it occurs, and these areas may in the future experience larger settlements of artisanal fisherman who utilize it to dry their catches. Where livestock are present and crops cultivated, the shoreline areas tend to be more denuded and exposed. Such areas provide good feeding opportunities for shoreline bird species.
Of note, in the less disturbed areas, is the narrow band of dried *Sorghum* sp. grass extending from the wood-line onto aquatic vegetation. This appears to form an important, yet restricted, habitat for numerous bird species.

Key species identified
No special species were noted from this portion, and those uncommon birds that were noted could not be directly attributed to the mopane vegetation type. The fact that most of the Cabora Bassa shoreline consists of this ecotype would suggest that species found here should have a broad representation throughout.

Recommendations for conservation or development
Larger herbivores, such as elephant and buffalo, are apparently present in this zone, nearer the western end of the lake on the southern shore. This portion would be the preferred site for any future wildlife based ecotourism and hunting activities. A single safari hunting operation presently comprises the only camp within this region. Future ecotourism initiatives should consider aesthetic impacts, as well as topographical constraints that might limit the construction of airstrips and road networks.

The presence of fossilized trees at CB 8, and the possibility of further paleontological finds, would suggest that this area should be retained for future study, and that any land based human activities are restricted.

Zone iii: Phragmites Reedbeds
These occur on the upper reaches of Cabora Bassa where the shoreline is flatter, in association with the areas where the Zambezi and its major tributaries (Panhame and Musengezi) enter the lake. Sand deposits and mud islands are both dominated by similar reedbeds. In areas of habitation, cultivation often intrudes right up to the water edge, such that the *Phragmites* beds in these areas, if not totally eradicated, are reduced to narrow belts along the water's edge.

Key species identified
The *Phragmites* reedbeds were particularly loaded with large numbers of Little Rush Warblers and Cape Reed Warblers, which might represent a winter influx from the higher and colder surrounding areas. Whitebrowed Coucal appeared to be common throughout this ecotype. In the absence of any dead trees in this section of the lake, it would appear that the reedbeds play an important role in providing roosting sites for certain birds, notably Blackcrowned Night Heron and Carmine Bee-eaters.

Recommendations for conservation or development
The *Phragmites* reedbeds associated with the major river mouths, together with the neighbouring alluvial flats, collectively support a particularly rich diversity of birds. It is suggested that these areas should be considered for conservation purposes and retained as refuge and breeding sanctuaries. Any current activities in these areas should be allocated further afield.

Seasonal burning appears to be common. Although the short-term environmental and habitat loss must be extreme, the rootstock is highly resilient, such that burning will probably only displace local populations until re-growth occurs. Nevertheless this practice should be discouraged.

Zone iv: Alluvial Flats
The Alluvial flats occur in association with shallower portions of the lake. Because of the shallow waters these areas tend to have relatively large euphotic zones, which provide important feeding areas. As a result, these are the richest areas in terms of bird density and biodiversity. Vegetation comprises a mixture of *Phragmites* and mixed aquatic vegetation.

The Rio Panhame had a small lens of alluvial mud within the dominant sandy deposits. This area hosted bird species not encountered elsewhere, and it is assumed that any additional and similarly sized alluvial muddy deposits would be equally important for habitat specific species. It is possible that additional mud flat areas may exist further inland on the Rio Panhame.

Key species identified
These areas had greater densities of Fish Eagles, and with a disproportionate concentration of juveniles, as compared to elsewhere. Breeding colonies of Lesser Gallinules, possibly Squacco Herons, and large flocks of Redwinged Pratincoles and mixed hirundines were also noted (Table 6.3).

Recommendations for conservation or development
The limited size of the alluvial flats, coupled with the high level of use by artisanal fisherman, suggests that this zone is vulnerable. These areas would appear to be of the greatest significance for conservation purposes, and existing villages and artisanal fishing practices should be relocated to neighbouring areas of lesser ecological importance.

Zone v: Aquatic Vegetation
The aquatic frontage onto the littoral zone, throughout the lake, is typically dominated by a thin band of the robust aquatic grass *Vossia cuspidata*. Within this floating ribbon other aquatic weeds such as *Eichhornia crassipes*, *Pistia stratiotes*, *Azolla* sp. and *Salvinia molesta* are also encountered. *Persicaria* sp. was the only other major species that had a purchase hold, but this tended to be in the shallower reaches. The band varies in width from about 5 –100 m. It appears to play an important role in the spatial distribution of aquatic bird species. In particular, the distributions of many of the more skulking and sedentary species appear to be linked to the presence of the floating matt, which provides important sanctuary, breeding refuges and feeding grounds.

Overhead, the sward appears to support a high abundance of small invertebrates, which create an 'aerial plankton' at dawn and dusk. This provides a rich feeding ground for the large flocks of low flying hirundines.

Key species identified
Small flocks of Openbilled Stork were encountered along most of this zone, possibly linked to the availability of the food item *Lanistes ovum*, a large aquatic snail. Blacksmith Plovers were also noted to be utilizing this food source. It appears that *Lanistes* has increased its range from the littoral zone to include the floating *Vossia* beds.

African Jacana and Black Crake were particularly abundant where the *Vossia* existed. Both intra and inter-specific competition would appear to be reasonably reduced within the largesse type environs that the *Vossia* offers.

Recommendations for conservation or development
The *Vossia* is clearly evident on the May/June 1998 Landsat imagery and appears to be well established. Its robust nature and ability to establish on fluctuating lake-levels, combined with similarly adaptable means of propagation and dispersal, should guarantee that this important vegetation band persists.

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5. CONCLUSIONS

Although there were limitations in terms of time and the number of sites surveyed, it was still possible to build up a clear picture of species representation for each of the major lakeshore zones.

At the time of the survey, Lake Cabora Bassa was only 2m down from the full watermark, with evidence that the lake had recently risen substantially. It would appear that it had previously been much lower for many seasons, judging by the larger woody species that were now inundated. This rapid increase will have had a profound effect on the normal littoral zone of the impoundment, and one assumes that it will require some further seasons to both stabilize and allow acclimatisation of the biota here. This is likely to influence the judgements and recommendations made, which are based on current observations.

Judging by the topography of Cabora Bassa, it would appear that there are relatively few areas that could establish any sizable mud flats that would be of importance to wading species. Such habitat was restricted to the exposed alluvial deposits of the larger river mouths, and to the few occurrences of mud lenses within the predominantly sandy profiles. Regardless of the fact that most of the visiting Palaearctic waders were absent from Southern Africa at the time of the survey, the resident Charadrines were found to be limited by the sparse habitat available. The apparent lack of this habitat type is of concern, more so because of the small and isolated nature of the existing few patches. It was noted that a significant number of bird species utilised them. In certain limited areas the terrestrial *Vossia* and *Panicum repens* beds had been reduced to a low sward, apparently through grazing by hippo, and these areas were similarly noted to be important for waders.

The limited occurrence of certain threatened and vulnerable species, such as the African Skimmer (*Rynchops flavirostris* - only two groups seen) and the Rock Pratincole (*Glareola nuchalis* - expected, but not encountered), may be attributed to the lack of suitable habitat, including the loss of habitat both through flooding and disturbance by humans. For the African Skimmer it is important that any unvegetated sandbars should be protected.

The abundant African Fish Eagle (*Haliaeetus vocifer*) population (total of 94 counted) was observed to include a good cross-sectional age spread. The larger river mouths support particularly high densities, with five adult pairs and three juveniles being recorded from CB11 (Musengezi basin). The African Fish Eagle is known to be an important indicator species of bio-accumulant toxins. The high abundance of eagles here suggests that this is not a problem in Lake Cabora Bassa (as was the case in Lake Kariba some years ago).

With fluctuations in water level, the extent of the *Vossia* beds is not expected to change dramatically, but the degree of exposure of the shoreline will do so, and this can be expected to result in marked changes in terms of bird species composition. This needs to be considered in the long term planning for any development initiatives, but may not alter the recommendations expressed.

A major observation is that any future wildlife based tourism would have to take cognisance of the lakeshore and kapenta fishing operations, whose distributions although patchy, have burgeoned in areas that are better suited for wildlife-based initiatives and conservation retention.

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Priority should be given to identifying these operations and, where necessary, relocating them to suitable sites.

6. REFERENCES

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TABLES

Table 6.1: Details of Sample Points for Cabora Bassa Bird Survey

SITE	LOCSTAT		DATE	WEATHER	SURVEY TIME	TOTAL TIME
CB1	S 15 37. 101	E 032 42.246	08/06	4/8	0700 - 1045	3 hrs 45 mins
CB2	S 15 34. 583	E 032 33.229	08/06	0/8	1345 - 1400	15 min
CB3	S 15 37. 978	E 032 30.569	08-09/06	0/8	1630 - 0900	3 hrs
CB4	S15 38.990	E 032 25.258	09/06	5/8	1215 - 1300	45 min
CB5	S 15 41. 888	E 032 14.144	09/06	2/8	1530 - 1600	30 min
CB6	S 15 46.758	E 032 07.804	09/06	1/8	0715 - 0830	1 hr 15 min
CB7	S 15 42.389	E 031 53.292	10/06	0/8	1400 -1500	1 hr
CB8	S 15 44.304	E 031 39.056	10/06	5/8	0645 - 0800	1 hr 15 min
CB9	S 15 41.443	E 031 19.362	11/06	2/8	1200 - 1230	30 min
CB10	S 15 49.342	E 031 12.530	11/06	6/8	1545 - 1630	45 min
CB11	S 15 55.539	E 031 07.626	12/06	3/8	0630 - 0800	1 hr 30 min
CB12	S 15 43.370	E 031 05.764	12/06	1/8	1200 - 1215	15 min
CB13	S 15 39.192	E 030 46.217	12/06	2/8	1600 - 1700	1 hr
CB14	S 15 36.591	E 030 38.006	13/06	7/8	0730 - 0830	1 hr
CB15	S 15 40.756	E 030 39.789	13/06	6/8	0945 - 1130	1 hr 45 min
CB16	S 15 38.317	E 030 30.056	13/06	1/8	1545 - 1630	45 min
CB17	S 15 39.094	E 030 54.065	16/06	2/8	0800 - 0900	1 hr
CB18	S 15 36.682	E 031 19.803	17/06	7/8	0700 - 0730	30 min
CB19	S 15 37.088	E 031 37.499	17/06	0/8	1515 - 1545	30 min

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Table 6.2: List of birds from Cabora Bassa Lakeshore, June 2000

SPECIES	NO. OF OCCURRENCES (SAMPLES)						COMMENTS
	Aquatic species	Zone i Gorge	Zone ii Mopane	Zone iii Reeds	Zone iv All. Flats	Total	
Reed Comorant *Phalacrocorax africanus*	a	2	6	1	4	13	See Table 6.3
Darter *Anhinga melanogaster*	a	1	3		1	5	See Table 6.3
Grey Heron *Ardea cinerea*	a	1	2	1	1	5	Small numbers
Blackheaded Heron *Ardea melanocephala*					1	1	
Goliath Heron *Ardea goliath*	a		4	1	3	8	Larger densities in *Vossia* sp. beds in rivermouths than in *Phragmites* sp. lined rivermouths
Purple Heron *Ardea purpurea*	a	1	3	1	1	6	Reasonable numbers, largest densities in *Phragmites* sp. mixed *Vossia* sp. areas
Great White Egret *Casmerodius alba*	a	2	5	1	2	10	Widely dispersed throughout *Vossia* sp. beds
Little Egret *Egretta garzetta*	a		1			1	Uncommon
Black Egret *Egretta ardesiaca*	a		1			1	Uncommon, possible winter refuge
Cattle Egret *Bubulcus ibis*	(a)		2		2	4	Uncommon, grassland bird
Squacco Heron *Ardeola ralloides*	a	1	4		4	9	See Table 6.3
Greenbacked Heron *Butorides striatus*	a	1	1		2	4	Commoner in areas with drowned vegetation in water
Blackcrowned Night Heron *Nycticorax nycticorax*	a			1	1	2	Only found in *Phragmites* sp., not much riparian vegetation available for normal refuge. Small groups noted
Little Bittern *Ixyobrychus minutus*	a		1		1	2	In *Vossia* sp., and assumed subspecies *I. m. payesii*

SPECIES	NO. OF OCCURRENCES (SAMPLES)						COMMENTS
	Aquatic species	Zone i Gorge	Zone ii Mopane	Zone iii Reeds	Zone iv All. Flats	Total	
Hamerkop *Scopus umbretta*	a	2				2	Uncommon, no suitable littoral feeding zone for its dabbling requirements
Black Stork *Ciconia nigra*	a	1				1	Possibly breeding in gorge as pair seen mobbing Black Eagle
Openbilled Stork *Anastomus lamelligerus*	a	1	5	1	3	10	See Table 6.3
Sacred Ibis *Threskiornis aethiopicus*	a				2	2	Uncommon
Glossy Ibis *Plegadius falcinellus*	a		1	1	2	4	Sporadic sightings as unsuitable feeding habitat. Group of 21 found in river mouth
Whitefaced Duck *Dendrocygna viduata*	a	2	4	1	2	9	Small flocks. Most areas not ideal for wading ducks
Egyptian Goose *Alopochen aegyptiacus*	a	2	2	1	1	6	Small numbers
Knobbilled Duck *Sarkidiornis melanotos*	a		1		3	4	Small numbers
Spurwinged Goose *Plectropterus gambensis*	a	1	1		1	3	Small numbers
Blackshouldered Kite *Elanus caeruleus*				1	1	2	
Black Eagle *Aquila verreauxii*		2				2	Gorge crags providing suitable eyries
African Hawk Eagle *Hieraaetus spilogaster*		1				1	
Martial Eagle *Polemaetus bellicosus*		3	1		1	5	Evenly distributed, assumed good recruitment as 2 being juveniles
Brown Snake Eagle *Circaetus cinereus*		2				2	
Bateleur *Terathopius ecaudatus*		1	2		2	5	
Augur buzzard *Buteo augur*		1				1	Gorge crags providing suitable habitat
African Fish Eagle *Haliaeetus vocifer*	a	3	7		4	14	See Table 6.3
Little Banded Goshawk *Accipiter badius*		1	1		1	3	
Gymnogene *Polyboroides typus*		1				1	

SPECIES	NO. OF OCCURRENCES (SAMPLES)						COMMENTS
	Aquatic species	Zone i Gorge	Zone ii Mopane	Zone iii Reeds	Zone iv All. Flats	Total	
Dickinson's Kestrel *Falco dickinsoni*		1				1	
Crested Francolin *Francolinus sephaena*		2	1			3	
Natal Francolin *Francolinus natalensis*		2	3		1	6	
Swainson's Francolin *Francolinus swainsonii*					1	1	
Helmeted Guineafowl *Numida meleagris*		1	2			3	
Black Crake *Amaurornis flavirostris*	a	1	6	1	2	10	See Table 6.3
African Skimmer *Rynchops flavirostris*	a			1	1	2	See Table 3
Lesser Gallinule *Porphyrula alleni*	a		1	1	1	3	See Table 6.3
African Jacana *Actophilornis africanus*	a	1	4		3	8	See Table 6.3
Painted Snipe *Rostratula benghalensis*	a		1		1	2	Unsuitable habitat. Only encountered in few marshy areas
Whitefronted Plover *Charadrius marginatus*	a			1		1	Unsuitable habitat. 14 concentrated on small exposed sandbar with African Skimmers and Greyheaded Gulls
Threebanded Plover *Charadrius tricollaris*	a		2	1	1	4	Unsuitable habitat. Sparsely distributed
Blacksmith Plover *Vanellus armatus*	a	1	4	1		6	Sparsely distributed along narrow belt of exposed shoreline. Larger numbers in river mouths
Whitecrowned Plover *Vanellus albiceps*	a	1	3	1	1	6	Encountered on sandy/gravelly open areas. Larger numbers in *Phragmites* sp. riverine areas
Wattled Plover *Vanellus senegallus*	a			1		1	Uncommon. No suitable habitat, and intra-specific competition from congeners

SPECIES	NO. OF OCCURRENCES (SAMPLES)						COMMENTS
	Aquatic species	Zone i Gorge	Zone ii Mopane	Zone iii Reeds	Zone iv All. Flats	Total	
Longtoed Plover *Vanellus crassirostris*	a			1		1	Uncommon, only 2 pairs encountered. Not seen on *Vossia* beds
Blackwinged Stilt *Himantopus himantopus*	a				1	1	Uncommon, limited suitable feeding grounds
Water Dikkop *Burhinus vermiculatus*	a		1		1	2	Probably common as suitable habitat with broken shorelines. Crepuscular habits denied records
Redwinged Pratincole *Glareola pratincola*	a				2	2	See Table 6.3
Whitewinged Tern *Chlidonias leucopterus*	a					0	None seen at samples sites, but seen elsewhere on lake. See Table 6.3
Greyheaded Gull *Larus cirrocephalus*	a		4	1	3	8	Sparsely but evenly distributed. No evidence of reliance on Kapenta drying operations as in Kariba
Redeyed Dove *Streptopelia semitorquata*		2		1	4	7	
African Mourning Dove *Streptopelia decipiens*		2	3	1	3	9	Large numbers noted, often in flooded vegetation, particularly *Faidherbia albida*
Cape Turtle Dove *Streptopelia capicola*		3	7	1		11	
Laughing Dove *Streptopelia senegalensis*		2	2		2	6	
Namaqua Dove *Oena capensis*			1			1	
Greenspotted Dove *Turtur chalcospilos*		2	3		1	6	
Green Pigeon *Treron calva*			1			1	
Meyer's Parrot *Poicephalus meyeri*		3				3	

SPECIES	NO. OF OCCURRENCES (SAMPLES)						COMMENTS
	Aquatic species	Zone i Gorge	Zone ii Mopane	Zone iii Reeds	Zone iv All. Flats	Total	
Lilian's Lovebird *Agapornis lilianae*			2	1	2	5	Predominantly in mopane, but also seen in *Phragmites* beds, possibly using reeds to access water below
Grey Lourie *Corythaixoides concolor*		2	3	1	1	7	
Burchell's Coucal *Centropus burchellii*	a		2		1	3	Largely distributed in mopane zone
Whitebrowed Coucal *Centropus superciliosus*	a		1	1	2	4	See Table 6.3
Scops Owl *Otus senegalensis*			1			1	
Pearlspotted Owl *Glaucidium perlatum*		1	3			4	
Giant Eagle Owl *Bubo lacteus*		1				1	
Little Swift *Apus affinis*		1				1	
Palm Swift *Cypsiurus parvus*		1	1		2	4	Resident and assumed associated with presence of *Hyphaene* sp.. Largest numbers of *Hyphaene* at CB15
Redfaced Mousebird *Urocolius indicus*		2				2	
Pied Kingfisher *Ceryle rudis*	a	3	4		4	11	Common throughout lake
Giant Kingfisher *Ceryle maxima*	a	2			2	4	Appears to be limited to areas with suitable overhanging vegetation in gorge and river mouths
Malachite Kingfisher *Alcedo cristata*	a	1	3		3	7	Largest numbers in shallower flooded areas with emergent vegetation and quiet backwaters
Brownhooded Kingfisher *Halcyon albiventris*			2	1		3	
Greyhooded Kingfisher *Halcyon leucocephala*		1				1	Unusual over-wintering record
Striped Kingfisher *Halcyon chelicuti*			1			1	

SPECIES	NO. OF OCCURRENCES (SAMPLES)						COMMENTS
	Aquatic species	Zone i Gorge	Zone ii Mopane	Zone iii Reeds	Zone iv All. Flats	Total	
Little Bee-eater *Merops pusillus*		2	5	1	4	12	
Whitefronted Bee-eater *Merops bullockoides*	a					0	None seen at surveyed sites, but few pairs on upper reaches Zambezi. Unsuitable habitat as no mudbanks
Carmine Bee-eater *Merops nubicoides*	a			1	1	2	
Lilacbreasted Roller *Coracias caudata*		2	4	1	4	11	
Redbilled Wood Hoopoe *Phoeniculus purpureus*		3				3	
Scimitarbilled Wood Hoopoe *Rhinopomastus cyanomelas*			1			1	
Grey Hornbill *Tockus nasutus*		2	2			4	
Redbilled Hornbill *Tockus erythrorhynchus*		2	6		1	9	
Crowned Hornbill *Tockus alboterminatus*		2	2		1	5	
Blackcollared Barbet *Lybius torquatus*		1				1	
Yellowfronted Tinker Barbet *Pogoniulus chrysoconus*		2				2	
Crested Barbet *Trachyphonus vaillantii*		2	1		1	4	
Lesser Honeyguide *Indicator minor*				1		1	
Goldentailed Woodpecker *Campethera abingoni*		1	1			2	
Cardinal Woodpecker *Dendropicos fuscescens*			1			1	
Grassveld Pipit *Anthus cinnamomeus*					1	1	Localised and restricted to few open areas and sandbanks of river mouths
Whitethroated Swallow *Hirundo albigularis*	a			1	4	5	See Table 6.3
Wiretailed Swallow *Hirundo smithii*	a	2	3		3	8	Pairs commonly encountered. Most in rivermouths
Lesser Striped Swallow *Hirundo abyssinica*					1	1	

SPECIES	NO. OF OCCURRENCES (SAMPLES)						COMMENTS
	Aquatic species	Zone i Gorge	Zone ii Mopane	Zone iii Reeds	Zone iv All. Flats	Total	
Greyrumped Swallow *Pseudhirundo griseopyga*			1		2	3	Distributed where few mud banks found. Small flocks possibly pre-breeding congregations
Rock Martin *Hirundo fuligula*		1				1	Uncommon, restricted to suitable rock faces in gorge area
Brownthroated Martin *Riparia paludicola*				1	3	4	Restricted to rivermouths and riverine. Few suitable banks for breeding requirements
Banded Martin *Riparia cincta*			1		1	2	See Table 6.3
Whitebreasted Cuckooshrike *Coracina pectoralis*			1			1	
Forktailed Drongo *Dicrurus adsimilis*		2	6		2	10	
European Golden Oriole *Oriolus oriolus*		1				1	Palaeartic migrant, unusual overwintering record
Blackheaded Oriole *Oriolus larvatus*		3	1			4	
Pied Crow *Corvus albus*		1				1	
Southern Black Tit *Parus niger*		2				2	
Arrowmarked Babbler *Turdoides jardineii*		2	2	1		5	
Blackeyed Bulbul *Pycnonotus barbatus*		4	4	1	1	10	
Terrestrial Bulbul *Phyllastrephus terrestris*		1				1	
Sombre Bulbul *Andropadus importunus*				1		1	Associated with tangled undergrowth of riverine
Yellowbellied Bulbul *Chlorocichla flaviventris*		2	2	1	1	6	
Yellowspotted Nicator *Nicator gularis*		1				1	
Familiar Chat *Cercomela familaris*		1				1	
Mocking Chat *Thamnolaea cinnamomeiventris*			1			1	
Heuglin's Robin *Cossypha heuglini*				1		1	

SPECIES	NO. OF OCCURRENCES (SAMPLES)						COMMENTS
	Aquatic species	Zone i Gorge	Zone ii Mopane	Zone iii Reeds	Zone iv All. Flats	Total	
Whitebrowed Robin *Erythropygia leucophrys*			1		1	2	
Cape Reed Warbler *Acrocephalus gracilirostris*	a	1	5	1	4	11	See Table 6.3
Afrcan Sedge Warbler *Bradypterus baboecala*	a		2	1		3	Restricted to rivermouths with *Phragmites*. Few noted extending into dense *Vossia* when *Phragmites* nearby
Yellowbreasted Apalis *Apalis flavida*					1	1	
Longbilled Crombec *Sylvietta rufescens*		1	2		1	4	
Burntnecked Eremomela *Eremomela usticollis*		1				1	
Greybacked Camaroptera *Camaroptera brevicaudata*		1	2			3	
Fantailed Cisticola *Cisticola juncidis*	(a)		1		2	3	Not suitable habitat. Restricted to lower grass sward on larger sandbanks
Rattling Cisticola *Cisticola chiniana*		2				2	
Redfaced Cisticola *Cisticola erythrops*	a	1	1	1	1	4	In rank grass and vegetation in river mouths
Tawnyflanked Prinia *Prinia subflava*		2	5	1	2	10	Common on ecotonal band of tree-lines onto water-line
Paradise Flycatcher *Terpsiphone viridis*					1	1	Over-wintering record. Possibly race *T. v. granti*.
Chinspot Batis *Batis molitor*			1		1	2	
African Pied Wagtail *Motacilla aguimp*	a	2	5	1	3	11	Common throughout
Tropical Boubou *Laniarius aethiopicus*		1	3	1	2	7	
Puffback *Dryoscopus cubla*		3	3		1	7	
Threestreaked Tchagra *Tchagra australis*		2	1		1	4	
Orangebreasted Bush Shrike *Telophorus sulfureopectus*		2			1	3	
White Helmetshrike *Prionops plumatus*		3	4			7	
Redbilled Helmetshrike *Prionops retzii*		3				3	

SPECIES	NO. OF OCCURRENCES (SAMPLES)						COMMENTS
	Aquatic species	Zone i Gorge	Zone ii Mopane	Zone iii Reeds	Zone iv All. Flats	Total	
Wattled Starling *Creatophora cinerea*			1		3	4	
Longtailed Starling *Lamprotornis mevesii*		2	7	1	3	13	
Greater Blue-eared Starling *Lamprotornis chalybaeus*		1		1	1	3	Small flocks encountered
Redwinged Starling *Onychognathus morio*		2				2	
Purplebanded Sunbird *Nectarinia bifasciata*				1		1	Associated with flowering *Calotropsis procera* and *Sesbania* sp. around river verges
Whitebellied Sunbird *Nectarinia talatala*				1	1	2	
Scarletchested Sunbird *Nectarinia senegalensis*					1	1	
House Sparrow *Passer domesticus*		1				1	
Greyheaded Sparrow *Passer diffusus*		2				2	
Whitebrowed Sparrowweaver *Plocepasser mahali*		2	6			8	
Spottedbacked Weaver *Ploceus cucullatus*					1	1	
Spectacled Weaver *Ploceus ocularis*				1	1	2	
Redheaded Weaver *Anaplectes rubriceps*			1			1	
Redbilled Quelea *Quelea quelea*			6		3	9	Non-breeding small flocks noted. Old nests found on flooded Acacia trees in mopane woodland
Melba Finch *Pytilia melba*		1			1	2	
Jameson's Firefinch *Lagonosticta rhodopareia*		2				2	
Redbilled Firefinch *Lagonosticta senegala*		1			1	2	
Blue Waxbill *Uraeginthus angolensis*		2	3		1	6	
Common Waxbill *Estrilda astrild*	a			1	2	3	Restricted to alluvial and river mouths
Orangebreasted Waxbill *Sporaeginthus subflavus*	a				1	1	See Table 6.3
Cutthroat Finch *Amadina fasciata*		1			1	2	

SPECIES	NO. OF OCCURRENCES (SAMPLES)						COMMENTS
	Aquatic species	**Zone i Gorge**	**Zone ii Mopane**	**Zone iii Reeds**	**Zone iv All. Flats**	**Total**	
Paradise Whydah *Vidua paradisaea*		1	1			2	
Steelblue Widowfinch *Vidua chalybeata*		1			1	2	
Purple Widowfinch *Vidua purpurascens*		1				1	
Goldenbreasted Bunting *Emberiza flaviventris*		1				1	
Rock Bunting *Emberiza tahapisi*		3				3	
Yelloweyed Canary *Serinus mozambicus*		2	2	1	1	6	
Total number of aquatic species		**25**	**37**	**28**	**44**	**55**	
Total number of species		**100**	**92**	**52**	**95**	**163**	
Total number of records		**165**	**238**	**52**	**168**	**623**	
Total number of samples		**4**	**9**	**1**	**4**	**18**	
Total observation time		**7:30**	**7:15**	**0:45**	**5:30**	**21:00**	

Table 6.3: Observations Concerning Aquatic Species of Interest

Species	No of Sightings	Comments
Reed Comorant	13	Fair numbers except in gorge. Very few roosting treelines. Large communal roost between CB5 and CB6. Approximately 2,000 mixed birds of egrets, darters and cormorants.
Whitebreasted Comorant	-	Although suitable sites and prey, no sightings on entire lake. Numerous piscivorous congeners.
Darter	6	Normal densities, small groups breeding, larger numbers in mixed *Vossia* sp. and aquatic weeds.
Yellowbilled Egret	-	None seen. Inadequate grassline/marshy verges.
Squacco Heron	9	Exceptional numbers found at CB11, flock of 250 excitedly milling around for 30 minutes in *Vossia* sp. and flooded dead small trees - possible breeding colony. Small flocks noticed in other *Vossia* sp. beds.
Openbilled Stork	10	Consistent small to medium flocks (6 - 60) throughout *Vossia* sp. beds. Observed to be feeding on *Lanistes ovum*. Substantial numbers throughout lake.
African Fish Eagle	14	Dense population noted. Up to 5 adult pairs in bays linked to rivermouths. Nesting confined to *Adansonia digitata* (19), *Sterculia quinqueloba* (3) and *Kirkia acuminata* (2). Fewer in upper reaches of Zambezi where *Phragmites* sp. present.
Black Crake	10	Large numbers throughout *Vossia* sp. and appearing to prefer this habitat even when near *Phragmites* sp. beds.
African Skimmer	2	Very few suitable exposed sandbanks for this species. 2 groups seen. 1 small group of 6 and another large group of 22, may be precursor to larger numbers arriving (mid-year intra-African migrant) . Possible precarious existence on the lake with restricted habitat. (Barely present on Lake Kariba).
Lesser Gallinule	3	Small colonies noted with breeding plumage in large *Vossia* sp. beds (unusual breeding record) primarily in secluded bays in rivermouths and recessed *Vossia* sp. beds in *Phragmites* sp. beds in main Zambezi River entrance.
African Jacana	8	Large numbers throughout suitable range where *Vossia* sp. present.
Redwinged Pratincole	2	Very large flocks encountered in Zambezi River onto *Phragmites* sp. None noticed on main lake.
Whitewinged Tern	2	Small group of 20 seen, with other pairs noted elsewhere. Possible over-wintering grounds.
Whitebrowed Coucal	4	Commonly distributed throughout *Phragmites* sp. lined riverine. Extended into *Vossia* sp. beds where sparser.
Carmine Bee-eater	2	Few pairs seen, then further 20 and 24 hawking over *Phragmites* sp.. Early arrivals or over-wintering ?
Whitethroated Swallow	5	Flocks of up to 35 birds hawking over expansive *Vossia* sp. beds in rivermouths. Possible new over-wintering grounds
Banded Martin	2	Flocks of 30 seen with White-throated Swallows and Brown-throated Martins. Hawking over *Vossia* sp. mainly in rivermouths. Possibly over-wintering base (for race *xerica* ?)
Cape Reed Warbler	12	Large numbers noted, in various habitats from *Sorghum* to *Phragmites* sp.
Orangebreasted Waxbill	1	Small flocks in vegetation on alluvial mud deposit. Possibly winter influx of *S.s. clarkei* from higher altitudes or the northern tropical subspecies, *S.s. niethammeri* . Few records from the lower Zambezi River in Zimbabwe.

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ANNEX

ANNEX 6.I: Terms of Reference for Lake Cabora Bassa Bird Survey

a) Provide a checklist of the bird species and subspecies and their scientific names, with an indication of their numbers, in accordance with the preliminary ecological stratification;

b) Provide a brief report evaluating the survey findings, including:

Identification and discussion of any species of special biological interest or conservation concern,

Identification and description of sites, habitats or areas of particular interest for conservation,

Identification and description of any species or areas with potential for utilization, particularly with respect to biodiversity and/or wilderness based tourism, and

Recommendations concerning lakeshore development that would serve to minimize impacts to any sites of high biodiversity or conservation value.

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VOLUME 11
TECHNICAL REPORTS

PLANT LIST FOR LAKE CABORA BASSA AND THE SURROUNDING TCHUMA TCHATO PROJECT AREA, TETE PROVINCE MOZAMBIQUE

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Consultancy Report Prepared For
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1. INTRODUCTION

The following plant species list has been compiled through amalgamation of records from the Cabora Bassa lakeshore vegetation and plant survey (Timberlake, 2000), the vegetation survey to the south of Lake Cabora Bassa (Cunliffe, 2001), and from published lists for Tete Province by Gonçalves (1978-1982). The latter is based on herbarium specimens from Lisbon, Coimbra and Maputo. Gonçalves lists species by families, but unfortunately not all families are covered.

Nomenclature follows that in current use at the National Herbarium, Harare. Species names that are no longer in use, particularly from Gonçalves lists, are included in brackets, eg. (*Maytenus senegalensis*). Common names of cultivated species are shown in square brackets eg. [ochra]. Records that are considered to be doubtful are indicated by ??

For the Gonçalves lists, species are recorded by districts (CB = Cabora Bassa, MA = Magoe, MR = Maravia, T = Tete and Z = Zumbo), but for the two Cabora Bassa surveys are merely indicated as being present (X) or not.

2. REFERENCES

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3. CABORA BASSA / TCHUMA TCHATO PLANT LIST, TETE PROVINCE, MOZAMBIQUE

Family/species/authority	Gonçalves	CB lake	T/T land
FERNS AND FERN ALLIES			
Actiniopteridaceae			
Actiniopteris dimorpha *Pic.Serm.*	Z CB		
Adiantaceae			
Adiantum capillus-veneris *L.*	CB		
Adiantum incisum *Forssk.*	MR CB		
Cheilanthes viridis *(Forssk.) Sw.* var. glauca *(Sim) Sim & N.C.Anthony* (Pellaea viridis var. glauca)	CB		
Cheilanthes viridis *(Forssk.) Sw.* var. involuta *(Sw.) Schelpe & N.C.Anthony* (Pellaea viridis var. glauca)	CB		
Doryopteris concolor *(Langsd.& Fisch.) Kuhn* var. nicklesii (*Tardieu) Schelpe*	CB		
Pellaea calomelanos (*Sw.) Link* var. calomelanos	CB		
Pellaea longipilosa *Bonap.*	CB		
Azollaceae			
Azolla filiculoides *Lam.*		X	
Azolla nilotica *Mett.*	CB T		
Dennstaedtiaceae			
Pteridium aquilinum *(L.) Kuhn* subsp. aquilinum	MR		
Equisetaceae			
Equisetum ramosissimum *Desf.*	MR		
Marsileaceae			
Marsilea ephippiocarpa *Alston*	MA		
Marsilea minuta *L.*	CB		
Marsilea sp.		X	
Ophioglossaceae			
Ophioglossum costatum *R.Br.*	CB		
Ophioglossum reticulatum *L.*	T		
Parkeriaceae			
Ceratopteris cornuta *(P.Beauv.) Lepr.*		X	
Polypodiaceae			

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Pyrrosia schimperiana *(Kuhn) Alston*	CB		
Pteridaceae			
Pteris vittata *L.*	CB		
Salviniaceae			
Salvinia molesta *D.S.Mitchell*	Z MA CB	X	
Selaginellaceae			
Selaginella abyssinica *Spring*	T		
Selaginella dregei *(C.Presl) Hieron.*	T		
Selaginella imbricata *(Forssk.) Spring & Decne.*	MR CB T		
MONOCOTYLEDONS			
Araceae			
Pistia stratiotes *L.*		X	
Arecaceae			
Hyphaene petersiana *Klotzsch*		X	X
Asparagaceae			
Asparagus sp.			X
Commelinaceae			X
Commelina diffusa *Burm.f.*		X	
Cyperaceae			
Cyperus alternifolius *L.*subsp. flabelliformis *Kük.*		X	
Cyperus digitatus *Roxb.* subsp. auricomis *(Spreng.) Kük.*		X	
Cyperus maculatus *Boeck.*		X	
Pycreus flavescens *(L.) Rchb.*		X	
Pycreus mundii *Nees*		X	
Dracaenaceae			
Sansevieria sp.			X
Poaceae			
Aristida sp.		X	X
Cynodon dactylon *(L.) Pers.*		X	
Dactyloctenium giganteum *B.S.Fisher & Schweick.*			X
Digitaria milanjiana *(Rendle) Stapf*			X
Digitaria sp.		X	

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Elytrophorus globularis *Hack.*			X
Echinochloa pyramidalis *(Lam.) Hitchc.& Chase*		X	
Enneapogon sp.		X	
Enteropogon sp.		X	
Eragrostis aethiopica *Chiov.*		X	
Eragrostis japonica *(Thunb.) Trin.*		X	
Eriochloa fatmensis *(Hochst.& Steud.) Clayton*		X	
Eriochloa meyeriana *(Nees) Pilg.*		X	
Hemarthria altissima *(Poir.) Stapf & C.E.Hubb.*		X	
Heteropogon contortus *(L.) Roem.& Schult.*		X	X
Heteropogon melanocarpus *(Ell.) Benth.*			X
Ischaemum afrum *(J.F.Gmel.) Dandy*			X
Loudetia sp.			X
Melinis repens *(Willd.) Zizka* subsp. repens		X	
Panicum coloratum *L.*		X	
Panicum maximum *Jacq.*		X	X
Panicum subalbidum *Kunth*		X	
Pennisetum polystachion *(L.) Schult.*		X	
Pennisetum purpureum *Schumach.*		X	
Phragmites mauritianus *Kunth*		X	X
Pogonarthria squarrosa *(Roem.& Schult.) Pilg.*			X
Schmidtia pappophoroides *Steud.*		X	X
Setaria incrassata *(Hochst.) Hack.*			X
Sorghum bicolor *(L.) Moench* subsp. arundinaceum *(Desv.) D*e *Wet & J.R.Harlan*		X	X
Urochloa mosambicensis *(Hack.) Dandy*		X	
Urochloa trichopus *(Hochst.) Stapf*		X	
Vossia cuspidata *(Roxb.) Griff.*		X	
Pontederiaceae			
Eichhornia crassipes *(Mart.) Solms*		X	
Typhaceae			
Typha sp.		X	
DICOTYLEDONS			

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Acanthaceae			
Anisotes bracteatus *Milne-Redh.*			X
Anisotes formosissimus *(Klotzsch) Milne-Redh.*			X
Barleria albostellata *C.B.Clarke*			X
Barleria kirkii *T.Anderson*			X
Barleria rogersii *S.Moore*			X
Barleria senensis *Klotzsch*			X
Crabbea hirsuta *Harv.*			X
Duosperma crenatum *(Lindau) P.G.Mey*.			X
Duosperma quadrangulare *(Klotzsch) Brummitt*			X
Elytraria acaulis *(L.f.) Lindau*		X	
Megalochlamys hamata *(Klotzsch) Vollesen*		X	X
Peristrophe paniculata *(Forssk.) Brummitt*			X
Aizoaceae			
Gisekia africana *(Lour.) Kuntze*	MA CB T		
Sesuvium nyasicum *(Baker) M.L.Gonçalves*	MA		
Trianthema portulacastrum *L.*	T		
Trianthema triquetra *Willd.*	Z		
Zaleya pentandra *(L.) C.Jeffrey*	CB T		
Amaranthaceae			
Alternanthera pungens *Kunth*		X	
Anacardiaceae			
Anacardium occidentale *L.* [cashew]	T		
Lannea antiscorbutica *(Hiern) Engl.*	CB		
Lannea schimperi *(A.Rich.) Engl.* var. schimperi	CB		
Lannea schimperi *(A.Rich.) Engl.* var. stolzii *(Engl.& v.Brehm.) R.& A.Fern.*	MA		
Lannea schweinfurthii *(Engl.) Engl*. var. stuhlmannii	CB	X	X
Lannea schweinfurthii *(Engl.) Engl.* var. tomentosa *Dunkley*	MA MR CB T		
Mangifera indica *L.* [mango]			X
Ozoroa reticulata *(Baker f.) R.& A.Fern.* subsp. grandifolia *R.& A.Fern.*	CB		
Ozoroa insignis *Delile* subsp. reticulata *(Baker f.) J.B.Gillett*	CB MR T		X

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Pseudospondias microcarpa *(A.Rich.) Engl.*	T		
Rhus leptodictya *Diels*	CB		
Rhus longipes *Engl.* var. longipes	MR		
Rhus natalensis *Krauss*	MA		
Rhus tenuinervis *Engl.*	CB		X
Sclerocarya birrea *(A.Rich.) Hochst.* subsp. caffra *(Sond.) Kokwaro*	CB T	X	X
Annonaceae			
Annona squamosa *L.* [fruit tree]	T		
Artabotrys brachypetalus *Benth.*	MA CB T		X
Artabotrys monteiroae *Oliv.*	T		
Cleistochlamys kirkii *(Benth.) Oliv.*	MA MR T	X	X
Friesodielsia obovata *(Benth.) Verdc.*	CB T		X
Hexalobus monopetalus *(A.Rich.) Engl.& Diels* var. obovatus *Brenan*	MR CB T?		
Melodorum gracile *(Engl.& Diels) Verdc.* subsp. gracile	MA		
Monodora junodii *Engl.& Diels*	CB T		X
Monodora stenopetala *Oliv.*	MA CB		
Apiaceae			
Heteromorpha trifoliata *(Wendl.) Eckl.& Zeyh.*	MR CB		
Steganotaenia araliacea *Hochst.*	MR CB T		X
Apocynaceae			
Diplorhynchus condylocarpon *(Müll.Arg.) Pichon*		X	X
Holarrhena pubescens *(Buch.-Ham.) G.Don*		X	X
Strophanthus kombe *Oliv.*		X	X
Strophanthus petersianus *Klotzsch*			X
Araliaceae			
Cussonia arborea *A.Rich.*	CB		
Cussonia spicata *Thunb.*	T		
Hydrocotyle bonariensis *Lam.*	T		
Asclepiadaceae			
Calotropis procera *(Aiton) W.T.Aiton*		X	X
Marsdenia macrantha *(Klotzsch) Schltr.* (Dregea macrantha)			X

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Pergularia daemia *(Forssk.) Chiov.*			X
Tacazzea apiculata *Oliv.*		X	X
Asteraceae			
Ageratum conyzoides *L.*		X	
Eclipta prostrata *(L.) L.* (E. alba)		X	
Nidorella microcephala *Steetz*		X	
Pluchea dioscoridis *(L.) DC.*			X
Psiadia punctulata *(DC.) Vatke*			X
Tarchonanthus camphoratus *L.*			X
Tarchonanthus trilobus *DC.* var. galpinii *(Hutch. & E.Phillips) Paiva*			X
Tridax procumbens L.		X	
Vernonia glabra *(Steetz) Vatke*		X	X
Vernonia steetziana *Oliv.& Hiern*		X	
Balanitaceae			
Balanites aegyptiaca *(L.) Delile*			X
Balanites maughamii *Sprague* subsp. maughamii	T		X
Bignoniaceae			
Kigelia africana *(Lam.) Benth.*			X
Markhamia obtusifolia *(Baker) Sprague*			X
Markhamia zanzibarica *(DC.) K.Schum.*		X	X
Stereospermum kunthianum *Cham.*			X
Bombacaceae			
Adansonia digitata *L.*	T	X	X
Rhodognaphalon schumannianum *A.Robyns*	CB	X	
Rhodognaphalon stolzii *(Ulbr.) A.Robyns*	CB		
Boraginaceae			
Cordia goetzei *Gürke*			X
Cordia mukuensis *Taton*			X
Cordia pilosissima *Baker*			X
Cordia sinensis *Lam.*		X	
Ehretia amoena *Klotzsch*		X	
Heliotropium indicum *L.*		X	

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Heliotropium ovalifolium *Forssk.*	X	X	X
Trichodesma zeylanicum *(Burm. f.) R.Br.*			X
Brassicaceae			
Brassica oleracea *L.* [cabbage]	T		
Brassica rapa *L.* [rape]	T		
Coronopus integrifolius *(DC.) Spreng.*	T		
Raphanus sativus *L.* [radish]	T		
Rorippa madagascariensis *(DC.) Hara*	T		
Buddlejaceae			
Nuxia oppositifolia *(Hochst.) Benth.*			X
Burseraceae			
Commiphora africana *(A.Rich.) Engl.* var. africana	MA MR CB T	X	X
Commiphora caerulea *B.D.Burtt*	Z MA CB	X	X
Commiphora edulis *(Klotzsch) Engl.*	MA MR CB T		X
Commiphora glandulosa *(Schinz) Wild*	MA CB T		X
Commiphora karibensis *Wild*		X	X
Commiphora madagascariensis *Jacq.*	T		
Commiphora marlothii *Engl.*	MA CB	X	X
Commiphora mollis *(Oliv.) Engl.*	MA MR CB T	X	X
Commiphora mossambicensis *(Oliv.) Engl.*	MR CB T		X
Commiphora ugogensis *Engl.*			X
Commiphora viminea *Burtt Davy* (C. merkeri)	MA CB T		
Commiphora zanzibarica *(Baill.) Engl.*	CB T		X
Capparaceae			
Boscia angustifolia *A.Rich.* var. corymbosa *(Gilg) DeWolf*	MA MR Z CB T	X	X
Boscia matabelensis *Pestal.*	MR		X
Boscia mossambicensis *Klotzsch*	Z MA MR CB T	X	X
Boscia salicifolia *Oliv.*	Z CB		
Cadaba kirkii *Oliv.*	CB T		X
Cadaba termitaria *N.E.Br.*	T		
Capparis erythrocarpos *Isert* var. rosea *(Klotzsch) DeWolf*	Z CB T MA		

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Capparis sepiaria *L.* var. subglabra *(Oliv.) DeWolf*	CB T		
Capparis tomentosa *Lam.*	Z T		X
Cladostemon kirkii *(Oliv.) Pax & Gilg*	MR CB		X
Cleome angustifolia *Forssk.* subsp. petersiana *(Sond.) Kers*	T		
Cleome gynandra *L.*	Z MR T		
Cleome hirta *(Klotzsch) Oliv.*	Z MA CB T MR?		
Cleome macrophylia *(Klotzsch) Briq.*	CB T		
Cleome monophylla *L.*	CB T		
Maerua angolensis *DC.*	MA T		X
Maerua buxifolia *(Oliv.) Gilg & Gilg-Ben.*			X
Maerua decumbens *(Brongn.) DeWolf* (Courbonia glauca)		X	X
Maerua edulis *(Gilg & Gilg-Ben.) DeWolf*	Z MA CB T		
Maerua juncea *Pax* subsp. juncea	MA MR T		X
Maerua parvifolia *Pax*	CB T		X
Maerua prittwitzii *Gilg & Gilg-Ben.*	MA		X
Maerua triphylla *A.Rich.* var. pubescens *(Klotzsch) DeWolf*	MR CB T		
Thilachium africanum *Lour.*	T		X
Caricaceae			
Carica papaya *L.*	T		
Caryophyllaceae			
Corrigiola litoralis *L.*	CB		
Polycarpaea corymbosa *(L.) Lam.*	T		
Polycarpaea eriantha *A.Rich.* var. effusa *(Oliv.) Turrill*	T		
Polycarpaea eriantha *A.Rich.* var. eriantha	MR T		
Polycarpaea linearifolia *(DC.) DC.*	T		
Polycarpaea sp.	T		
Polycarpon prostratum *(Forssk.) Asch.& Schweinf.*	CB T		
Celastraceae			
Elachyptera parvifolia *(Oliv.) N.Hallé* (Hippocratea parvifolia)	MR CB T		X
Elaeodendron matabelicum *Loes.*	CB		X
Elaeodendron schlechterianum *(Loes.) Loes*.	MA CB T		X

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Gymnosporia buxifolia *(L.) Szyszyl* (Maytenus heterophylla subsp. heterophylla)	CB		
Gymnosporia pubescens *(N.Robson) Jordaan* (Maytenus pubescens)	CB T		X
Gymnosporia putterlickioides *Loes.* (Maytenus putterlickioides)	T		X
Gymnosporia senegalensis *(Lam.) Loes.*(Maytenus senegalensis)	Z MR CB T	X	X
Loeseneriella africana *(Willd.) N.Hallé* var. richardiana *(Cambess.) N.Hallé* (Hippocratea africana)	Z T		X
Loeseneriella crenata *(Klotzsch) N.Hallé* (Hippocratea crenata)	T		
Maytenus undata *(Thunb.) Blakelock*	CB		
Mystroxylon aethiopicum *(Thunb.) Loes.*	CB T		X
Pleurostylia africana *Loes.*	MR CB		X
Pristimera longipetiolata *(Oliv.) N.Hallé* (Hippocratea longipetiolata)	MR T		
Pristemera andongensis *(Oliv.) N.Hallé* var. volkensii *(Loes.) N.Hallé & B.Mathew* (Hippocratea volkensii)	CB		
Reissantia buchananii *(Loes.) N.Hallé* (Hippocratea buchananii)	MR CB T	X	X
Reissantia indica *(Willd.) N.Hallé* var. orientalis *N.Hallé & B.Mathew* (Hippocratea indica)	MA T		X
Ceratophyllaceae			
Ceratophyllum demersum *L.*		X	
Chrysobalanaceae			
Parinari curatellifolia *Benth.*	MR CB		
Clusiaceae			
Garcinia buchananii *Baker* (G. huillensis)	CB		
Garcinia livingstonei *T.Anders.*	MR CB T	X	X
Psorospermum febrifugum *Spach*	CB		
Combretaceae			
Combretum adenogonium *A.Rich.* (C. fragrans)	Z CB T		X
Combretum apiculatum *Sond.* subsp. apiculatum	Z MA MR CB T	X	X
Combretum apiculatum *Sond.* subsp. leutweinii *(Schinz) Exell*	MR CB T		
Combretum celastroides *Laws.* subsp. celastroides	T	X	X
Combretum collinum *Fresen.* subsp. suluense *(Engl.& Diels) Okafor*	MR CB		X

Family/species/authority	Gonçalves	CB lake	T/T land
Combretum elaeagnoides *Klotzsch*	Z MA MR CB T	X	X
Combretum goetzei *Engl.& Diels*	MR T	X	X
Combretum hereroense *Schinz* subsp. hereroense	CB T		X
Combretum imberbe *Wawra*	MR CB T	X	X
Combretum kirkii *M.A.Lawson*	Z MA CB T		X
Combretum lasiocarpum *Engl.& Diels*	T		
Combretum microphyllum *Klotzsch*	MR CB T		X
Combretum molle *R.Br.*	MR		
Combretum mossambicense *(Klotzsch) Engl.*	MR T	X	X
Combretum obovatum *F.Hoffm.*	MA CB T MR	X	X
Combretum padoides *Engl.& Diels*	MA CB T MR		X
Combretum paniculatum *Vent.*			X
Combretum pisoniiflorum *(Klotzsch) Engl.*	Z		
Combretum zeyheri *Sond.*	MA MR CB T		X
Meiostemon tetrandrus *(Exell) Exell & Stace* subsp. australis *Exell*			X
Meiostemon tetrandrus *(Exell) Exell & Stace* subsp. tetrandrus	T		
Pteleopsis anisoptera *(M.A.Lawson) Engl.& Diels*	MA		X
Pteleopsis myrtifolia *(M.A.Lawson) Engl.& Diels*	Z MA MR CB T	X	X
Terminalia brachystemma *Hiern* subsp. brachystemma			X
Terminalia brachystemma *Hiern* x T. sericea *Exell*	MR		
Terminalia gazensis *Baker f.*	CB		
Terminalia prunioides *M.A.Lawson*	MA MR CB T	X	X
Terminalia sambesiaca *Engl.& Diels*	MR CB T	X	X
Terminalia sericea *DC.*	MA MR CB T		X
Terminalia stenostachya *Engl.& Diels*	MA MR CB		X
Terminalia stuhlmannii *Engl.*	MA CB T	X	X
Terminalia trichopoda *Diels*	CB T		
Convolvulaceae			
Ipomoea aquatica *Forssk.*		X	

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Ipomoea eriocarpa *R.Br.*			X
Ipomoea rubens *Choisy*		X	
Jacquemontia tamnifolia *(L.) Griseb.*			X
Crassulaceae			
Kalanchoe lanceolata *(Forssk.) Pers.*	T		X
Cucurbitaceae			
Citrullus lanatus *(Thunb.) Matsum.& Nakai*	T		
Coccinia adoensis *(A.Rich.) Cogn.*	CB T		
Coccinia fernandesiana *C. Jeffrey*	T		
Coccinia senensis *(Klotzsch) Cogn.*	Z MA CB T		
Corallocarpus bainesii *(Hook.f.) A.Meeuse*	T		
Ctenolepis cerasiformis *(Stocks) Hook.f.*	CB T		
Cucumis africanus *L.f.*	T		
Cucumis anguria *L.*	CB T		
Cucumis hirsutus *Sond.*	CB		
Cucumis metuliferus *Naud.*	MA T		
Cucumis sativus *L.* [cucumber]	T		
Cucurbita maxima *Lam.* [pumpkin]	T		
Cucurbita pepo *L.* [squash]	T		
Cyclantheropsis parviflora *(Cogn.) Harms*	MR CB		
Eureiandra eburnea *C.Jeffrey*	CB T		
Eureiandra fasciculata *(Cogn.) C.Jeffrey*	T		
Kedrostis foetidissima *(Jacq.) Cogn.*	T		
Kedrostis leloja *(J.F.Gmel.) C.Jeffrey*	CB		
Lagenaria siceraria *(Molina) Standley* [gourd]	T		
Lagenaria sphaerica *(Sond.) Naud.*	CB T		
Luffa acutangula *(L.) Roxb.*	T		
Luffa cylindrica *(L.) M.Roem.* [loofah]	T	X	
Momordica cardiospermoides *Klotzsch*	CB T		
Momordica charantia *L.*	CB T		
Momordica corymbifera *Hook.f.*	MR CB		
Momordica kirkii *(Hook.f.) C.Jeffrey*	CB T		
Mukia maderaspatana *(L.) M.J.Roem.*	MA		

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Dichapetalaceae			
Tapura fischeri *Engl.*	T		
Dipterocarpaceae			
Monotes engleri *Gilg*	CB		
Monotes katangensis *(De Wild.) De Wild*.	MR		X
Ebenaceae			
Diospyros kirkii *Hiern*		X	X
Diospyros mespiliformis *A.DC.*		X	X
Diospyros quiloensis *(Hiern) F.White*		X	X
Diospyros senensis *Klotzsch*			X
Diospyros squarrosa *Klotzsch*			X
Euclea divinorum *Hiern*			X
Euclea racemosa *Murr.* subsp. schimperi *(A.DC.) F.White*			X
Elatinaceae			
Bergia ammannioides *Roth*	T		
Erythroxylaceae			
Erythroxylum zambesiacum *N.Robson*	MA		X
Euphorbiaceae			
Alchornea laxiflora *(Benth.) Pax & K.Hoffm.*			X
Antidesma venosum *Tul.*			X
Bridelia cathartica *G.Bertol.*			X
Bridelia mollis *Hutch.*			X
Croton gratissimus *Burch.* var. gratissimus			X
Croton longipedicellatus *J.Léonard* var. longipedicellatus			X
Croton megalobotrys *Müll.Arg.*			X
Croton menyharthii *Pax*		X	X
Drypetes mossambicensis *Hutch*.		X	X
Erythrococca menyharthii *(Pax) Prain*			X
Euphorbia cooperi *A.Berger*		X	
Euphorbia espinosa *Pax*			X
Euphorbia griseola *Pax*		X	
Euphorbia ingens *Boiss.*			X
Euphorbia matabelelensis *Pax*			X

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Excoecaria bussei *(Pax) Pax*			X
Flueggea virosa *(Willd.) Voigt*		X	X
Jatropha gossypifolia *L.* var. elegans *(Pohl) Müll.Arg.* [Jatropha]		X	
Margaritaria discoidea *(Baill.) G.L.Webster* var. nitida *(Pax) Radcl.-Sm.*			X
Phyllanthus pinnatus *(Wight) G.L.Webster*			X
Phyllanthus reticulatus *Poir.*		X	X
Pseudolachnostylis maprouneifolia *Pax*		X	X
Ricinus communis *L.*		X	X
Tragia brevipes *Pax*		X	
Fabaceae: Caesalpinioideae			
Afzelia quanzensis *Welw.*	MR CB T	X	X
Bauhinia petersiana *Bolle* subsp. petersiana	MR CB MA	X	X
Bauhinia tomentosa *L.*	MR CB T		X
Brachystegia allenii *Burtt Davy & Hutch.*	MR CB		X
Brachystegia allenii *Burtt Davy & Hutch.* x B. boehmii	MR CB		
Brachystegia boehmii *Taub.*	MR CB		
Brachystegia bussei *Harms*	MR		
Brachystegia floribunda *Benth.*	MR CB		
Brachystegia glaucescens *Burtt Davy & Hutch.*	CB		X
Brachystegia x longifolia *Benth.*			X
Brachystegia manga *De Wild.*	MR		X
Brachystegia spiciformis *Benth.*	CB MR		
Brachystegia stipulata *De Wild.*	MR		
Brachystegia utilis *Burtt Davy & Hutch.*	MR T		
Burkea africana *Hook.*	MR CB		X
Cassia abbreviata *Oliv.* subsp. abbreviata	MR CB T		X
Cassia abbreviata *Oliv.* subsp. beareana *(Holmes) Brenan*	T		
Chamaecrista absus *(L.) Irwin & Barneby* (Cassia absus)	CB T		
Chamaecrista grantii *(Oliv.) Standley* (Cassia grantii)	MR		
Chamaecrista mimosoides *(L.) Greene* (Cassia mimosoides)	MA CB T		

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Chamaecrista zambesiaca *(Oliv.) Lock* (Cassia zambesica)	T		
Colophospermum mopane (*Benth.) J.Léonard*	CB T	X	X
Cryptosepalum maraviense *Oliv.*	MR		
Erythrophleum africanum *(Benth.) Harms*	T		
Guibourtia conjugata (*Bolle) J.Léonard*	T		
Julbernardia globiflora *(Benth.) Troupin*	MR CB		X
Parkinsonia aculeata *L.*	T		
Peltophorum africanum *Sond.*	MR T		X
Piliostigma thonningii *(Schumach.) Milne-Redh.* (Bauhinia thonningii)	CB T		X
Senna alexandrina *Miller* (Cassia senna var. senna)	T		
Senna obtusifolia *(L.) Irwin & Barneby* (Cassia obtusifolia)	Z CB T		X
Senna petersiana *(Bolle) Lock* (Cassia petersiana)	MR T		
Senna singueana *(Delile) Lock* (Cassia singueana)	MR T CB	X	X
Swartzia madagascariensis *Desv.*	MR CB		
Tamarindus indica *L.*	MR CB T	X	X
Tylosema fassoglensis *(Schweinf.) Torre & Hillc.*	CB T		X
Fabaceae: Mimosoideae			
Acacia amythethophylla *A.Rich*. (A. macrothyrsa)	MR		
Acacia ataxacantha *DC.*	MA MR CB T	X	X
Acacia eriocarpa *Brenan*	MA		X
Acacia galpinii *Burtt Davy*	Z CB		X
Acacia gerrardii *Benth.*	MR CB		
Acacia goetzei *Harms* subsp. goetzei	CB		
Acacia goetzei *Harms* subsp. microphylla *Brenan*	MR		
Acacia kirkii Oliv.	Z MA CB		
Acacia latistipulata *Harms*	T		
Acacia mellifera *(Vahl) Benth.* subsp. detinens *(Burch.) Brenan*	CB		
Acacia nigrescens *Oliv.*	MR CB T	X	X
Acacia nilotica *(L.) Delile* subsp. kraussiana *(Benth.) Brenan*	MR CB T	X	X
Acacia polyacantha *Willd.*	CB T		X

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Acacia robusta *Burch.* subsp. clavigera *(E.Mey.) Brenan*	MA CB T	X	X
Acacia schweinfurthii *Brenan & Exell*	T	X	X
Acacia senegal *(L.) Willd.* var. leiorhachis *Brenan*	MA MR CB T		X
Acacia sieberiana *DC.* var. vermoesenii *(De Wild) Keay & Brenan*	Z MR CB		
Acacia sieberiana *DC.* var. woodii *(Burtt Davy) Keay & Brenan*	CB		X
Acacia tortilis *(Forssk.) Hayne* subsp. spirocarpa *(A.Rich.) Brenan*	MA MR CB T	X	X
Acacia welwitschii *Oliv.* subsp. delagoensis *(Harms) J.Ross & Brenan* (??)	T		
Acacia xanthophloea *Benth.*	T		X
Albizia anthelmintica *Brongn.*	Z MR CB T	X	X
Albizia antunesiana *Harms*	MR		
Albizia brevifolia *Schinz*	MA CB T		X
Albizia glaberrima *(Schumach.& Thonn.) Benth.* var. glabrescens *(Oliv.) Brenan*	T		
Albizia harveyi *Fourn.*	MR CB T	X	X
Albizia lebbeck *(L.) Benth.* [ornamental]	T		
Albizia tanganyicensis *Baker f.*	MR CB T		X
Albizia versicolor *Oliv.*	CB MA/T		
Dichrostachys cinerea *(L.) Wight & Arn*. subsp. africana *Brenan & Brummitt*	CB T	X	X
Dichrostachys cinerea *(L.) Wight & Arn*. subsp. argillicola *Brenan & Brummitt*	MA MR CB		
Elephantorrhiza goetzei *(Harms) Harms* subsp. *goetzei*	MR CB T		X
Entada chrysostachys (*Benth.) Drake*	MR CB		X
Faidherbia albida *(Delile) A.Chev.* (Acacia albida)	MA CB T	X	X
Leucaena leucocephala (*Lam.) De Wit* [leucaena]	T		
Mimosa mossambicensis *Brenan*	CB T		X
Mimosa pigra *L.*	CB T MA	X	X
Newtonia hildebrandtii *(Vatke) Torre* var. pubescens *Brenan*	CB		X
Xylia torreana *Brenan*			X
Fabaceae: Papilionoideae			
Abrus precatorius *L.* subsp. africanus *Verdc.*	MR CB T		X

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Abrus schimperi *Baker* subsp. africanus *(Vatke) Verdc.*	CB T MA		X
Aeschynomene abyssinica *(A.Rich.) Vatke*	MR CB		
Aeschynomene indica *L.*	MA CB		
Aeschynomene minutiflora *Taub.* subsp. minutiflora	CB		
Alysicarpus ovalifolius *(Schumach.) J.Léonard*	CB		
Arachis hypogaea *L.* [groundnut]	T		
Baphia massaiensis *Taub.* subsp. obovata *(Schinz) Brummitt*			X
Bolusanthus speciosus *(Bolus) Harms*	MA CB		X
Cajanus cajan *(L.) Millsp.* [pigeonpea]	T		
Canavalia ensiformis *(L.) DC.* [jackbean]	T		
Canavalia virosa *(Roxb.) Wight & Arn.*	T		
Clitoria ternatea *L.* [ornamental climber]	Z CB T		
Cordyla africana *Lour.*	MR CB T	X	X
Crotalaria barnabassii *Baker f.*	T		
Crotalaria cephalotes *A.Rich.*	MR CB		
Crotalaria cleomifolia *Baker*	MR		
Crotalaria hyssopifolia *Klotzsch*	T		
Crotalaria laburnifolia *L.* subsp. laburnifolia	CB		
Crotalaria lanceolata *E.Mey.*	T		
Crotalaria microcarpa *Benth.*	CB		
Crotalaria monteiroi *Baker f.*	MA		X
Crotalaria pallida *Ait.* var. obovata *(G.Don) Polhill*	Z MA		
Crotalaria pallida *Ait.* var. pallida	CB		
Crotalaria platysepala *Harv.*	T		
Crotalaria podocarpa *DC.*	CB T	X	
Crotalaria reptans *Taub.*	MA		
Crotalaria senegalensis *(Pers.) DC.*	MA T		
Crotalaria sphaerocarpa *DC.* subsp. sphaerocarpa	T		
Crotalaria virgulata *Klotzsch*	MA MR T		
Dalbergia arbutifolia *Baker* subsp. arbutifolia	MA CB T		X
Dalbergia boehmii *Taub.* subsp. boehmii	CB		
Dalbergia fischeri *Taub.*	CB		

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Dalbergia lactea *Vatke*	MR		
Dalbergia martinii *F.White*			X
Dalbergia melanoxylon *Guill.& Perr.*	MA CB T	X	X
Dalbergia sambesiaca *Schinz*	T		
Dalbergiella nyasae *Baker f.*			X
Decorsea schlechteri *(Harms) Verdc.*	CB T		
Eminia antennulifera *(Baker) Taub.*	MR CB		X
Eriosema englerianum *Harms*	MR		
Erythrina abyssinica *DC.*	CB		
Erythrina livingstoniana *Baker*	T		
Flemingia grahamiana *Wight & Arn.*	MR		
Indigofera astragalina *DC.*	MA	X	
Indigofera colutea *(Burm.f.) Merr.*	CB		
Indigofera dyeri *Britten* var. dyeri	T		
Indigofera dyeri *Britten* var. parviflora *J.B.Gillett*	T		
Indigofera emarginella *A.Rich.* var. emarginella	MR		
Indigofera flavicans *Baker*	Z CB T		
Indigofera hirsuta *L.*	T		
Indigofera lupatana *Baker f.*	Z MA CB T		
Indigofera oblongifolia *Forssk.*	T		
Indigofera ormocarpoides *Baker*	MR CB T		
Indigofera praticola *Baker f.*	Z		
Indigofera schimperi *Jaub.& Spach* var. schimperi	MA CB T		
Indigofera setiflora *Baker*	MA		
Indigofera subcorymbosa *Baker*	T		
Indigofera suffruticosa *Mill.*	CB T		
Indigofera tinctoria *L.* var. arcuata *J.B.Gillett*	T	X	
Indigofera trita *L.f.* var. scabra *(Roth) Ali*	CB		
Indigofera trita *L.f.* var. subulata *(Poir.) Ali*	CB T		X
Indigofera vicioides *Jaub.& Spach*	T		
Indigofera wildiana *J.B.Gillett*	MA		
Indigofera sp. 1.	T		

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Indigofera sp. 2.	T		
Indigofera sp. 3.	?T		
Lablab purpureus *(L.) Sweet* subsp. uncinatus *Verdc.*	CB		
Lens culinaris *Medic.* [lentil]	T		
Lonchocarpus bussei *Harms* (now Philenoptera bussei)	CB T	X	X
Lonchocarpus capassa *Rolfe* (now Philenoptera violacea)	Z CB T	X	X
Lonchocarpus sericeus *(Poir.) Kunth*	CB		
Lotus arabicus *L.*	CB T		
Macrotyloma axillare *(E.Mey.) Verdc*. var. glabrum *(E.Mey.) Verdc.*	T		
Mucuna pruriens *(L.) DC.* var. pruriens		X	
Mundulea sericea *(Willd.) A.Chev.*	CB		X
Neonotonia wightii *(Wight & Arn.) Lackey* subsp. wightii var. longicauda *(Schweinf.) Lackey* (Glycine wightii subsp. wightii var. longicauda)	CB		
Neorautanenia mitis *(A.Rich.) Verdc.*	CB		
Ormocarpum kirkii *S.Moore*	MR		X
Ormocarpum trichocarpum *(Taub.) Engl.*	MA CB		X
Ormocarpum zambesianum *Verdc*. (O. trachycarpum)	Z		
Pericopsis angolensis *(Baker) van Meeuwen*	MR CB		
Phaseolus vulgaris *L.* [bean]	T		
Pisum sativum *L.* [pea]	T		
Pseudarthria hookeri *Wight & Arn.* var. hookeri	CB		
Pterocarpus angolensis *DC.*	T		X
Pterocarpus brenanii *Barbosa & Torre*		X	X
Pterocarpus lucens *Guill. & Perr.)* subsp. antunesii *(Taub.) Rojo* (P. antunesii)		X	X
Pterocarpus rotundifolius *(Sond.) Druce* subsp. polyanthus *(Harms) Mendonça & E.P.Sousa* var. polyanthus	CB MR T		X
Pterocarpus rotundifolius *(Sond.) Druce* subsp. polyanthus *(Harms) Mendonça & E.P.Sousa* var. martinii *(Dunkley) Mendonça & E.P.Sousa*	CB		
Pterocarpus tinctorius *Welw.*	MR CB		
Rhynchosia luteola *(Hiern) K.Schum*. var. luteola	MR T		
Rhynchosia minima *(L.) DC*. var. minima	CB T		

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Rhynchosia resinosa *(A.Rich.) Baker*	MR CB		
Rhynchosia sublobata *(Schumach.& Thonn.) Meikle*	CB T		
Rhynchosia totta *(Thunb.) DC.* var. fenchelii *Schinz*	MA		
Rhynchosia wildii *Verdc.* (R. sp. 2 of Gonçalves)	MA MR		X
Sesbania bispinosa *(Jacq.) W.Wight*	CB		
Sesbania cinerascens *Baker*		X	
Sesbania greenwayi *J.B.Gillett*	Z MA	X	
Sesbania leptocarpa *DC.*	CB		
Sesbania mossambicensis *Klotzsch* subsp. minimiflora *J.B.Gillett*	MA T		
Sesbania mossambicensis *Klotzsch* subsp. mossambicensis	T		
Sesbania sericea *(Willd.) Link*	T		
Sesbania sesban *(L.) Merr.* subsp. nubica var. nubica *Chiov.*	Z MR T	X	
Sesbania tetraptera *Baker*	CB T		X
Sphenostylis marginata *E.Mey.* subsp. erecta *(Baker f.) Verdc.*	MR		
Stylosanthes fruticosa *(Retz.) Alston*	MA CB		
Tephrosia acaciifolia *Baker*	CB		
Tephrosia euprepes *Brummitt*	T	X	
Tephrosia noctiflora *Baker*	CB		
Tephrosia purpurea *(L.) Pers*. subsp. leptostachya *(DC.) Brummitt*	T		X
Tephrosia reptans *Baker* var. arenicola *Brummitt & J.B.Gillett*	CB		
Tephrosia reptans *Baker* var. reptans	CB		
Tephrosia rhodesica *Baker f.* var. polystachyoides *(Baker f.) Brummitt*	CB		
Tephrosia rhodesica *Baker f.* var. rhodesica	MA CB		X
Tephrosia uniflora *Pers.* subsp. uniflora	CB T	X	
Tephrosia villosa *(L.) Pers.* subsp. ehrenbergiana *(Schweinf.) Brummitt*	MA CB T	X	
Tephrosia sp. 1.	T		
Tephrosia sp. 2.	?T		
Vigna frutescens *A.Rich.* subsp. frutescens	MR		
Vigna luteola *(Jacq.) Benth.*		X	
Vigna macrorhyncha *(Harms) Milne-Redh*.	CB		

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Vigna subterranea *(L.) Verdc.* (Voandzeia subterranea) [nyimo bean]	T		
Vigna unguiculata *(L.) Walp.* subsp. unguiculata [cowpea]	T		
Vigna vexillata *(L.) A.Rich.* var. vexillata	CB		
Xanthocercis zambesiaca *(Baker) Dumaz-le-Grand*	CB T		X
Xeroderris stuhlmannii *(Taub.) Mendonça & E.P.Sousa*	MA MR CB T	X	X
Zornia glochidiata *DC.*	CB		
Flacourtiaceae			
Flacourtia indica *(Burm.f.) Merr.*	CB T		X
Xylotheca tettensis *(Klotzsch) Gilg* var. macrophylla *(Klotzsch) Wild*	MR CB T		
Xylotheca tettensis *(Klotzsch) Gilg* var. tettensis	MA CB T		X?
Geraniaceae			
Monsonia senegalensis *Guill.& Perr.*	MR		
Hernandiaceae			
Gyrocarpus americanus *Jacq.*		X	
Icacinaceae			
Pyrenacantha kaurabassana *Baill.*	CB T		
Lamiaceae			
Hyptis suaveolens *Poit.*		X	
Karomia tettensis *(Klotzsch) R.Fern.* (Holmskioldia tettensis)		X	X
Leonotis nepetifolia *(L.) W.T.Aiton*			X
Tinnea rhodesiana *S.Moore*			X
Lentibulariaceae			
Utricularia inflexa *Forssk.*		X	
Linaceae			
Hugonia orientalis *Engl.*	MR CB		X
Loganiaceae			
Strychnos decussata *(Pappe) Gilg*			X
Strychnos innocua *Delile*			X
Strychnos madagascariensis *Poir.*		X	X
Strychnos potatorum *L.f.*		X	X
Strychnos spinosa *Lam.*			X
Strychnos usambarensis *Gilg*			X

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Lythraceae			
Ammannia auriculata *Willd.*	T		
Ammannia prieuriana *Guill.& Perr.* (A. multiflora)	T		
Ammannia sp. 1.	T		
Ammannia sp. 2.	T		
Lawsonia inermis L.	T		
Malpighiaceae			
Caucanthus auriculatus *(Radlk.) Niedenzu*	MR CB T		X
Sphedamnocarpus pruriens *(A.Juss.) Szyszyl.* var. pruriens	CB		
Triaspis macropteron *Oliv.* subsp. massaiensis *(Niedenzu) Launert*	CB T		
Malvaceae			
Abelmoschus esculentus *(L.) Moench* [ochra]	CB T		
Abelmoschus ficulneus *(L.) Wight*	CB		
Abutilon angulatum *(Guill.& Perr.) Mast.* var. angulatum	CB T		X
Abutilon austro-africanum *Hochr.*	T		
Abutilon hirtum *(Lam.) Sweet*	Z T		
Abutilon indicum *(L.) Sweet* subsp. guineense *(Schumach.) Borss.*	T		
Abutilon lauraster *Hochr.*	CB T		
Abutilon ramosum *(Cav.) Guill.& Perr.*	MA CB MR T		
Azanza garckeana *(F.Hoffm.) Exell & Hillc.*	CB T		X
Gossypium barbadense *L.* var. barbadense [cotton]	T		
Gossypium herbaceum *L.* var. africanum *(Watt) Hutch.& Ghose*	MA		
Gossypium hirsutum *L.* var. hirsutum [cotton]	CB		
Hibiscus allenii *Sprague & Hutch*.	MR T		
Hibiscus caesius *Garcke*	CB T		
Hibiscus cannabinus *L.*	MA CB		
Hibiscus dongolensis *Delile*	MA T		
Hibiscus engleri *K.Schum.*	MR CB		
Hibiscus jacksonianus *Exell*	MA		
Hibiscus kirkii *Mast.*	CB T		
Hibiscus lobatus *(Murr.) Kuntze*	MR CB T		

Family/species/authority	Gonçalves	CB lake	T/T land
Hibiscus ludwigii *Eckl.& Zeyh.*	CB		
Hibiscus mastersianus *Hiern*	MR CB T		
Hibiscus micranthus *L.f.*	MA MR CB T		
Hibiscus migeodii *Exell*	CB		
Hibiscus palmatus *Forssk.*	CB T		
Hibiscus panduriformis *Burm.f.*	T		
Hibiscus physaloides *Guill.& Perr.*	CB T		
Hibiscus platycalyx *Mast.*	CB T		
Hibiscus rhabdotospermus *Garcke*	CB T MR		
Hibiscus seineri *Engl.*			X
Hibiscus sidiformis *Baill.*	CB T		
Hibiscus surattensis *L.*	T		
Hibiscus trionum *L.*	CB		
Hibiscus vitifolius *L.* subsp. vulgaris *Brenan & Exell*	Z CB MR T		
Pavonia burchellii *(DC.) R.A.Dyer* (P. procumbens)	MR CB T		X
Sida acuta *Burm.f.*	CB		
Sida alba *L.*	CB T	X	
Sida cordifolia *L.*	T		
Sida ovata *Forssk.*	CB T		
Sida rhombifolia *L.*	CB T		
Urena lobata *L.*	CB T	X	
Melastomataceae			
Dissotis canescens *(Grah.) Hook. f.*	MR		
Meliaceae			
Entandrophragma caudatum *(Sprague) Sprague*	CB		X
Melia azedarach *L.*	T		
Trichilia capitata *Klotzsch*	CB T		X
Trichilia emetica *Vahl* subsp. emetica	CB T		X
Turraea nilotica *Kotschy & Peyr.*	MR CB T		X
Turraea zambesica *Styles & F.White*	MA		X
Menispermaceae			
Anisocycla blepharosepala *Diels*	T		

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Cissampelos mucronata *A.Rich.*	MA CB T		X
Cissampelos pareira *L.* var. orbiculata *(DC.) Miq.*	T CB		
Cocculus hirsutus *(L.) Diels*	CB T MA?		X
Jateorhiza palmata *(Lam.) Miers*	CB		
Tiliacora funifera *(Miers) Oliv.*	T		
Tinospora caffra *(Miers) Troupin*	CB		
Tinospora mossambicensis *Engl.*	CB		
Tinospora tenera *Miers*	CB T		
Molluginaceae			
Corbichonia decumbens *(Forssk.) Exell*	MR CB T		
Glinus lotoides *L.* var. lotoides	T		
Glinus lotoides *L.* var. virens *Fenzl*	T		
Mollugo cerviana *(L.) Ser*. var. spathulifolia *Fenzl*	CB		
Mollugo nudicaulis *Lam.*	CB T		
Moraceae			
Ficus abutilifolia Miq. (F. soldanella)			X
Ficus bussei *Mildbr.& Burret* (F. zambesiaca)			X
Ficus capreifolia *Delile*		X	X
Ficus cordata *Thunb.* subsp. salicifolia *(Vahl) C.C.Berg*			X
Ficus sansibarica *Warb.*			X
Ficus sur *Forssk.*		X	
Ficus sycomorus *L.*		X	X
Ficus tettensis *Hutch.*		X	
Maclura africana *(Bureau) Corner*			X
Myrothamnaceae			
Myrothamnus flabellifolius *Welw.*	CB		
Myrtaceae			
Eucalyptus citriodora *Hook.* [gum tree]	Z		
Psidium guajava *L.* [guava]	T		
Syzygium cordatum *Krauss*	MR		
Syzygium cordatum *Krauss* x S. guineense *(Willd.) DC.*	MR		
Syzygium guineense *(Willd.) DC.* subsp. guineense	MR		
Nyctaginaceae			

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Commicarpus plumbagineus *(Cav.) Standl.*			X
Nymphaeaceae			
Nymphaea lotus *L.*	MA CB T		
Nymphaea nouchali *Burm.f.* var. caerulea *(Savigny) Verdc.* (N. caerulea)	MA	X	
Nymphaea petersiana *Klotzsch*	T		
Ochnaceae			
Brackenridgea zanguebarica *Oliv.*			X
Ochna leptoclada *Oliv.*	MR		
Ochna multiflora *DC.* (??)			X
Ochna puberula *N.Robson*	CB		
Olacaceae			
Olax dissitiflora *Oliv.*	CB T		X
Ximenia americana *L.*	CB T	X	X
Ximenia caffra *Sond.* var. caffra	Z CB T	X	X
Oleaceae			
Jasminum fluminense *Vell.*			X
Jasminum stenolobum *Rolfe*			X
Schrebera trichoclada *Welw.*		X	X
Onagraceae			
Ludwigia erecta *(L.) Hara*	MR CB T		
Ludwigia leptocarpa *(Nutt.) Hara*	CB T	X	
Ludwigia octovalvis *(Jacq.) Raven* subsp. brevisepala *(Brenan) Raven*	MR CB		
Ludwigia stolonifera *(Guill.& Perr.) Raven*	CB T	X	
Opiliaceae			
Opilia amentacea *Roxb.* (O. celtidifolia var. tomentella)	MR CB T		X
Oxalidaceae			
Biophytum abyssinicum *A. Rich.*	CB		
Oxalis semiloba *Sond.* subsp. semiloba	CB		
Papaveraceae			
Argemone mexicana *L.*	T	X	
Passifloraceae			
Adenia digitata *(Harv.) Engl.*	CB		

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Adenia gummifera *(Harv.) Harms* var. gummifera	CB T		
Adenia panduriformis *Engl.*	MR CB T		
Adenia stricta *(Mast.) Engl.*	CB T		
Basananthe hanningtoniana *(Mast.) De Wilde*	CB		
Periplocaceae			
Cryptolepis obtusa *N.E.Br.*			X
Stomatostemma monteiroae *(Oliv.) N.E.Br.*			X
Polygalaceae			
Polygala albida *Schinz* var. albida	CB		
Polygala erioptera *DC.*	MA CB T		
Polygala sphenoptera *Fresen.*	MR CB T		
Securidaca longipedunculata *Fresen.*	CB T		
Polygonaceae			
Persicaria attenuata *(R.Br.) Sojak* subsp. africana *K.L.Wilson* (Polygonum pulchrum)		X	
Persicaria senegalensis *(Meisn.) Sojak* (Polygonum senegalense)		X	
Portulacaceae			
Portulaca foliosa *Ker-Gawl.*	T		
Portulaca hereroensis *Schinz*	Z MA		
Portulaca oleracea *L.*	CB T		
Portulaca quadrifida *L.*	MA CB		
Talinum portulacifolium *(Forssk.) Asch.*	CB		
Talinum tenuissimum *Dinter*	CB		
Punicaceae			
Punica granatum *L.*	T		
Ranunculaceae			
Clematis brachiata *Thunb.*	CB T		
Clematis villosa *DC.* Subsp. kirkii *(Oliv.) Brummitt* (Clematopsis scabiosifolia)	MR		
Clematis viridiflora *Bertol.*	CB		X
Rhamnaceae			
Berchemia discolor *(Klotzsch) Hemsl.*	MR CB T	X	X
Gouania scandens *(Gaertn.) R.B.Drumm.*	CB		
Helinus integrifolius *(Lam.) Kuntze*	CB		X

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Ziziphus mauritiana *Lam.*	MA CB MR	X	X
Ziziphus mucronata *Willd.* subsp. mucronata	CB T		X
Ziziphus mucronata *Willd.* subsp. rhodesica R.B.*Drumm.*	CB		
Ziziphus pubescens *Oliv.* subsp. pubescens	T		X
Rhizophoraceae			
Cassipourea mollis *(R.E.Fr.) Alston*	CB		
Rubiaceae			
Bertiera sp. (??)	T		
Canthium glaucum *Hiern* subsp. frangula *(S.Moore) Bridson* (C. frangula)	CB		X
Canthium setiflorum *Hiern*	T		
Carphalea pubescens *(Klotzsch) Verdc.*	CB T	X	X
Catunaregam obovata *(Hochst.) A.E.Gonçalves*	CB T		
Catunaregam spinosa *(Thunb.) Tirveng.* subsp. taylorii *(S.Moore) Verdc*.			X
Chazaliella abrupta *(Hiern) Petit & Verdc.* var. abrupta	MR		
Crossopteryx febrifuga *(G.Don) Benth.*	MA MR CB		X
Feretia aeruginescens *Stapf*	MA MR CB		X
Gardenia resiniflua *Hiern* subsp. resiniflua	CB T	X	X
Gardenia ternifolia *Schumach.& Thonn.* subsp. jovis-tonantis *(Welw.) Verdc.*	MR		
Hymenodictyon parvifolium *Oliv.* subsp. scabrum *(Stapf) Verdc*.	MR CB		X
Kohautia longifolia *Klotzsch*	MR CB		
Lagynias dryadum *(S.Moore) Robyns*	CB T		X
Multidentia crassa *(Hiern) Bridson & Verdc.* (Canthium crassum *Hiern*)	MR CB		
Mussaenda arcuata *Poir.*	MR		
Oldenlandia affinis *(Roem.& Schult.) DC.* subsp. fugax *(Vatke) Verdc.*	CB T		
Oldenlandia capensis *L.f.* var. capensis	CB T		
Oldenlandia corymbosa *L.*	CB T		
Paederia bojeriana *(A.Rich.) Drake* subsp. foetens *(Hiern) Verdc.*	MR CB T		X
Pavetta cataractarum *S.Moore*	CB T		X

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Pavetta gardeniifolia *A.Rich.* var. gardeniifolia (P. assimilis var. glabra-brevituba)	CB		
Pavetta incana *Klotzsch* (P. klotzschiana)	T		X
Pavetta schumanniana *K.Schum.*	CB		
Pentas angustifolia *(DC.) Verdc.*	CB		
Polysphaeria sp.	T		
Psychotria kirkii *Hiern* var. kirkii	CB		
Psydrax livida *(Hiern) Bridson* (Canthium huillense)	CB		X
Psydrax martinii *(Dunkley) Bridson*			X
Psydrax parviflora *(Afzel.) Bridson* subsp. chapmanii *Bridson* (Canthium rubrocostatum)	CB		
Rothmannia fischeri *(K.Schum.) Bullock*	MR		
Rytigynia umbellulata *(Hiern) Robyns*	CB		
Spermacoce chaetocephala *DC.*	CB		
Spermacoce dibrachiata *Oliv.*	MR		
Spermacoce senensis *(Klotzsch) Hiern* (S. ruelliae)	CB		
Spermacoce sphaerostigma *(A.Rich.) Vatke*	CB		
Tapiphyllum velutinum *(Hiern) Robyns*	CB		
Tarenna luteola *(Stapf) Bremek.*	Z MA		
Tarenna mossambicensis *Hiern*	T		
Tarenna zygoon *Bridson* (Zygoon graveolens)	MA CB T		X
Tricalysia junodii *(Schinz) Brenan* var. kirkii *(Hook.f.) Robbr.*	MA MR CB		X
Tricalysia nyassae *Hiern*	MR		
Tricalysia revoluta *Hutch.*	CB		
Vangueria infausta *Burch.* (V. tomentosa)	CB T		X
Rutaceae			
Citropsis daweana *Swingle & M.Kellerm.*	CB		
Citrus aurantium *L.* [orange]	T		
Vepris zambesiaca *S.Moore*			X
Zanthoxylum chalybeum *Engl.*	CB T	X	X
Zanthoxylum leprieurii *Guill.& Perr.*	CB		X
Zanthoxylum sp. aff. Z. chalybeum *Engl.*	CB		
Salvadoraceae			

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Salvadora persica *L.*			X
Sapindaceae			
Allophylus africanus *Beauv.*	MR CB MA		
Allophylus rubifolius *(A.Rich.) Engl.*	CB T		X
Allophylus rubifolius x A. africanus	MA T		
Cardiospermum corindum *L.*	MR CB T		
Cardiospermum halicacabum *L.* var. halicacabum	CB T		
Deinbollia xanthocarpa *(Klotzsch) Radlk.*	T		X
Dodonaea viscosa *Jacq.*		X	
Haplocoelum foliolosum *(Hiern) Bullock*	MA MR CB T	X	X
Lecaniodiscus fraxinifolius *Baker*	MR CB T	X	X
Pappea capensis *Eckl.& Zeyh*.			X
Zanha africana *(Radlk.) Exell*	CB		
Sapotaceae			
Manilkara mochisia *(Baker) Dubard*		X	X
Simaroubaceae			
Kirkia acuminata *Oliv.*	MR CB T	X	X
Solanaceae			
Solanum incanum *L.*			X
Solanum tettense *Klotzsch*			X
Sterculiaceae			
Dombeya burgessiae *Harv.* (D. johnstonii) (D. nyasica)	MR		
Dombeya kirkii *Mast.*	MR CB		X
Dombeya rotundifolia *(Hochst.) Planch*.	MR		
Guazuma ulmifolia *Lam.* [ornamental tree]	T		
Hermannia glanduligera *K.Schum.*	MA MR T CB		
Hermannia kirkii *Mast.*	CB T		
Melhania acuminata *Mast.* var. acuminata	CB T		X
Melhania forbesii *Mast.*	CB T		
Sterculia africana *(Lour.) Fiori*	CB T	X	X
Sterculia appendiculata *K.Schum.*	T		X

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Sterculia quinqueloba *(Garcke) K.Schum.*	MR CB T	X	X
Waltheria indica *L.*	Z CB MR T MA	X	
Tiliaceae			
Corchorus aestuans *L.*	T		
Corchorus asplenifolius *Burch.*	MR		
Corchorus junodii *(Schinz) N.E.Br.*	T		
Corchorus kirkii *N.E.Br.*	T		
Corchorus olitorius *L.*	CB T		
Corchorus tridens *L.*	Z CB MR T		
Corchorus trilocularis *L.*	MA CB T		
Grewia bicolor *Juss.*	Z MA CB T	X	X
Grewia flavescens *Juss.* var. flavescens	Z MA MR CB T	X	X
Grewia flavescens *Juss.* var. olukondae *(Schinz) Wild*	Z T	X	X
Grewia forbesii *Mast.*	T		
Grewia gracillima *Wild*	MA		
Grewia hornbyi *Wild* (??)	CB		
Grewia inaequilatera *Garcke*	MA CB T		
Grewia lepidopetala *Garcke*	CB T	X	
Grewia micrantha *Mast.*	CB T		
Grewia microcarpa *K.Schum.*	MR CB		
Grewia monticola *Sond.*	MA MR CB	X	
Grewia pachycalyx *K.Schum.*	Z MA CB T		X
Grewia praecox *K.Schum.*	CB		X
Grewia sulcata *Mast.*	CB		
Grewia truncata *Mast.*	T		
Grewia villosa *Willd.*	CB		
Triumfetta annua *L.*	MR CB		
Triumfetta pentandra *A.Rich.*	MA MR CB T		
Triumfetta pilosa *Roth* var. nyasana *Sprague & Hutch.*	MR		
Triumfetta pilosa *Roth* var. tomentosa *Sprague & Hutch.*	CB		

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Triumfetta tomentosa *Boj.*	CB		
Turneraceae			
Tricliceras glanduliferum *(Klotzsch) R.Fern.*	CB T	X	
Tricliceras lobatum *(Urb.) R.Fern.*	CB		
Vahliaceae			
Vahlia capensis *(L.f.) Thunb.* subsp. vulgaris *Bridson*	T		
Vahlia dichotoma *(Murray) Kuntze*	CB T		
Vahlia digyna *(Retz.) Kuntze*	T		
Verbenaceae			
Premna senensis *Klotzsch*			X
Vitex ferruginea *Schumach.& Thonn.* (V. amboniensis)		X	
Vitex mombassae *Vatke*			X
Vitex payos *(Lour.) Merr.*			X
Vitex petersiana *Klotzsch*			X
Vitex schliebenii *Moldenke*			X
Violaceae			
Hybanthus enneaspermus *(L.) F.Müll.* var. enneaspermus	MR		
Vitaceae			
Ampelocissus africana *(Lour.) Merr.*	MA MR CB T		X
Ampelocissus multistriata *(Baker) Planch.*	CB		
Ampelocissus obtusata *(Baker) Planch.* subsp. kirkiana *(Planch.) Wild & R.B.Drumm.*	CB T		
Cayratia gracilis *(Guill.& Perr.) Suess.*	T		
Cissus cornifolia *(Baker) Planch.*	MR CB		X
Cissus cucumerifolia *Planch.*	T		
Cissus grisea *(Baker) Planch.*	MR CB T		
Cissus integrifolia *(Baker) Planch.*	T MA MR CB		X
Cissus quadrangularis *L.*			X
Cissus welwitschii *(Baker) Planch.*	MA CB		
Cissus sp. 1 *Schinz*	T		
Cissus sp. 2 *Schinz*	T		
Cissus sp. 3 *Schinz*	T		

Family/species/authority	**Gonçalves**	**CB lake**	**T/T land**
Cyphostemma barbosae *Wild & R.B.Drumm.*	CB		
Cyphostemma bororense *(Klotzsch) Wild & R.B.Drumm.*	MR CB T		
Cyphostemma buchananii *(Planch.) Wild & R.B.Drumm.*	MR CB T		
Cyphostemma congestum *(Baker) Wild & R.B.Drumm.*	CB		
Cyphostemma gigantophyllum *(Gilg.& Brandt) Wild & R.B.Drumm.*	CB		
Cyphostemma kirkianum *(Planch.) Wild & R.B.Drumm.*	T		
Cyphostemma lovemorei *Wild & R.B.Drumm.*	Z CB		
Rhoicissus revoilii *Planch.*	MR CB		
Zygophyllaceae			
Tribulus terrestris *L.*	CB T		

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