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CHAPTER 3
REDUNCINE ANTELOPE OF THE ZAMBEZI BASIN

Fenton Cotterill

3.1 INTRODUCTION

The Reduncini (also known as reduncine antelopes) is a tribe of large to medium sized antelopes found only within Africa. It comprises a diversity of waterbuck, reedbuck, puku, lechwe and kob. According to the established taxonomy (Ansell 1971), at least ten species encompassing numerous subspecies have been described to science. Two genera are recognized, namely *Redunca* and *Kobus*. With one exception, all extant reduncine antelopes share a predilection for wetlands in the African tropics: these wetlands are all located within the savanna biomes of south-central and northern Africa. Reduncines are reliant on surface water, and so do not occur far from perennial water bodies. These antelopes have evolved distinct adaptations to an aquatic life, exemplified by the elongated hooves of lechwe. They are entirely grazers and are gregarious, living in small family units (waterbuck and reedbuck) or large herds (lechwe and kob).

An especially high diversity of reduncine antelopes is centred in and around the Zambezi Basin. Several endemic populations of lechwe are restricted to within certain Zambezian wetlands: well known populations occur on the Kafue Flats, Bangweulu Basin and Okavango Delta. At least 16 distinctive populations affiliated to complexes of four species of lechwe occur within the modern limits of the region. The origins of this high diversity deserve detailed study but this has yet to be carried out. Until recently, very large herds of lechwe and equally large collective populations of waterbuck, puku and reedbuck occurred within suitable habitats in the Zambezi Basin. Numbers and distributions of all these populations have shrunk radically in recent decades. The role of these antelopes in the ecology of the wetlands, where a high biomass of herbivores concentrated, was likely to have been profound.

The huge herds of charismatic lechwe and kobs on open sunlit wetlands has repeatedly been marveled at, written about, and also exploited. A popular public image is of herds of lechwe plunging through the shallows of a central African wetland – as depicted on the cover of *Okavango: Sea of Land, Land of Water* (Johnson & Bannister 1977). Lechwe and kobs have become firmly established as flagship species for conservation. This began before the Second World War in the then Northern Rhodesia, where the colonial Game Management authorities were concerned over the future of the black lechwe around Lake Bangweulu, a concern heightened in the 1950s with the rapid decline in populations of Kafue and black lechwe. A major catalyst in conservation was the activities and advocacy of an NGO, the Game Preservation Society of Northern Rhodesia (that later became the Wildlife Society of Zambia). Indeed, the official journal of the Wildlife Society of Zambia was named "Black Lechwe", and the research journal of the Zambian Department of National Parks was named *The Puku.* This focus on these single species symbolized concern about the future of Zambia’s formerly rich wildlife.

3.1.1 **Geographical and taxonomic scope**

The focus of this review is on the evolution, diversification and current status of the Reduncini. This is the crux of the knowledge of a taxon regarding properties of biodiversity. With respect to the attributes of biodiversity knowledge, information pertaining to evolutionary biology and biogeography has been reviewed rather than the larger assemblage of detailed information published about the behaviour and ecology of the Reduncini in the Zambezi Basin and elsewhere in Africa.

The extent of the Zambezi Basin recognized in this review extends beyond its modern watersheds. It includes the entire modern drainage of the Zambezi as well as the Okavango Delta and its tributaries; and the Bangweulu and Mweru basins (northern Zambia). It also considers the Upemba and Rukwa depressions in the Democratic Republic of Congo (DRC) and Tanzania, respectively. This region encompasses much of Malawi, eastern Angola, southern Shaba Province of the DRC, central Mozambique, northeastern Botswana, and northern Zimbabwe. All of Zambia is included. This coverage is essential to account for the evolution of the Zambezi and neighboring drainage systems, and the biota therein, which have changed considerably over the past five million years since the Miocene.

The Bohor reedbuck (including a total of seven subspecies recognized by Ansell 1971) is excluded from this review because there is no evidence of the species occurring in the Zambezi Basin, nor in Malawi or Zambia, but it does extend into the Rovuma Valley of northern Mozambique and perhaps further south. Mountain Reedbuck, *R. fulvorufula*, does not occur within the Zambezi Basin; three subspecies have been described, the populations of which are restricted to suitable mountainous habitat in southern Africa (*R. f. fulvorufula*), north-east Africa (*R. f. chanleri*), and a relict population on Mount Adamua in Cameroon (*R. f. adamuae*). The Nile lechwe, *Kobus megaceros* is not specifically reviewed given its restricted distribution in southern Sudan and adjacent western Ethiopia. The Kob, *K. kob,* formerly widely distributed across the Guinean savannas of North Africa, is excluded for a similar reason. It is pertinent to note that *K. kob* (of which several allopatric populations have been described as subspecies) in equatorial Africa and the northern, Guinean savannas is very closely related to the pukus (*K. vardoni* and *K. senganus*), whose distribution centres on Zambia.

3.2 PHYLOGENETIC ORIGINS AND PALAEONTOLOGICAL BACKGROUND

3.2.1 Taxonomic preamble

With the exception of painstaking palaeontological research into various fossil beds in Africa (for example, Gentry 1990, Vrba 1979, Vrba *et al.* 1994) the study, and most especially resolution, of the systematics of reduncine antelopes has not kept pace with more utilitarian attention to their exploitation and conservation. Comparatively little has been published about the taxonomic status of the many described populations of the Reduncini, and the few available tend to focus on the lechwes (Ansell 1964, 1971, Ansell & Banfield 1980, Barclay 1933). Apart from Vrba *et al.* (1994), no systematic research of the Reduncini has employed the modern techniques and philosophy of modern systematics. This is unfortunate. It is difficult to state unequivocally how many species of reduncine antelopes occur within the Zambezi Basin or within Africa overall. Lack of data, and more especially its synthesis by modern phylogenetic systematists, is one cause of this deficiency. Another allied reason is that an objective concept of the species (one which objectively interprets mammalian diversity) has yet to be applied to the Reduncini, and indeed most other mammals.

The establishment of objective criteria to identify a reduncine species is obviously a prerequisite to study any aspect of its biology and generate reliable knowledge. Some discussion is devoted to this problem, given its impacts on scientific knowledge and biodiversity conservation. An underlying premise of this review is that the study of the ecology and behaviour of any aspect of an organism’s biology must be founded on accurate taxonomy. Such taxonomy must seek to "carve nature at its historical joints" and discover species and their historical relationships – to objectively identify real species, that is relevant evolutionary products of diversification. This procedure must unearth cryptic species yet avoid descriptions of artificial taxa. It is precisely this knowledge that is a prerequisite to frame scientifically-sound knowledge to conserve organismal biodiversity (Cracraft 1997, Dimmick *et al*. 1999, Soltis & Gitzendanner 1999). Indeed, the application of a more objective perspective on what species are (their ontology) confers profound implications on how the Reduncini are classified, and this in turn provides important lessons to the understanding of biogeography and biodiversity in the Zambezi Basin. The Reduncini constitute an important case study for the scientific study of biodiversity and its conservation in Africa and elsewhere. The perspective gained from understanding reduncine diversity is especially relevant to wetlands.

3.2.2 **Evolution**

The Reduncini evolved over 15 million years ago. The oldest known fossils are 11 million years old from East Africa. The group formerly occurred in Asia, as of 5 million years ago. It has been suggested that this dispersal out of Africa corresponded with mesic conditions that facilitated their dispersal down the Nile Valley. Diagnostic characters of reduncine antelopes are transverse ridges on their horns (only present in males), a large maxillary tuberosity, comparatively small cheek teeth, and no less than three other diagnostic characters of the lower and upper molar teeth (Gentry 1990, Kingdon 1982).

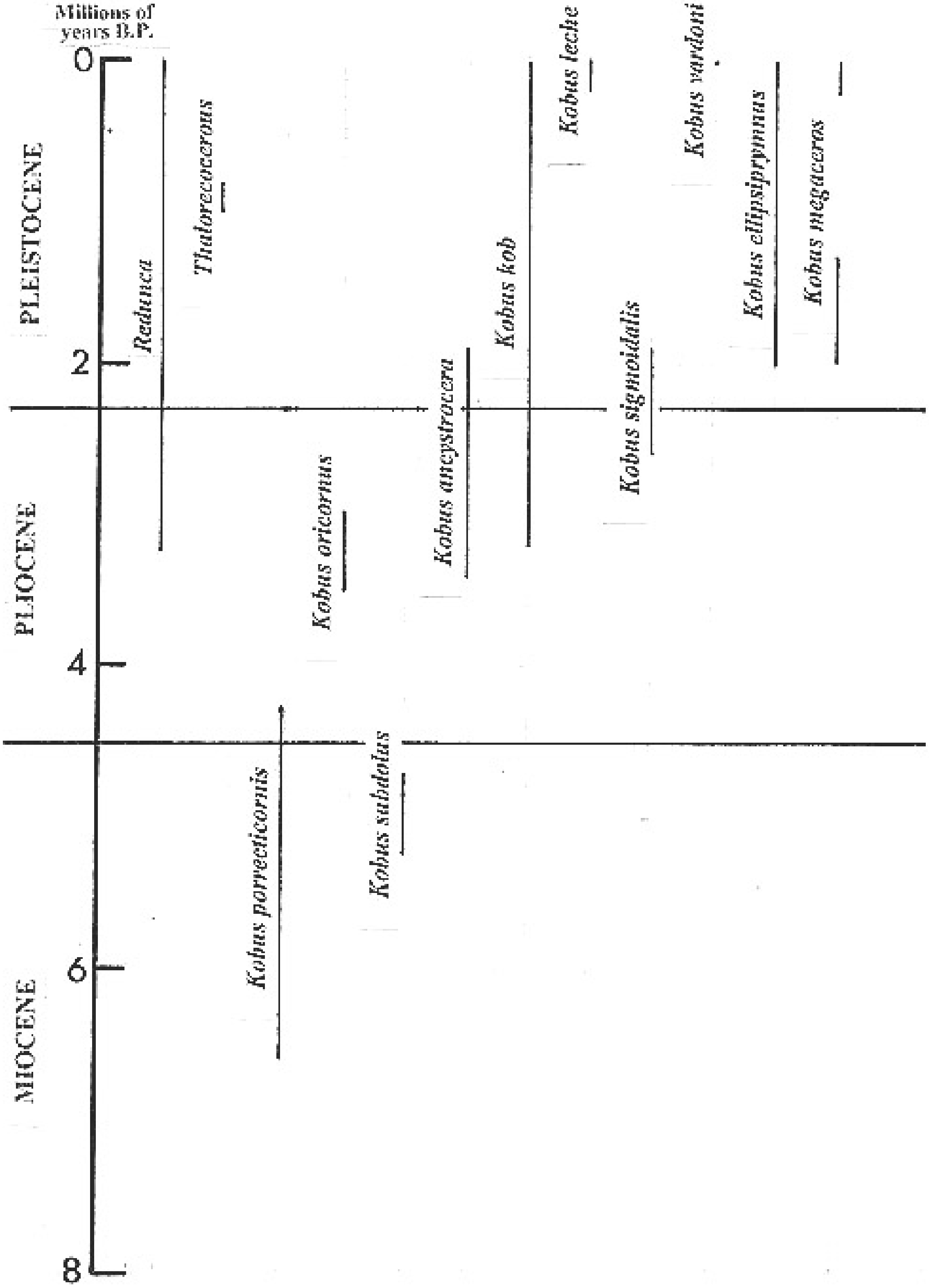
Reduncine fossils have been collected from many of Africa's fossil beds in Quaternary and Tertiary formations in Kenya, Ethiopia, Tanzania and South Africa. The earliest known fossils are assigned to *Kobus porrecticornis* (7-4.5 Million years ago [Mya]) and *K. subdolus* (5 Mya). A pulse of diversification of *Kobus* occurred in the late Miocene and early Pleistocene (Figure 3.1; Gentry 1990). Noteworthy records are that the lineage of "waterbuck", *K. ellipsiprymnus* and "Ugandan Kob", *K. kob* can be traced back to 2 and 3 Mya, respectively. The fossil reduncines assigned to "Red lechwe" *K. leche* and "Nile Lechwe" *K. megaceros* are far more recent – tens of thousands of years old.

The genus *Redunca* appears over 3.0 Mya. No less than three sympatric species have been discovered from the dolomite strata of northern South Africa, including examples of the extant *arundinum* and *fulvorufula*, and the extinct *R. darti* (McKee 1995). Exploration of geological formations likely to hold fossils in Zambia and northern Zimbabwe has yet to be carried out.

Nevertheless, the identity of the immediate ancestors of the Reduncini and their extant relatives is unclear. This uncertainty is evident in how inferences of higher level phylogeny have influenced classifications of the Bovidae. Vrba (1979) concluded that the Reduncini diverged from a clade which ultimately formed the Neotragini (stenbuck, suni, royal antelope and grysbucks). This treatment was followed by Meester *et al*. (1986) and Skinner & Smithers (1990). Neotragines are considered to be primitive antelopes, as exemplified by *Raphicerus sharpei* (Sharpe's grysbuck). Evidence for this relationship can be seen in puku, which possess a vestigial preorbital gland common to all neotragines. Additional evidence is represented in the ontogeny of horn growth in waterbuck, lechwe and reedbuck. Primitive swept back horns (a shared neotragine trait) in juveniles proceeds to the large, lyrate horns of the adult reduncine. Indeed, reduncine evolution has involved elaboration of horns and scent glands (Kingdon 1982).

In a different taxonomic treatment, Gentry (1990) placed the tribe Reduncini alongside its sister tribe Hippotragini (oryx, sable, roan and allies) to form the subfamily Hippotraginae, but acknowledged understanding of bovid relationships at this level (above the genus) to be poor. One derived character which Gentry considered shared among these antelopes is the enlarged basioccipital (where an enlarged longus capitis muscle inserts on the skull). This adaptation permits powerful and rapid downward head movements, and occurs in alcelaphines, hippotragines and reduncines: nevertheless, as Kingdon (1982)

Figure 3.1. Geological time scale showing the approximate durations of certain morphospecies of the Reduncini as established from the African fossil record since the late Miocene (modified from Gentry 1990).



argues, its possession does not necessarily infer common ancestry. Separate fossils from Langebaanweg, South Africa and Pinjor, Siwaliks, even suggest that Reduncini as currently recognized might be paraphyletic. In this respect, Gentry (1990) notes that the genus *Ourebia* (currently recognized as a neotragine) possesses certain characters more typical of reduncines than neotragines. This is apparent in the considerable similarity of the subauricular glands of oribi, *Ourebia ourebi*, and mountain reedbuck, *Redunca fulvorufula* (Kingdon 1982, Vrba *et al.* 1994). The inclusion of *Ourebia* in the Reduncini is also supported by dependence of oribi on mesic habitats and their need for surface water, and their loud whistling call reminiscent of reedbucks. Conversely, most other neotragines are adapted to dry forests, savannas and deserts, with one species occurring in moist forest. Given its resemblance to neotragines, but also reduncine affinities, the extant *Ourebia ourebi* could be a primitive reduncine.

3.2.3 **Adaptation to aquatic habitats and environmental disturbance**

The lechwe are unique among the reduncine antelopes in being able to live permanently in wetlands. Their adaptations represent extreme specialization. Kingdon (1982) has suggested that a neotragine ancestor of the Reduncini occupied tropical valleys and its descendants diversified to exploit valley grasslands, followed by adaptation to aquatic conditions in mesic environments. Nevertheless, wetlands are characterized by frequent disturbance, and the exploitation and associated specialization required to exploit wet grasslands exposed reduncines to such disturbances as diseases, parasites, fluctuating water levels associated with climatic extremes (floods to droughts), fires and predation.

Very recently (on a palaeoecological time scale), humans have become a dominant agent of disturbance in reduncine habitats, either through direct depredation, or habitat modification (especially through fire and hydrological developments), or by competition with livestock. However, disturbances has not all been caused by humans. Climate and tectonic-driven changes to wetlands appear to have had a major impact on reduncine diversity. These have caused dramatic and recent changes in the distribution and diversification of reduncine antelopes. In particular, comparatively recent disturbances (on an evolutionary time scale) to Zambezian wetlands are of considerable interest. The details and implications of these phenomena are considered in the final section of this review.

Some even more recent changes in distribution have also occurred. Fluctuations in the distribution of *K. leche* in northern Botswana since the mid-19th century exemplify the susceptibility of these antelopes to habitat change. David Livingstone during his search for Lake Ngami in 1849 collected the first specimens of *Kobus leche* known to science from its vicinity (Spinage 1994), while Andersson (1856) recorded hundreds of this species on the Taoghe Delta on the edge of Lake Ngami. This area was then perennial swamp. Today, the landscape supports open, semiarid grassland and the Taoghe river is dry. The lechwe of Lake Ngami are extinct. The nearest lechwe only occur in the Okavango, over 60 km to the north (Smithers 1971, Spinage 1994). This example illustrates how vagaries of changes in habitats have modified the distributions of these antelopes within very short time periods.

3.3 SOCIAL ORGANISATION AND BEHAVIOUR

3.3.1 **Sociality and adaptation to open, mesic habitats**

The social organization of nearly all currently recognized species of reduncines has been well studied, and is characterized by high levels of competition amongst males for mates. Only a minority of males secure territorial tenure and thus matings. These social systems have evolved in response to the comparative uniformity of the grassland and aquatic habitats exploited by reduncines, where high densities of antelopes congregate (Nefdt 1995, 1996, Rosser 1987). All reduncine antelopes live in herds, which reach their highest extremes in density and size in the kobs and lechwes. The behavioural organization of lechwe (Nefdt 1995, 1996, Thirgood *et al*. 1992), waterbuck (Hanks *et al.* 1969, Herbert 1972, Melton 1978, Spinage 1982), reedbuck (Howard 1986a, 1986b) and puku (de Vos 1965, de Vos & Dowsett 1966, Rosser 1987) have been studied in detail, focussing especially on social organization and mating systems.

The lek breeding system – based on territorial defence where only a minority of dominant males secure matings – are exemplified in certain lechwe, puku and kob. Significantly, the first record of lek breeding in a mammal was recorded in the Reduncini (*K. kob*, Buechner 1961). These social systems have evolved in response to high densities of antelopes in specific habitats. Territorial and other disputes between individuals are frequent and follow highly ritualized behavioural repertoires (Leuthold 1977). Lechwe exhibit significant diversity in breeding systems: *K. kafuensis* and *K. leche* (in the Linyanti) defend and mate on leks, but *K. smithemani* does not (Thirgood *et al*. 1992). These social systems of reduncines are correlated with their morphological adaptations. Chief amongst these are the scent glands and robust horns. Scent marks are important in denoting information about reproductive and social status (Kingdon 1982), thus the social organization of reduncines is dominated by olfactory cues. All reduncines have a strong musky odour from secretions of the sebaceous glands – waterbuck (*K. ellipsiprymnus*) are noted for their strong "turpentine-like" odour, and strong odours also characterize reedbuck and lechwe. It appears that reduncine scents are species-specific and are involved in recognition of conspecifics in territoriality and mate choice. A semiochemical function of scent marks has been demonstrated for two species of lechwe (Deustch & Nefdt 1992). A diversity of specialized scent glands in reduncines include subauricular, pedal and inguinal glands, and the scented fur is maintained by an oily secretion into the fur from the sebaceous glands (Kingdon 1982). Territorial, sexually active puku males have a glandular secretion on the neck (Rosser 1987).

Only male reduncines have horns. The evolutionary trend has been toward enlargement of horns, which has reached its extreme in lechwe and waterbuck. Large horns function as signalling devices and are used in ritual sparring among males over status, territories and mates. A key adaptation has evolved to allow the powerful and violent head movements of males, manifest in the thick necks of puku, lechwe and kob. Sexual dimorphism renders this trait especially noticeable in males. The conspicuous evidence of this adaptation has been hypertrophy of the longus capitis muscle underlying the spinal column, which contracts the neck and lowers the head. Enlargement of this muscle is associated with larger processes of the cervical vertebrae and the basioccipital processes at the base of the reduncine skull (Kingdon 1982).

3.3.2 **Ecological relevance**

A common trait of Reduncini is close association with aquatic habitats, and all are dependent on surface water. Lechwe, in particular, have a predilection for floodplains, a dependency that appears to be physiological and is presumably primitive in its evolution, being manifest throughout extant reduncines (Kingdon 1982) including Mountain Reedbuck, *Redunca fulvorufula* (Smithers 1971).

Several authors (Schuster 1976, 1980) have emphasized the impact of lechwe on floodplains, especially the Kafue and Bangweulu. Here, dense concentrations of lechwe represent an extreme manifestation of the phenomenon.

The dominant role of reduncine antelopes in the ecology of aquatic landscapes in Africa has been largely inferred. Williamson (1981) notes that grazing by lechwe in the Linyanti has had a major impact on the sward, reducing large areas to closely-cropped lawns. Apart from calculations of biomass, there has been no quantitative demonstration of the impacts of these antelopes on nutrient flux or effects on other populations (invertebrates, fishes and waterbirds). It is equally valid to infer that the specific habitat selection by reduncine antelopes will have a marked impact through their trampling of the substrate. This would especially apply to seasonal concentrations of these antelopes when breeding. In this respect, *K. smithemani* and *K. kafuensis* appear to hold a keystone role in certain aquatic landscapes, such as the Bangweulu and Kafue floodplains, due to trampling of the floodplain and participating in nutrient cycling. The biomass of Kafue lechwe has been recorded as the highest known carrying capacity for large mammals (11,000 kg/km^2), although this figure fluctuated with seasonal flooding regimes (Schuster 1980).

3.4 POPULATION STATUS AND HISTORICAL DECLINES

This section summarizes the status of Reduncini in significant areas within the Zambezi Basin, with a focus on the principal wetlands. The definitive source is East's (1989a, 1989b) multi- authored survey of the status and conservation of antelopes in southern and south-central Africa, which includes country reports and a regional review. Where possible, evidence for changes within the basin is included. The earliest records are from the writings of David Livingstone, who explored the Zambezi and some of its tributaries in the mid-19th century. Important records have been summarized by Benson (1974). Additional information can be obtained in the writings of later explorers and hunters, notably F.C. Selous (Selous 1881, 1908).

3.4.1 **Barotseland**

Populations of waterbuck and lechwe have declined within the region (Figures 3.2 and 3.3), as concluded from historical records since the early 20th century (Ansell 1960a, 1978). Waterbuck do not occur west of the Zambezi. Reedbuck appear widespread where human depredation is not excessive (East 1989a).

3.4.2 **South eastern and central Angola**

Populations of red lechwe and waterbuck extend from the Upper Zambezi valley within western Zambia into southern Angola (Figures 3.2 and 3.3). The status of waterbuck along the Cubango, Luiana and Okavango (Kavango) rivers is unknown, but they are suspected to have declined. Given the decline of the Namibian population, the overall status of this population (believed to be *penricei*) could be precarious. It is noteworthy that an isolated population of puku occurs in the Luando National Park in C Angola. Red lechwe occur along the Zambezi in E Angola and the Cuando in the south east within the Luiana and Mavinga Reserves (East 1989a). Red lechwe are considered rare in Angola (East 1989a) and their current status cannot be established. This situation is unsettling, as the taxonomic status of these populations (especially the widely separated populations of the Cubango, Luiana and Kavango rivers) is unclear.

Figure 3.2. Distribution of two species of waterbuck (*Kobus crawshayi, K. ellipsiprymnus*) in the Zambezi Basin (after Ansell 1978, Ansell & Dowsett 1988, East 1989a,b, Griffin & Joubert 1991, Rodgers 1984, Skinner & Smithers 1990). Distributions of *K. kondoensis* and *K. penricei* are not mapped in detail, being subject to future biogeographical and phylogenetic refinement. Hatched areas depict approximate distributions summarized by East (1989a,b) where specimen data could not be located. Open symbols are localities of historical occurrence.

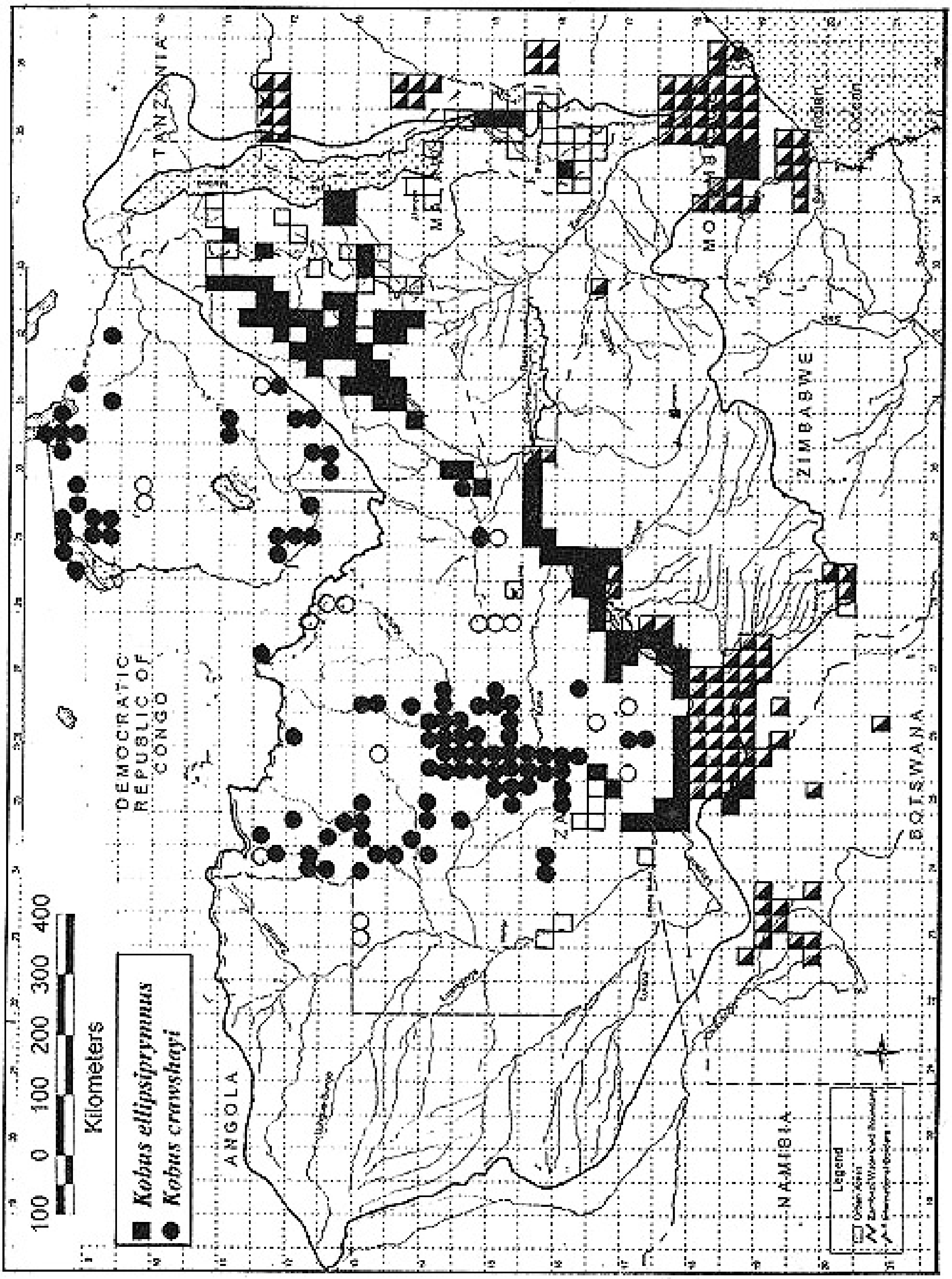
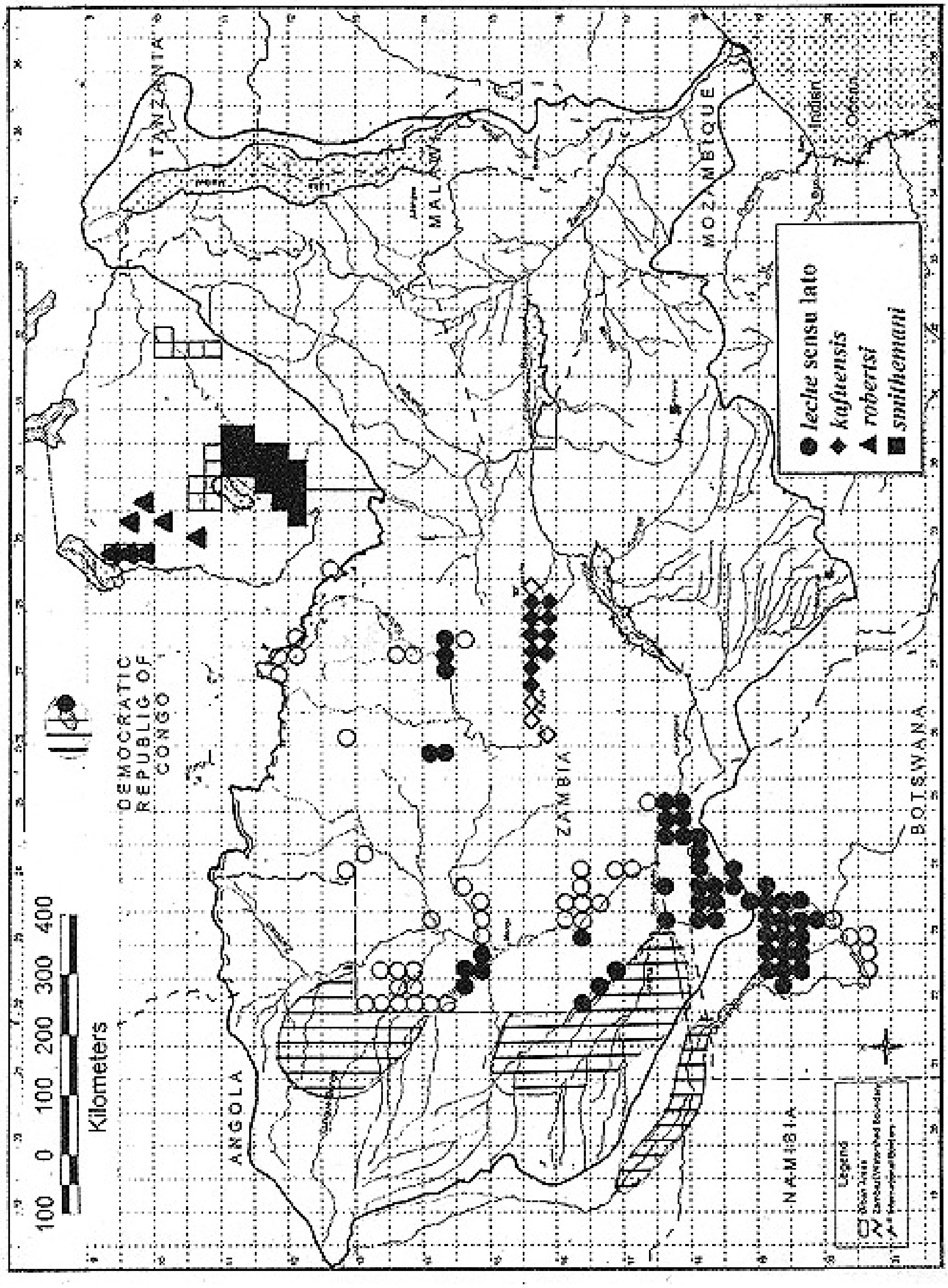


Figure 3.3. Distribution of four "subspecies" of lechwe (*Kobus l. leche* sensu lato, *K. l. kafuensis, K. l. robertsi*, *K. l. smithemani*) in the Zambezi Basin (data from Ansell 1978, Ansell & Dowsett 1988, Dollman 1921, East 1989a,b, Griffin & Joubert 1991, Smithers 1971, Skinner & Smithers 1990). Distributions of outlying allopatric populations of *K.* "*leche*" are also depicted which include *K. notatus* and *K. amboellensis*. Hatched areas depict approximate distributions summarized by East (1989a,b) where specimen data could not be located. Open symbols are localities of historical occurrence.



3.4.3 Caprivi and Chobe/Linyanti

Overall, reduncine populations have declined in the western Caprivi and certain species apparently occur marginally (East 1989a). Over the past 100 years, puku have declined greatly in the eastern Caprivi (East 1989a, Smithers 1983), and their status is marginal and precarious in Namibia (Figure 3.4). As of the 1980s, a relic population of approximately 50 animals persisted on the Chobe floodplain in Botswana (East 1989a, Smithers 1983). F.C. Selous first visited the Puku Flats in 1874, when puku were very numerous, but they were greatly disturbed by dense settlement in 1876 by refugees following political turmoil in Barotseland. They have never recovered from this human impact (Dollman 1921). Puku also declined to extinction on Impalila Island in the Caprivi after its settlement in 1958 (Child 1968).

It has been suggested that the total population of reedbuck within Namibia is approximately 50 individuals (East 1989a). Griffin & Grobler (1991) noted sightings of waterbuck in the eastern Caprivi between 1983 and 1987 but none since, and record a decline of waterbuck along the Kwando floodplain. Red lechwe are the exception. As of the late 1980s, a population of over 4300 occurred in the eastern Caprivi, and 150-200 in the western Caprivi. It has been estimated that several thousand red lechwe occur in the Linyanti area of Botswana, and these migrate seasonally into the Chobe floodplain (Williamson 1981, East 1989a).

3.4.4 Okavango Delta

Populations of reduncine populations appear healthy where human settlement has not excluded or depleted their populations. This includes stable populations of waterbuck (the Botswana national population of 900 is largely concentrated within the Okavango), reedbuck (small) and red lechwe. Over 20 000 red lechwe are estimated to occur in the Okavango.

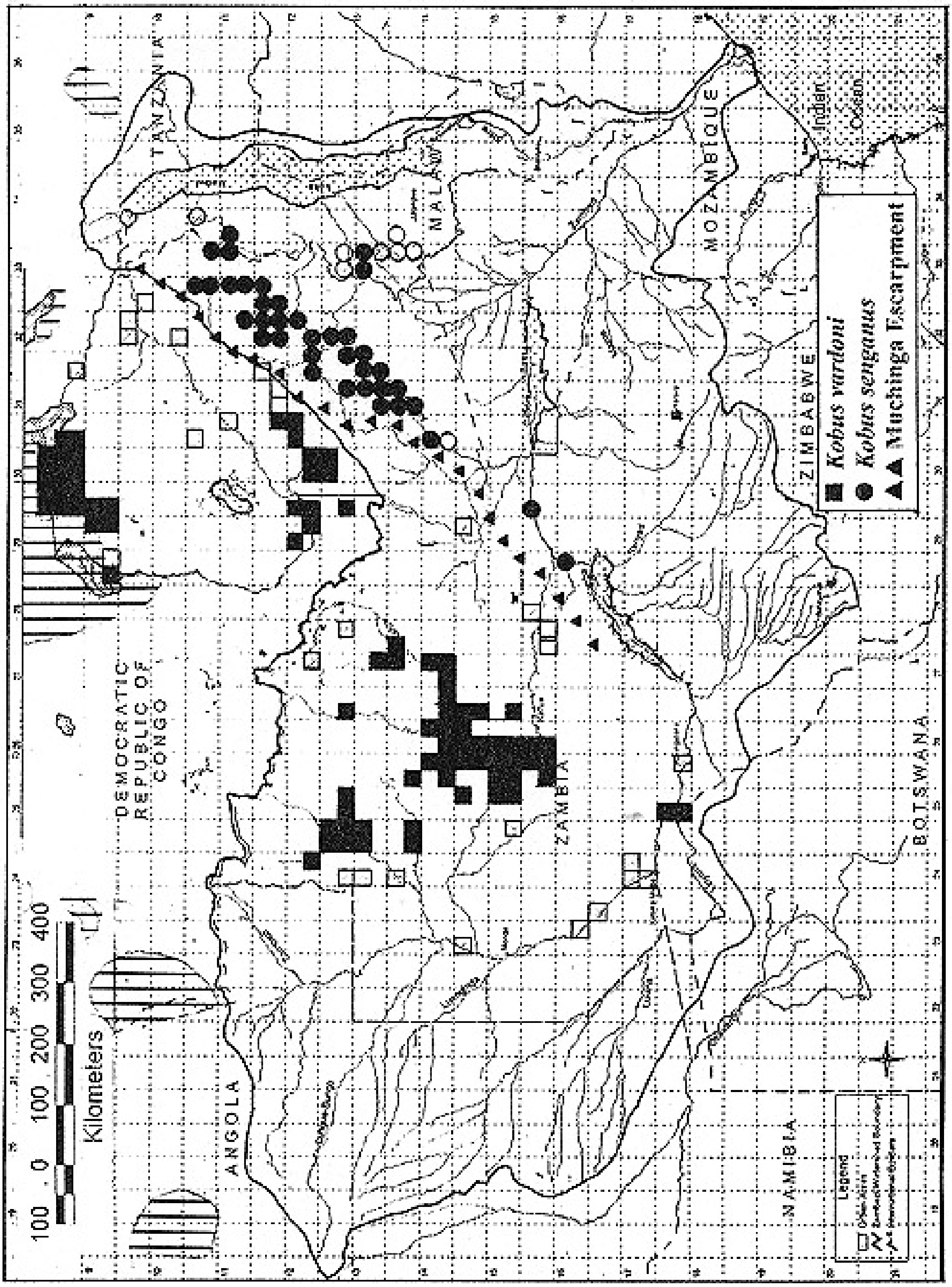
Smithers (1971) discusses the local extinction of lechwe from Lake Ngami since the last century. They were not encountered by the Vernay-Lang Kalahari expedition which crossed Lake Ngami in May 1930, and which went on to collect 10 red lechwe from the vicinity of the Kwaai River from 6-28 May 1930 (Hill 1942).

3.4.5 Bangweulu Flats

Black lechwe formerly occurred in their hundreds of thousands in the Bangweulu Basin in the early part of the 20th Century (Allen 1963, Ansell 1978, Bell & Grimsdell 1973, Howard *et al.* 1984, Hughes 1933, Letcher 1910, Thirgood *et al.* 1994). The biology and status of black lechwe and their environment has been the subject of a comprehensive report (Grimsdell & Bell 1975). The population has since undergone a dramatic decline both in its range and abundance. This extirpation elicited considerable concern and much subsequent study.

The major cause of the decline of *K. smithemani* has been accelerated human depredations – much of it driven by commercial poaching to supply protein demands on the Copperbelt. This commercialization of exploitation changed what had previously been a localized economy of subsistence hunting by the resident people (Batwa, Baunga and Bisa tribes). Modern technology – in the form of firearms for hunting, and vehicles for transportation – aided and accelerated these depredations (Grimsdell & Bell 1976). An added mortality agent was predation by the abundant lion, *Panthera leo*, population in the Mpika District of Lake Bangweulu in the mid-20th century. Following a drastic decline in the prey populations of the miombo savannas surrounding the wetland, these lions modified their hunting behaviour to a semi-aquatic existence, successfully hunting Black Lechwe (Allen 1963).

Figure 3.4. Distribution of two species of puku (*Kobus senganus* and *K. vardoni*) in the Zambezi Basin (data from Ansell 1978, Ansell & Dowsett 1988, Griffin & Joubert 1991, Rodgers 1984, Skinner & Smithers 1990, Smithers 1971). The taxonomic status of the isolated populations in Tanzania are not known. The cross-hatched line approximates the Muchinga Escarpment. Hatched areas depict approximate distributions summarized by East (1989a,b) where specimen data could not be located. Open symbols are localities of historical occurrence.



It is noteworthy that an abnormally high flood after 1936 significantly depleted numbers of *K. smithemani*, which dropped from at least 150,000 to 40-60,000 individuals. The raised water level squeezed the population into the remaining habitat, where they were also more susceptible to intense hunting that began with poaching for meat rations during the Second World War, and was commercialized thereafter. Numbers declined to about 16,000 in 1969.

This episodic flooding illustrates the comparative susceptibility of a large herbivore with specific habitat requirements, although in the case of lechwe it is offset by their high reproductive potential. Grimsdell & Bell (1976) estimated a population increase approximating 25% from 16,000 in 1969 to 30,000 in 1976. Based on repeated censuses from 1988 to 1991, the latest report (Thirgood *et al.* 1994) records the population of *K. smithemani* in the southern Bangweulu to have recovered to approximately 30,000 individuals. It remains threatened by poaching and improved access to the area (especially in the west). Thirgood *et al.* (1994) emphasize the importance of securing the Chimbwi Plain as a dry season refuge for the population.

3.4.6 **Lake Mweru**

I have not been able to obtain reports which focus directly on the reduncines occurring on the margins of Lake Mweru and its tributaries. This is unfortunate. Ansell (1974) paid some attention to the taxonomic position and status of the Luena lechwe, *K. robertsi* – concluded to be extinct (Figure 3.3).

3.4.7 **Busanga Flats, Kafue National Park**

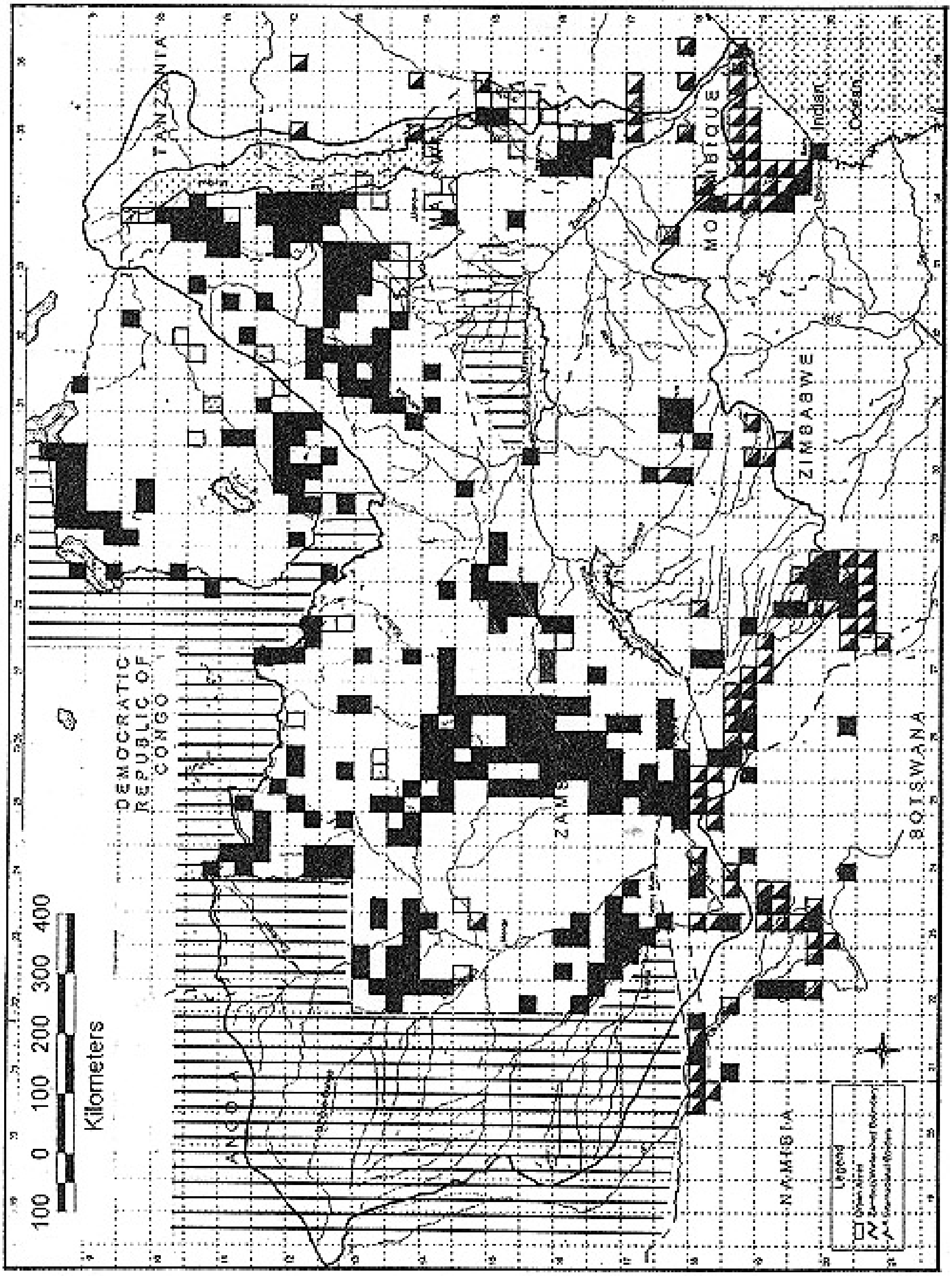
Rapid recovery of lechwe populations has been recorded in the northern region of the Kafue National Park (Figure 3.3), where the red lechwe population had recovered from an estimated 71 animals in October 1948 to 1163 in July 1971 (Grimsdell & Bell 1972). The most recent report estimated that this population numbered 3400 in 1985 (Howard & Chabwela 1987). The latter census covered both wet and dry seasons.

3.4.8 **Kafue Flats**

The Kafue Flats are of significant conservation status as the endemic Kafue lechwe is entirely restricted to this locality (Figure 3.3). The formerly widespread population is now restricted to Blue Lagoon and Lochinvar National Parks. Construction of hydroelectric schemes (centered on the Kafue Dam) were predicted to cause major disruptions to the Kafue Flats and its biota. Alteration of the flooding regime was particularly expected to affect Kafue lechwe by impacting on their social behaviour (Schuster 1980). Numbers declined by 50% between 1972 and 1981, but their total distribution has not changed significantly. Long term affects of this acute hydrological perturbation on the Kafue biota have still to be established (East 1989a, Sheppe 1985). The leks of Kafue lechwe are restricted to a remarkably small area (Nefdt 1996). Nonetheless, the reproductive seasonality of Kafue lechwe has since changed with a modification in timing of floods released from impoundments upstream. The primary cue that initiates mating appears to be rising flood waters: young born seven months later benefit nutritionally from exposed forage as waters recede from the floodplain (Nefdt 1996). Nefdt (1996) records that although Kafue lechwes mate and conceive throughout the year, a significant peak in births occurs in periods of maximal forage availability (over a period of one to two months), especially when water levels on the floodplain are receding and exposing nutritious forage.

A recent visit to Lochinvar National Park in October 1999 and discussions with local authorities revealed that commercial poaching of *K. kafuensis* is rife, especially in Blue Lagoon National Park, where depredations are unsustainable.

Figure 3.5. Distribution of southern and northern reedbuck (*Redunca arundinum* and *R. occidentalis*) in the Zambezi Basin (data from Ansell 1978, Ansell & Dowsett 1988, East 1989a,b, Griffin & Joubert 1991, Skinner & Smithers 1990). No attempt has been made to distinguish between distributions of the two populations. Hatched areas depict approximate distributions summarized by East (1989a,b) where specimen data could not be located. Open symbols are localities of historical occurrence.



3.4.9 Lower Shire and Malawi

Waterbuck and reedbuck (Figures 3.2 and 3.5) originally occurred throughout the Lower Shire in suitable habitat (Ansell & Dowsett 1988). These populations were virtually extirpated with widespread settlement by rural human populations and associated development. They only persist in the Liwonde and Majete Reserves. Reedbuck still occur in certain protected areas, notably Nyika National Park (East 1989a). Elsewhere in Malawi, waterbuck only survive in protected areas such as Liwonde National Park and Nkhotakhota and Majete Game Reserves. It appears to be declining in the Kasungu National Park and is believed extinct in the Vwaza Marsh Game Reserve (Ansell & Dowsett 1988). Puku have always had a very restricted distribution in Malawi (Ansell & Dowsett 1988, Lyell 1913; Figure 3.4).

3.4.10 Middle Zambezi Valley

Healthy populations of waterbuck persist within the protected areas across the middle Zambezi Basin, including Matusadona, Mana and Zambezi National Parks, and where human settlement has not reduced their numbers in suitable habitat (East 1989a). Reedbuck appear to be absent from large parts of the middle Zambezi Valley, and occur locally in northwestern Zimbabwe upstream of Victoria Falls. Reedbuck appear to have declined within the region, possibly due to increased aridity. Large numbers of waterbuck and reedbuck were extirpated in the Sebungwe and Urungwe regions of Zimbabwe during Tsetse Control operations into the 1960s – a total of 16,644 reedbuck and 10,371 waterbuck were shot between 1933 and 1958 – the majority from the Middle Zambezi Valley. The falling proportion of these reduncines' contribution to total kills through this period suggests a significant impact on the population (Child & Riney 1987).

3.4.11 Zambezi Delta and Gorongosa

Important populations of reedbuck and waterbuck persisted in Sofala Province and southern regions of the Zambezi Delta into the 1980s, but experienced major depredations thereafter. The northern region of Sofala Province (including Gorongosa and Marromeu) was estimated to support 90% of the vulnerable waterbuck population in Mozambique (East 1989a).The first census in 1968 suggested a population of 4300 waterbuck, concentrated in south and central Marromeu (Tinley 1969). A survey in June 1994 revealed that intact populations of reedbuck occurred in Gorongosa National Park, but comparatively few were seen in Marromeu. Previously, the waterbuck population in Marromeu was of the order of 50,000 in the late 1970s, but the 1994 census estimated that only between 33 and 230 animals had survived (Cumming *et al.* 1994). Given the localized, apparently allopatric range of this waterbuck population (Figure 3.2), its taxonomic status requires investigation. Originally, reedbuck were widespread and common where human depredations are not excessive, with Marromeu-Gorongosa being the stronghold of the species in Mozambique. They also appear to have benefited from a partial drying out of the Marromeu floodplain during the 1980s. Chambal (1989) suggested that very few reedbuck (21) existed in Marromeu in 1988, and Cumming *et al.* (1994) estimated the total population of central Marromeu at a meagre 10 individuals. These figures appear to be underestimates as Anderson *et al.* (1990) estimated the population of the ecotone and floodplains (admittedly a larger area) at 260. Nonetheless, reedbuck have declined catastrophically since the 1970s. Recent catastrophic crashes in these reduncine populations (and other large mammals) have obviously created a conservation crisis in the region. Most recently (July 1999), the population of reedbuck appears to be recovering.

3.5 TAXONOMY AND STATUS OF REDUNCINE POPULATIONS

I have attempted to identify each significant population of the reduncine antelopes that have been recognized by taxonomists at the subspecific level or higher, and/or have been recognized as discrete populations with definite geographical boundaries. Thus the following species accounts apply the species category loosely and would be better labelled "population accounts". They provide short reviews of the taxonomy and distribution of each discrete population (selected mainly on subspecific criteria), with a synopsis of the current status of each. The accounts form an introductory framework to review the diversity of the Reduncini in more detail to elucidate a more accurate taxonomy. Conservation status is derived from East (1989a, 1989b).

I place particular emphasis on the evolutionary distinction of a species. This recognizes most allopatric populations as full species, and is in direct conflict with the traditional orthodoxy of the Biological Species Concept (BSC) with its firm reliance on reproductive isolation. A significant departure from this orthodoxy is that the concept of subspecies is not applied (see Cracraft 1997 for further discussion). The differences, and especially the implications and impacts for conservation, of this two philosophies are important, and are discussed in detail in the next section.

REEDBUCK

Southern Reedbuck, *Redunca arundinum*

Taxonomy and Distribution

R. arundinum is sympatric with the Bohor reedbuck, *R. redunca* in W Tanzania in the drainage of the Ugalla and Moyowosi rivers. Key characters distinguishing these species include the number of inguinal pouches, pelage and horn shape (Ansell 1971).

Two subspecies were recognized by Ansell (1971), who notes that *thomasinae* Sclater, 1900 (from the Songwe River separating Tanzania and Malawi) has priority over usage of *occidentalis*, should the northern race prove separable:

R. a. arundinum (Boddaert,1785) includes *eleotragus* Schreber,1787; *coerulescens* Link,1795; *arundinacea* Bechstein,1799; *cinerea* Bechstein,1800; *isaellina* Afzelius,1815; *oleotragus* Desmoulins,1822; *multiannulata* Fitzinger,1869; *caffra* Fitzinger,1869; and *algoensis* Fitzinger, 1869.

The southern reedbuck was formerly widely distributed in the Zambezi Basin in all the riparian states, wherever suitable habitat occurs.

Status

Status of this widely distributed species varies from Vulnerable to Least Concern. Southern reedbuck have declined within large parts of their former range due to human settlement and depredations. They still persist along dambos within the southern catchment of the Middle Zambezi, but have declined in W Zimbabwe apparently due to increasing aridity. The large population of C Mozambique appears Near Threatened in Gorongosa and is Endangered in Zambezi Delta (Marromeu floodplain) based on a catastrophic decline since the 1970s (Cumming *et al.* 1994).

Northern Reedbuck, *Redunca occidentalis* Rothschild, 1907

Taxonomy and Distribution

Widely distributed through Gabon, N Angola, DRC, Zambia, Tanzania, and possibly N Mozambique and N Malawi. The taxonomic treatment by Ansell (1971) is provisional and it is uncertain where the two taxa (*arundinum* and *occidentalis*) actually occur in the Zambezi Basin, particularly in the southern regions. In all respects, *Redunca arundinum* (*sensu lato*) is an antelope associated with the southern savannas – a distributional pattern which distinguishes it from *R. redunca*, the Bohor reedbuck.

In conclusion, the available evidence suggests that two different populations of reedbuck occur within the Zambezi Basin; their exact distributions and taxonomic status await elucidation. Lydekker & Blaine (1914) differentiated between the two taxa on the greyer fur of the neck and grey tail of *occidentalis* compared with *arundinum*. It remains to be ascertained whether this character represents a geographical cline across Africa, or represents discontinuous variation. Overall status is Vulnerable. Reedbuck have declined in parts of Zambia, and especially in Malawi (Figure 3.5).

Table 3.1. Comparison of taxonomic units recognizing by lumping or splitting reduncine taxa at the population level within the genera *Kobus* and *Redunca* that occur within the Zambezi Basin. *K. ellispsiprymnus* in the central (and particularly NE) Zambezi Basin could be specifically distinct from the topotypical population of N South Africa and S Botswana. It is unclear whether the Tanzanian population of puku in the Rukwa and Kilombero valleys is *vardoni* or *senganus*.

Biological species	**Subspecies**	**Evolutionary species**
R. arundinum	R. a. arundinum	R. arundinum
	R. a. occidentalis	R. occidentalis
K. ellipsiprymnus	K. e. ellipsiprymnus	K. "ellipsiprymnus"
	K. e. crawshayi	K. crawshayi
	K. e. kondoensis	K. kondoensis
	K. e. penricei	K. penricei
K. leche	K. l. leche	K. leche (restricted to Okavango Delta)
	K. l. amboellensis	K. amboellensis
	K. l. notatus	K. notatus
		K. "leche - Busanga"
		K. "leche - Upemba"
		K. "leche - Luando"
	K. l. smithemani	K. smithemani
	K. l. robertsi	K. robertsi
	K. l. kafuensis	K. kafuensis
K. vardoni	K. v. vardoni	K. vardoni
	K. v. senganus	K. senganus
		K. "vardoni - Tanzania"
		K. "vardoni - Luando"
Relevant populations **4**	**14**	**19+**
Total species **4**	**4**	**19+**

WATERBUCK

Common Waterbuck, *Kobus ellipsiprymnus*

Taxonomy and Distribution

Two broad divisions within *K. ellipsiprymnus sensu lato* have been traditionally recognized by taxonomists. These are the *defassa* group (discussed below) and *ellipsiprymnus* group. The major character distinguishing the two forms is the elliptical ring of pale fur on the rump (*ellipsiprymnus*) versus a pale patch (*defassa*). Haltenorth (1963), followed by Ansell (1971), recognized eight subspecies under the vaguely defined *defassa* group.

It appears that the majority of waterbuck within the Zambezi Basin belong to the nominate *ellipsiprymnus*. These two species groups (*defassa* and *ellipsiprymnus*), formalized by Ansell (1971) for *K. ellipsiprymnus sensu lato*, have been recognized in later treatments (Meester *et al.* 1986), but the situation remains confused. Most importantly, the exact geographical and taxonomic relationship of *ellipsiprymnus* with *penricei, crawshayi* and *kondoensis* awaits elucidation. The relationship between *kondoensis* and *ellipsiprymnus* along the northeastern edge of the latter's range is equally unclear. The distribution of *kondoensis* centres on C and E Tanzania, but its southern limits (bordering *ellipsiprymnus*) and northern limits (bordering *thikae* (Matschie, 1910)) are unknown.

Status

Endangered in C Mozambique. Elsewhere, waterbuck are widely distributed within the southern and eastern portion of the Zambezi Basin where suitable habitat occurs and human impacts are not excessive. Ansell & Dowsett (1988) and East (1989a) do not state which taxon occurs in Malawi, but it is thought to be *ellipsiprymnus* (C. Dudley, pers. comm.)

Kondo Waterbuck, *Kobus kondoensis* (Matschie, 1911)

Taxonomy and Distribution

The distribution of the Kondo waterbuck is centred in S Tanzania, but the southern and northern limits to this population have yet to be established. It has been classified in the *ellipsiprymnus* group – apparently closely related to the nominate race (Ansell 1971). I draw attention to this population, because its possible occurrence within the northeastern margin of the Zambezi Basin needs to be considered. Here it would occur parapatrically, or perhaps sympatrically, with *ellipsiprymnus* and/or *crawshayi*.

Status

Indeterminate. This situation that can only be resolved by a thorough systematic study of this population and its allies. The population of waterbuck extending west of Lake Tanganyika to Lake Mweru could represent this *K. kondoensis* (Figure 3.2).

Crawshay's Waterbuck, *Kobus crawshayi* P. L. Sclater, 1894

Taxonomy and Distribution

Typically classified as *K. defassa crawshayi*, the distribution of Crawshay's waterbuck is centred on the southern Congo Basin west of the Muchinga Escarpment. It also has a scattered distribution across south eastern Tanzania, where its relationship with *kondoensis* is uncertain. The Muchinga Escarpment forms a significant southwestern boundary to its distribution. In a localized area along the Lusemfwa River, *crawshayi* occurs sympatrically with *ellipsiprymnus*, and hybridization has been recorded (Ansell 1978). Ansell (1982) also describes hybrids of these waterbucks near Ngoma in Kafue National Park, but no progeny appeared to survive.

In Zambia, Crawshay's waterbuck has often been called the Defassa waterbuck, *K. defassa* (for example, Hanks *et al.* 1969, De Vos & Dowsett 1966). This is strictly speaking incorrect as true Defassa waterbuck only occur in S and C Ethiopia (Ansell 1971).

Status

Vulnerable. Endangered locally within its formerly wide range. Its exact status requires elucidation of the northern extent of its distribution. Populations have been established on private game ranches in S Zambia (A. Middleton, *pers. comm.* 1990). Griffin & Grobler (1991) record the occurrence of a few individuals, which they designate *K. e. crawshayi*, in the Zambezi area of the Caprivi between 1983-1987. These are perhaps better allocated to *K. penricei*.

Penrice's Waterbuck, *Kobus penricei* Rothschild, 1895

Taxonomy and Distribution

The distribution of Penrice's waterbuck is centred in S and C Angola in the drainage of the Okavango, Upper Cunene and Kwando rivers, and the population extends marginally into the Caprivi. The type specimen was collected "from Bongo, Kuvali River, 100 miles (approx.) S.E. of Benguella" (Shortridge 1934: 528). This distribution was noted by Shortridge (1934) who, citing D.G. Lancaster (*in litt.*), mapped the range of *penricei* eastwards along the Chobe River in Angola to Shesheke in SW Zambia. In this context, *crawshayi, penricei* and *ellipsiprymnus* exhibit a parapatric distributional pattern across the region of E Caprivi and the Chobe-Zambezi confluence, a situation not followed by Ansell (1978). It remains to be established whether historical records of waterbuck along the Upper Zambezi (Ansell 1978) are referable to *penricei* or *ellipsiprymnus*.

This uncertainty is reflected in recent reviews of southern African mammals (Smithers 1983, Skinner & Smithers 1991) which do not cite the occurrence of *K. penricei* in southern Africa (the W Caprivi) and only recognize *K. ellipsiprymnus*. Nevertheless, the authoritative *Classification of Southern African Mammals* (Meester *et al.* 1986) recognizes both *ellipsiprymnus* and *penricei* as occurring in southern Africa. Here, *penricei* is listed provisionally, based on the occurrence of vagrant individuals in the Caprivi from Angola. In a final word on its status, Meester *et al.* (1986) quote W.F.H. Ansell (*in litt.*) that *ellipsiprymnus* and *defassa* (including *penricei*) form parts of a superspecies.

As with the other populations of waterbuck, the status of *penricei* is difficult to ascertain, especially with respect to *crawshayi*. Lydekker & Blaine (1914) distinguished between the darker- furred *penricei* and lighter-furred *crawshayi*. It is perhaps pertinent to note that Letcher (1910) distinguishes two varieties of "*defassa*" waterbuck – a paler-furred population south of Lake Mweru and west of the Muchinga Escarpment "in eastern Northern Rhodesia", and a darker-furred variety he only encountered and shot in the western part of the country.

Although Ansell (1971) lists *penricei* as also occurring in the southwestern DRC and S Gabon, it is unlikely that this vast area is inhabited by only a single waterbuck taxon. As with the other described populations occurring within the basin, similar taxonomic problems apply to *penricei*, a problem that can only be resolved by a thorough systematic review.

Status

Vulnerable and likely Endangered in Angola. Its exact status requires elucidation of the overall distribution of *K. penricei*, especially along its northern and eastern margins. The population of waterbuck has declined on the Kwando floodplain in Namibia. No individuals were recorded in the Kavango, Linyanti or Zambezi areas, but reasons for this decline are unknown. Some individuals, attributable to either *crawshayi* or *penricei* were recorded from the Zambezi area of Namibia (E Caprivi) between 1983 and 1987, but have not been resighted (Griffin & Grobler 1991).

LECHWE

Black Lechwe, *Kobus smithemani* (Lydekker, 1900)

Taxonomy and Distribution

The taxonomic distinctiveness of the smaller, darker coloured lechwe in N Zambia was recognized early in the 20th century, although queried by Barclay (1933). Male black lechwe had long been sought after as trophies (Lyell 1913), so this antelope was unquestionably recognized as distinct. Ansell (1964) recognized this, which had previously been unquestioned by conservation authorities. This taxonomic distinctiveness, exhibited in darker colouration and shorter horns of *smithemani*, was conclusively demonstrated by Ansell & Banfield (1980). Black lechwe formerly occurred along the northern shores of Lake Bangweulu, and also in the upper reaches of the Chambeshi River (Ansell 1978), but these populations were extirpated in the early part of this century.

Kobus smithemani only occurs along the southern and eastern margins of Lake Bangweulu, where the population migrates seasonally as water levels fluctuate. The core area used by black lechwe focuses on Chikuni Island, which only becomes isolated during high water levels (Grimsdell & Bell 1975).

Status

Vulnerable. The numbers of *K. smithemani* have recovered from a radical decline through the 1950s. The majority of this population is concentrated in the southern Bangweulu floodplain, and the localized extent of this habitat means that the population is at risk of disease (such as anthrax and rinderpest) and political unrest. A recent visit to the Bangweulu Flats in October 1999 revealed large herds in the vicinity of Chikuni Island and its surrounds. Black lechwe herds were encountered over 10 km west and 5 km east of Chikuni Island. Subsistence poaching continues as shown by the abundance of skulls a few months old on the floodplain. The population of *K. smithemani* in the western reaches of the Bangweulu Flats is exposed to commercial poachers who exploit improved access from the tarred Mansa-Serenji road (R. Nefdt, *pers. comm.* 1999).

Kafue Lechwe, *Kobus kafuensis* Haltenorth, 1963

Taxonomy and Distribution

The population of lechwes confined to the Kafue Flats of S Zambia had flippantly been described as "red lechwe" into the 1960s. The Kafue lechwe was only described as taxonomically distinct in 1963, although this had previously been suspected and even tacitly acknowledged (see Ansell 1964). *K. kafuensis* is larger than other lechwe, with larger horns (Ansell 1964). The morphology of the inguinal glands also differ from other lechwe (Ansell 1960b). *K. grandicornis*, Ansell 1964 is a synonym of *kafuensis*.

Status

Endangered. Although, the numbers of Kafue lechwe have recovered from a radical decline through the 1950s, they have not recovered to former densities or range. The majority of this population occurs in the Lochinvar National Park (with a smaller population in Blue Lagoon National Park), but is dependent on resources outside of the protected area on commercial farms and densely settled areas (East 1989a). The leks, essential for breeding, are remarkably localized in their number and location – only five existed between 1990 and 1991 within the entire range of this species on the south bank of the Kafue Flats. Despite intensive surveys, no other leks were located (Nefdt 1996). The localized extent of this habitat means that the population is at risk of disease (perhaps anthrax and rinderpest) and human depredations. A recent visit to Lochinvar in October 1999, and discussions with resident biologists and safari operators in Zambia, revealed that commercial poaching of *K. kafuensis* is rampant, especially in Blue Lagoon National Park. This situation appears to be severe and requires drastic action if the species is not to decline to extinction.

Red Lechwe, *Kobus leche* (Gray, 1850)

Taxonomy and Distribution

Based on the entrenched taxonomic classification, reduncine antelopes affiliated to the nominate race of the red lechwe are believed to exhibit an extensive, albeit scattered, distribution across the modern Zambezi Basin, with outliers in SE and C Angola, and southern Shaba province of the DRC (Ansell 1971, East 1989a, 1989b, Shortridge 1934). Red lechwe also occurred in the southern DRC in the Upemba National Park (Ansell & Banfield 1980, Schouteden 1947). An important population of lechwe occurs in S Angola, centred along the Kavango (Okavango) River and extending into the western Caprivi: the name *amboellensis* (Sokolowsky 1903) is available, with the type locality in S Angola at approximately 16º20'E and 19º30'E (Shortridge 1934). The eastern Caprivi (Linyanti) population was described as *notatus* (Matschie, 1912) and would appear to extend into SE Angola along the Luiana and Cuando rivers. The specimens noted by Ansell (1978) along the Angola-Zambian border in SW Zambia are probably from this population.

It is currently impossible to elucidate the precise taxonomic and distributional status of this complex of populations of "red" lechwes, not least because they have not been adequately studied and several appear to be extinct. Few museum specimens appear to be available. Currently allocated to *K. l. leche*, the taxonomic status of the Namibian, Angolan and DRC populations require elucidation.

Barclay (1933) concluded that no subspecific divisions were warranted in *K. leche*, but his conclusions were weakened by reliance on patterns and colour of pelage. A facile attempt at a taxonomic review by Howard & Sidorowicz (1976) concluded that all lechwe formed one species, and only two subspecies were valid. The mistakes, weaknesses and overall failure of their analysis was subsequently demonstrated, not least in being based on a false sample of *K. leche* (Ansell & Banfield 1980). The latter study focussed on the differences between *smithemani*, *robertsi* and *kafuensis* and demonstrated that *smithemani* and *leche* are the most similar in skull proportions and size, with *kafuensis* the most distinct. Given the recent diversification of lechwes (evident in *kafuensis, robertsi* and *smithemani*), it is likely that *K. l. leche* is actually a polyphyletic taxon. Radical declines in the historical range of unrecognized taxa (to extinction in *K. robertsi*), indicates that special attention should be paid to the actual taxonomic and conservation status of the plethora of populations currently attributed to *Kobus leche* (Figure 3.3).

Williamson (1994) summarized a detailed study of the lechwe in the Linyanti area of Botswana focusing on territorial and reproductive behaviour. His data demonstrated significant differences between the reproductive behaviour of this Linyanti population of "*leche*" and *kafuensis* in the timing of breeding, and other significant behavioural differences. The Linyanti lechwe are sedentary and occur at a lower density than *kafuensis*. They also defend territories of a larger size continuously through the year, and breeding adults in Linyanti differ markedly in size and colouration from *kafuensis* (Williamson 1994).

Status

Locally Endangered. Any attempt at an assessment of the status of "red lechwe" is handicapped by an inadequate taxonomy. Child (1975) records the decline of *K. leche* in the E Caprivi, which was especially noticeable on the Chobe floodplain. Here a minimum of 2500 individuals were counted in 1962 but had declined over eight years to 5% of this. Other populations of "red lechwe" are thriving (East 1989a). These include the nominate population (definitely *K. leche*) of the Okavango Delta and Caprivi, assuming these form a contiguous population. The population (possibly *K. amboellensis*) in Namibia (W Caprivi) along the Okavango River had increased from 1400 individuals in 1985 to 2000 in 1990 (Griffin & Grobler 1991). As with all lechwe, the formerly extensive range of the "red lechwe" has experienced a major shrinkage, especially within Angola and Zambia. They were formerly widely distributed across the Upper Zambezi in suitable habitat. A huge reduction in numbers and range has occurred within the Barotse floodplain, with few remnant populations persisting (Ansell 1978). The status of "red lechwe" in Angola and southern DRC requires urgent study – these are most likely Critically Endangered. Unequivocal understanding of the conservation status of the "red lechwe" is contingent on a thorough systematic review of all extinct and extant populations across their entire historical range.

Roberts' Lechwe, *Kobus robertsi* Rothschild, 1907

Taxonomy and Distribution

Only acknowledged as distinct in the late 1970s, this taxon is represented by only one population with a localized distribution in N Zambia. *Kobus robertsi* originally occurred within the Pambashye Swamps on the Luongo-Kalungwishi drainage north of Lake Bangweulu (Ansell 1978), and is certainly the most poorly known of the Reduncini, if not of all African bovids. Very few scientific specimens are known. Lydekker & Blaine (1914) listed only two specimens in the British Museum (Natural History), stating the type to be in the Rothschild Museum, Tring, and accepted *robertsi* as valid:

> "As this lechwe occurs in company with the true lechwe, it must be regarded - if anything more than a melanistic phase - as a species rather than a race." (Lydekker & Blaine 1914: 249).

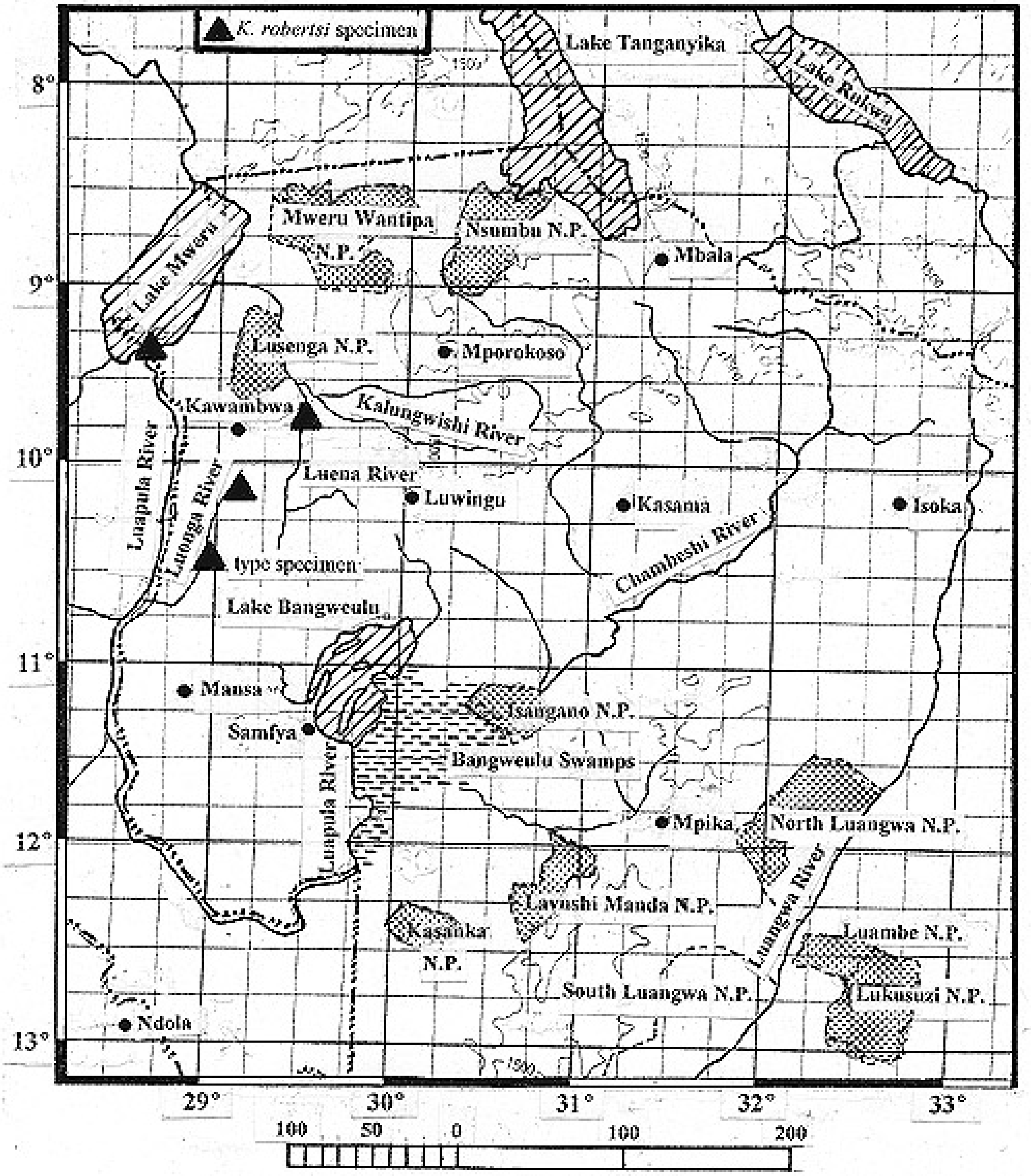
The taxon was described on the basis of only two specimens (Rothschild 1907), which were subsequently lost (Ansell 1974). Ansell (1974) allocated BM 13.11.27.1 as the neotype of *Kobus robertsi*. This was collected on the Luongo River (10°35'S; 28°59' E) on 7 October 1913. Two other specimens are known from the Luongo River (10°10'S; 29°05'E) and the Luena River (9°45'S; 29°25'E) south of its confluence with the Kalungwishi (Figure 3.6).

The type locality was restricted to the Luongo River (10°35'S; 28°59'E) by Ansell (1974). Two specimens (previously reported by Ansell 1974 as of indeterminate status) were recently reexamined in the mammal collection, Natural History Museum, Bulawayo (out of a total of 187 specimens of *K. leche sensu lato*); both specimens are in a reasonable condition. Their cranial measurements agree with that of the neotype of *robertsi* published by Ansell & Banfield (1980), and shown to be distinct from all other lechwe. These two specimens consist of a single skull (NMZB 2753), and skin and skull (NMZB 2751); both were collected from Chisenga Island (9°22'S; 28°37'E; Figure 3.6) in 1947. Situated in the south of Lake Mweru, this is north of the above mentioned localities – some 150 km northwest of the type locality of *robertsi* and the Luongo and Luena rivers (Figures 3.3 and 3.6). In total, it appears that only five specimens of *K. robertsi* are known.

Status

Extinct. Should any individuals persist they are Critically Endangered. Ansell (1974, 1978) and Ansell & Banfield (1980), followed by East (1989a), inferred *K. robertsi* to be extinct in the Pambashye Swamps and on Chisenga Island. No recent published investigation is known that has attempted to investigate the status of lechwe in northern Zambia, aside from considerable attention paid to *K. smithemani*. The relationships between collecting localities and protected areas in N

Figure 3.6. Detailed distribution of *Kobus robertsi* in northern Zambia (data from Ansell 1974, 1978, and reexamination of two specimens in the Natural History Museum of Zimbabwe) in relation to the network of protected areas. The type locality is shown.



Zambia is depicted in Figure 3.6. Virtually nothing is known about the ecology, behaviour and general biology of the Luena lechwe, aside from what can be discerned from a paucity of museum specimens and anecdotal reference in the form of very few publications. Prior to Ansell & Banfield (1980), most authorities had concluded that *robertsi* was *incertae sedis*, and glossed over its existence.

PUKU

Puku, *Kobus vardoni* (Livingstone, 1857)

Taxonomy and Distribution

Puku (*K. vardoni sensu lato*) are restricted to a limited area of the southern savanna zone, an area within the catchment of the Upper Zambezi and Luapula rivers in Zambia. The taxonomic status of the allopatric populations of pukus in Rukwa and Kilombero, S Tanzania (Rodgers 1984) and C Angola (East 1989a) is unknown. Ansell (1971) recognized two subspecies, whose distributions are separated by the Muchinga Escarpment:

> "*K. v. vardoni* (Livingstone, 1857) occurs in southern Congo basin, Angola, north eastern Botswana and Caprivi and western Zambia. It was originally described from Libonda, Barotseland by David Livingstone - where puku no longer occur."

This population also occurred eastwards along the Upper Zambezi River to the Victoria Falls (Ansell 1971, Selous 1908; Figure 3.4).

Ansell (1971) suggested that *K. vardoni* and *K. senganus* comprise a superspecies together with the Ugandan Kob, *K. kob*. Other authorities have considered the former populations to be subspecies of *K. kob*. These antelopes are morphologically uniform with similar habitat requirements, which suggests their divergence was recent (Ansell 1971). Important differences occur in the morphology of the inguinal and pedal glands between kobs and puku (Ansell 1960b).

Status

Endangered in parts of its range; elsewhere Vulnerable. Ansell (1978) emphasized that puku had declined significantly since the early 20th century. *K. vardoni* has declined significantly in NE Botswana over the past 100 years. Selous (1881) recorded the species as numerous on the Pookoo Flats, where herds of 50 were common. Puku occurred for approximately 112 km along the south bank of the Chobe upstream of the Chobe-Zambezi confluence. They also occurred at the Victoria Falls on the south bank of the Zambezi in 1874, where one was shot by Selous's colleague J. L. Garden (Dollman 1921, Selous 1908), but these were probably vagrants. More recently, Child (1968) estimated that less than 100 individuals occurred between Kasane and Simwanza along the Chobe River. Smithers (1971) reiterated that a radical reduction had occurred at the southwestern edge of their range, and this was first recorded by F.C. Selous (Dollman 1921). Ansell (1978) also noted that *K. vardoni* had undergone a significant reduction within its former range across western and northern Zambia. No information appears to be available on the Angolan populations, only on their existence (East 1989a, Machado 1969). Under adequate protection, puku populations recover rapidly. This has occurred over the past decade in Kasanka National Park in NE Zambia (Cotterill, *pers. obs*. 1999). Populations of puku introduced on to game ranches in S Zambia and into the Middle Zambezi Valley (in Zambia in the 1990s) are increasing (I. Bruce-Miller, *pers. comm*. 1999)

Senga Puku, *Kobus senganus* Sclater &Thomas, 1897

Taxonomy and Distribution

Kobus senganus occurs widely in the Luangwa Valley and eastwards into parts of Malawi (where its range has undergone significant reduction), and the Rukwa and Kilombero valleys of Tanzania (Rodgers 1984). There were recently two isolated records from the Middle Zambezi Valley in Zimbabwe, which are referable to *K. senganus*. A sighting of an adult female was recorded by Dunham & Tsindi (1984) from the Mana Pools floodplain near the Sapi-Zambezi Confluence (15°40'S; 29°35'E). Another individual (NMZB 67049) was collected by the Department of National Parks and Wildlife Management of Zimbabwe near Chirundu (16°02'S; 28°51'E) on 13 August 1984.

Status

Locally Endangered. The population in Zambia's Luangwa Valley appears healthy. Ansell and Dowsett (1988) concluded their status within Malawi to be precarious, with populations still persisting in the Kasungu National Park. Extirpated from large areas, but some have been reintroduced (Ansell & Dowsett 1988). Lyell (1913) emphasized that puku only occurred in C Malawi in the catchment of the Bua River. Ansell & Dowsett (1988) identified other localities north of here (Figure 3.4). The individuals recorded from the Zambezi Valley in Zimbabwe appear to be vagrants, and their persistence contingent on the establishment of a viable population – there are no previous records of the occurrence of puku in the area.

3.6 WHAT ARE THE SPECIES OF REDUNCINE ANTELOPES?

3.6.1 Defining the problem

The above overview demonstrates that the taxonomy of the Reduncini is complicated by controversies over the taxonomic status of most taxa, their unambiguous identity, and precise distributions. The current taxonomy is obsolete in its dependence on vague classifications of morphospecies within which a plethora of subspecies are subsumed. This has seriously influenced studies of reduncines and applications of biological knowledge. For example, Hanks *et al.* (1969) argued that individual waterbucks referable to both *crawshayi* and *ellipsiprymnus* occurred together in the Kafue National Park. In another example, Howard & Sidorowicz (1976) concluded that *Kobus leche* was a monotypic species with only two valid subspecies, with *kafuensis* merely a form of *K. l. leche*. More recent authorities such as Kingdon (1982, 1997), avoided major problems in reduncine taxonomy, simply by not mentioning the existence of controversial subspecies, notably in *K. ellipsiprymnus*. This is surprising because Kingdon devotes deserving attention elsewhere to the many cryptic species of primates and other mammals. A serious attempt to resolve this problem needs to briefly consider the history of mammalian taxonomy and how the entrenched taxonomy of reduncine antelopes was constructed. This provides a setting from which to understand patterns of diversification of Zambezian Reduncini more objectively.

Prior to the Neo-Darwinian Synthesis in evolutionary biology (Mayr & Provine 1980), typological perspectives often dominated taxonomy and were the *modus operandi* in mammalian taxonomy (as in many biological subdisciplines) before the biological species concept became widely adopted (Corbet 1997). Cognisance of this historical situation is important. The majority of vertebrates described and classified up until the Second World War were based on remarkably little material, and the reduncine antelopes were no exception. Rothschild (1907), for example, described *K. robertsi* as a specific taxon distinct from *Kobus leche* on the basis of only two specimens with scant comparison with other populations. The situation was exacerbated by reliance on pelage characters which vary considerably, even within localized populations.

The principal characters employed to describe species and subspecies of reduncine antelopes were pelage patterns and colouration. These formed the criteria by which taxonomists (including Lyddeker, Matschie, Rothschild and Schwarz) described numerous subspecies and species of waterbucks, reedbucks, kobs, and lechwes. The study by Ansell & Banfield (1980) is an exception in its use of cranial measurements, which justified subspecific divisions of lechwe populations subsumed under *K. leche*. With very few exceptions, all taxa of extant reduncines were described by taxonomists working before the Neo-Darwinian Synthesis had hardened. This watershed in biology more or less coincided with the Second World War, and particularly with the publication of a seminal book "*Systematics and the Origin of Species*" in 1942 by the German ornithologist Ernst Mayr, then at the American Museum of Natural History in New York (Mayr 1942). Today acknowledged as the eminent evolutionary biologist of the 20th century, Mayr provided abundant evidence that new species evolved as a result of divergence of parent populations. The key lesson of this review was that “population thinking” is essential to carefully quantify and evaluate the variation within populations in order to identify taxonomic boundaries (O’Hara 1997). Influence of population thinking on taxonomic mammalogy was apparent by the early 1950s (for example, Ellerman *et al*. 1953), but considerable research remained to be done to cope with the challenges of elucidating mammalian diversity in Africa, and indeed all biodiversity. This challenge remains, and African bovids, exemplified by the Reduncini, are not exempt. Ansell (1971) tried to resolve the taxonomy of the Reduncini (and extant African Bovidae in its entirety) by applying Mayr’s methods and philosophy of microtaxonomy, relying on the biological species concept (BSC) and, in certain cases, its derivative, the superspecies. The superspecies concept applied to waterbuck and puku to try and surmount complex taxonomic problems was not successful.

Resolution of such taxonomic problems requires objective identification of the real evolutionary products that comprise the Reduncini. This must focus on the genetically divergent populations of these semi-aquatic antelopes and further reconstruct the patterns of their diversification in space and time. The taxonomic overview given in the previous section has separated the reduncine antelopes into the smallest divisible units recognizable on the basis of morphospecies, originally described as species and subspecies. Its resolution hinges on the thoroughness with which reduncines have been scrutinized by mammalian taxonomists, and what future, more refined, analyses will reveal of other real evolutionary products in the Reduncini, especially its more cryptic taxa. My treatment obviously tends toward a splitting of taxa, as opposed to the converse treatment of extreme lumping (Table 3.1).

3.6.2 **What is a species?**

Further elucidation of reduncine taxonomy requires attention to the ontology of species, because the solution to the species problem in biology and conservation lies largely within the domain of the philosophy of science. The ontology of the entity "species" has to do with what a species actually is in terms of biological theory. Considerable controversy surrounds the species concept, and is probably unmatched by any other controversy in biology. An unambiguous species definition is very hard (if not impossible) to obtain – quite possibly one of the toughest tasks in contemporary evolutionary biology. This controversy is grounded in different perspectives on how to recognize and measure biodiversity. One approach, perhaps idealistic, has been to strive for a universal species concept, applicable to all organisms, bacteria, fungi, animals and plants; irrespective of whether they reproduce sexually or asexually. Hull (1988) has pointed out that at least two thirds of populations in the entire biosphere comprise asexually reproducing organisms, and this has been so through the geological history of life since its inception. For this reason alone (a primary dichotomy between how organisms make more organisms) a universal species concept is very difficult to obtain. This endorses a pluralistic approach to species concepts, with at least one for plants, another for arthropods, yet another for vertebrates, and more for microbes. This dichotomy between sexual and asexual reproduction need concern us no further, as all mammals reproduce sexually. We can progress to review applications of the BSC to the Reduncini.

I now devote some attention to the characterization of reduncine species. This must begin with some consensus as to what it is about species we recognize in distinguishing between diverse reduncine populations. As stated above, the impetus for attention to what species are actually lies in an oft-quoted adage that "species are the currency of conservation". Resolution of the species problem is critical to any objective assessment of organismal biodiversity and its sound study and management. The mandate for objectivity does not make this a simple exercise. The place to start is to establish deficiencies in the existing taxonomy, and then build on these through two stages to resolve the problem. I begin with an examination of the biological species concept as applied to the Reduncini and other vertebrates.

3.6.3 **The biological species concept as applied to Reduncini: superspecies or subspecies?**

The established taxonomy of the Reduncini (Ansell 1971, followed by Meester *et al.* 1986 and Grubb 1993) rests on the biological species concept (BSC). The first step before attempting an improvement of reduncine taxonomy (with a focus on the Zambezi Basin) is to review the details of how science has tried to characterize and classify populations of these antelopes. Each of the several species recognized clearly encompasses different, but frustratingly similar, populations. The latter were characterized as subspecies, or allospecies – parts of superspecies. This modification of the BSC recognized the superspecies as:

> "...consists of a monophyletic group of entirely or essentially allopatric species that are morphologically too different to be included in a single species. The principal feature of the superspecies is that geographically it presents essentially the picture of a polytypic species, but that the allopatric populations are so different morphologically or otherwise that reproductive isolation between them can be assumed." (Mayr, 1963: 499)

The superspecies concept has been widely applied to Afrotropical birds (Hall & Moreau 1970, Snow 1978 for numerous examples). Grubb (1978) inferred that a large percentage of extant Afrotropical mammals are superspecies (Table 3.2). Application of the superspecies solution to reduncine antelopes in the Zambezi Basin recognizes three superspecies comprising a total of at least twelve allospecies. These superspecies are *K. leche, K. ellipsiprymnus* and *K. kob*. This is tentative as a thorough review of the 12 populations traditionally recognized as subspecies might not elevate all to allospecies rank according to criteria of the BSC. Furthermore, following the terminology of Haffer (1986), allopatric members of a superspecies (for example, *K. leche*) are termed allospecies, while parapatric populations (*K. crawshayi* and *K. ellipsiprymnus*) are termed paraspecies (Figure 3.2).

Table 3.2. Tabulation of superspecies of African mammals as a proportion of total diversity (after Grubb 1978).

Taxa	No. species	No. superspecies	No. (and proportion) of species that are allospecies	Species/superspecies ratio
Carnivores	70-76	59	24-33(0.34-0.43)	1.2-1.3
Artiodactyls	85-96	64	36-52(0.42-0.52)	1.3-1.5
All ungulates	95-112	72	39-63(0.41-0.56)	1.4-1.7
Primates	45-69	30	25-49(0.56-0.71)	1.5-2.3
Squirrels	37	26	17(0.46)	1.3

While numerous cases of recent evolutionary divergence in African antelopes have traditionally been viewed as representing subspecific differences (and/or superspecies, Grubb 1978), recent evidence suggests that this is a superficial interpretation of the divergence that actually has occurred in these clades of recently-speciated antelope populations. Previously unsuspected divergences in some Afrotropical bovids have recently been revealed by analysis of molecular characters – in this case mitochondrial DNA of certain antelopes in East Africa. Examples include two populations of blue wildebeest, *Connochaetes* "*taurinus*" separated by the Rift Valley in East Africa. Unprecedented genetic divergence was also discovered in waterbucks, *K.* "*ellipsiprymnus*" and impalas, *Aepyceros* "*melampus*" in the same region (Arctander *et al*. 1996). It appears that future studies are likely to reveal hitherto unsuspected genetic divergence in such apparently "good" species. These developments prescribe unprecedented revision of these clades of bovids as molecular characters are incorporated into systematic revisions.

Although the biological species concept became a bastion in taxonomic zoology, its ubiquity has been widely challenged over the past two decades. The concept was originally developed for sexually-reproducing vertebrates, especially birds. The BSC has been modified and stretched in attempts to recognize species in other phyla, including invertebrates and plants, but it has encountered serious problems.

The problem with allospecies versus paraspecies or subspecies to populations, such as those of reduncines, is in the subjectivity of its application, such that some authorities might describe these reduncine taxa as semispecies given their allopatric distributions. A pertinent example is the treatment of *K. senganus*, *K. kob* and *K. vardoni* as either allospecies of one superspecies or merely subspecies of *K. kob* (Ansell 1971). In terms of the BSC (on which the superspecies concept has been built) these populations must be reproductively isolated to qualify as species. Reproductive isolation is not a prescriptive criterion for recognition of a species. Many divergent species (such as eland *Taurotragus oryx* and greater kudu, *Tragelaphus strepsiceros*) hybridize. Hybridization is not uncommon between different populations which are relevant products of evolutionary divergence. Furthermore, concern over hybridization is actually a side issue when it comes to evaluating species as divergent products of evolutionary processes. Reproductive isolation actually has only a partial role in the conceptualization of species as evolutionary lineages. This is a major danger in the interbreeding criterion of the BSC which fosters misleading interpretations of evolutionary lineages (Frost & Hillis 1990, Zink & McKitrick 1995).

The prescription by the BSC that species be reproductive isolates places a prerequisite on sympatry if a "good species" is to be unequivocally diagnosed. This is another weakness of the BSC. Ultimately, taxonomic status under the BSC hinges on geographical relationships, which are often dynamic and further subject to biases in surveys which tend to under-represent rarer taxa. Other weaknesses are that the BSC ignores some evolutionary significant entities, and does not rigorously define the ranges of species it recognizes (Cracraft 1997). An important argument against the BSC by Patterson (1985) defines a species as a population possessing a distinct SMRS (Specific Mate Recognition System). An SMRS (see below) is shared property of a population of interbreeding organisms and is subject to strong stabilising selection acting on individual organisms. A species defined by its SMRS is created entirely differently from the isolation mechanisms postulated by Mayr to maintain the distinctiveness of a biological species. According to Patterson, speciation is an effect of adaptations that evolve to support successful matings in sexually reproducing organisms. So, application of these philosophical criteria of evolutionary causation identifies yet another critical weakness in how the BSC is formulated, which limits the ability of the BSC to characterize biodiversity (Patterson 1985).

3.6.4 Reduncine species distinguished by the Recognition Species Concept

Given these deficiencies of the BSC, a possible solution is to apply the Recognition Species Concept (RSC) defined by Patterson (1985):

> "A species is that most inclusive population of individual, biparental organisms which share a common fertilization system." (Paterson 1985: 21)

This has particular merit in elucidation of sympatric species, especially cryptic or morphologically similar species. The SMRS of reduncine antelopes is evident in the horns and pelage patterns of the different populations. These include the facial and leg markings of different lechwes, and the different dorsal patterns of the waterbucks. Equally important are ritualistic behavioural repertoires associated with territory establishment and defence, and courtship, where visual cues are important. Olfactory cues specific to species are equally if not more important in the Reduncini (Kingdon 1982), but have only been investigated in *K. kafuensis* and *K. kob thomasi* – chemicals in female urine deposited in the soil of leks influence the reproductive behaviour of other females (Deustch & Nefdt 1992). The morphology of scent glands could be equally important traits of an SMRS, as Ansell (1960b) demonstrated for *kafuensis* and "*leche*", *kob* and *vardoni*.

Distinctly different traits distinguish species-specific SMRS of two reduncine populations traditionally characterized as representatives of two subspecies (Ansell 1971, 1974, Ansell & Banfield 1980) or two allospecies (Grubb 1978). These are *K. smithemani* and *K. kafuensis*, which differ in pelage colouration, horn morphology, skull morphology (Ansell 1974, Ansell & Banfield 1980) and semiochemistry (Deustch & Nefdt 1992). I hypothesize that evolution of a distinct SMRS has occurred in various species of waterbuck, kob and puku, and perhaps reedbuck. Elucidation of the SMRS is integral to applying the RSC to different populations of reedbuck and waterbuck.

A similar divergence is illustrated in the reproductive behaviours of *kafuensis* and the Linyanti population of "*leche*" (see above, Williamson, 1994). I infer these differences to represent a different SMRS in these two populations. Published studies of "*leche*" in the Okavango (Joubert 1972, Lent 1969) do not present data sufficient to compare with those of Schuster (1976, 1980) and Nefdt (1996) or Williamson (1994) for *kafuensis* and the Linyanti population of "*leche*". Nevertheless, the outline of divergences between the SMRS of certain reduncines can be summarized in Table 3.3.

Table 3.3. Comparison of some semio-chemical, behavioural and morphological traits documented for certain populations of the Reduncini of the genus *Kobus* indicative of a Specific Mate Recognition System. The emphasis is on comparison of differences with closely related species of lechwe, kob and waterbuck. Data obtained from Allen (1963), Ansell (1960b, 1964, 1974), De Vos & Dowsett (1966), Grimsdell & Bell (1975), Hanks *et al.* (1969), Kingdon (1982), Lent (1969), Leuthold (1977), Nefdt (1995, 1996), Robinette & Child (1964), Rosser (1987), Schuster (1976), Skinner & Smithers (1990), Smithers (1983), Thirgood *et al.* (1992) and Williamson (1994).

Taxon **Trait**	**smithemani**	**leche - Linyanti**	**leche - Kasempa**	**kafuensis**	**kob**	**vardoni**	**crawshayi**	**ellipsiprymnus**
Mating system	polygamous territories	aseasonal lek	?	temporary lek	seasonal lek	resource defence mating system	polygamous territories	polygamous territories
Scent	?	?	?	specific?	specific?	?	?	“turpentine” tainted fur
Pedal glands	?	?	?	?	?	vestigial	?	?
Inguinal glands	?	?	open anteriorly	open laterally	open ventrally	open anteriorly	?	?
Coloration	black pelage in adults	dark stripe on foreleg	?	foreleg stripe, patch on neck	black forelegs	rufous forelegs	pale rump patch, dark neck & flanks	pale ring on rump
Body size	smallest	intermediate	intermediate	largest	_	_	_	_
Horns	smallest	intermediate	intermediate	largest	_	_	_	_

Although the RSC appears to confer major strengths to characterize reduncine species, its major weakness is its non-historical limitations (as for the BSC). It cannot recognize the temporal dimension of species – that they are lineages. Neither the RSC nor BSC recognize that species – reduncine antelope or other – are lineages with a birth (speciation) and a death (extinction). These problems have received the attention of phylogenetic systematists since the early 1980s as part of the spread of historical perspectives through systematics, culminating in widespread adoption of cladistic philosophy and its methods in recognizing and classifying taxa. This philosophy – termed tree thinking (O’Hara 1997) – has radical implications for how we conceptualize species (Ghiselin 1997).

Speciation can be caused by many different processes driven by different determinants of disturbance and selection. An important commonality to speciation is that most species are believed to form in geographical isolation – in allopatry. An important set of processes results in vicariance – the disruption of populations’ ranges in a geographical context. In terms of the RSC, the primary change in speciation in a sexually reproducing population as in mammals) is the formation of a new SMRS. Thus a mammalian species has a birth and death, with the overall temporal pattern being the origin and extinction of its SMRS.

3.6.5 Recognizing that Reduncine species have an evolutionary dimension

Complementary to population thinking, tree thinking conceptualizes extant individuals of a species not just as populations occupying some geographical zone, but also as the living parts of a historical lineage. Cognisance of a temporal, as well as a spatial, attribute of species has generated a number of historical species concepts. A major impetus for recognizing a temporal dimension to species concepts was the widespread adoption of phylogenetic perspectives in systematics (Baum 1992). Although both developed through the 1980s, phylogenetic treatments of species have scarcely interacted with the parallel development of the Recognition Species Concept. Distinct allopatric populations are distinct lineages, and thus phylogenetic species, but may still maintain the same SMRS.

Atemporal deficiencies of the BSC and RSC can be overcome if we consider the evolutionary divergence of populations. Tree thinking recognizes a commonality to all episodes of speciation with respect to the underlying pattern. Species result when a population exhibiting continuous variation has diverged to produce two or more populations exhibiting a pattern of discontinuous variation. Thus, the patterns of horn shape and size, skull morphology and pelage colour in *K. kafuensis* and *K. smithemani* exhibit a classic example of discrete variation, although the traits used as taxonomic characters vary continuously within each population.

Mayr (1957) originally distinguished between primary and secondary concepts of species. With the notable exception of Mayden (1997), this key distinction has been ignored in the plethora of publications seeking to resolve the species problem in evolutionary biology. The only concept that qualifies as a primary species concept is the Evolutionary Species Concept (ESC) originally proposed by Simpson (1951, 1961) and developed subsequently (Mayden 1997, Wiley 1978). No matter the mechanisms underlying its formation, any species (plant, microbial or animal) is an evolutionary species. A primary property of any species – whether comprised of sexual or asexual organisms – is that it persists as a lineage through time. This property underpins the primary species concept as articulated in the Evolutionary Species Concept (Mayden 1997, Simpson 1961):

> "...an entity composed of organisms which maintains its identity from other such entities through time and over space, and which has its own independent evolutionary fate and independent tendencies." (Wiley & Mayden 1997, quoted in Mayden 1997: 395).

3.6.6 **Characterization of the evolutionary species of Reduncine antelopes**

The stated objective to cleave nature at its historical joints so as to identify real evolutionary entities, is to ensure that no distinct biodiversity falls through the cracks in the conceptual maps we construct of its patterns of divergence. Fissured taxonomies (exemplified by artificial treatments such as adherence to the typological belief that all lechwes are "red lechwes") are inaccurate and prevent characterization of real evolutionary products. Complete and rigorous characterization of a species needs to apply the Evolutionary Species Concept (ESC) as the primary concept of species applicable to all biodiversity. In practice, this exercise encounters a severe hurdle.

The ESC is not operational, and secondary concepts are required to recognize a species depending on whether the population is sexual or asexual, and whether it has (or does not have) fossilized representatives of its extinct parts. In philosophical terms, application of the ESC as the primary species concept, using secondary species concepts to recognize evolutionary lineages applies a combination of monism and pluralism (Mayden 1997), a strategy followed by Dimmick *et al.* (1999). A pluralistic solution uses secondary species concepts (notably recognition, RSC, and phylogenetic, PSC) to discover species. Following Baum & Donoghue (1995), a similar strategy has been employed by Soltis and Gitzendanner (1999) in characterizing botanical diversity using a historical application of the phylogenetic species concept. This approach is revolutionary, and the conservation lessons and implications are extreme (Dimminck *et al.* 1999, Soltis & Gitzendanner

1999); because it objectively elucidates the actual products and patterns of diversification. A similar conclusion is drawn by de Queiroz (1998), who emphasizes that the RSC is more fine-grained and identifies smaller-scale properties of species, whilst the PSC takes a broader-scale view of a species in considering its entire lineage.

Nevertheless, characterization of evolutionary species is difficult, especially where fossil data are scarce or non-existent (as with the Reduncini). To move beyond the deficiencies of the current reduncine taxonomy based on the biological species concept, I see the only solution is to apply both the RSC and PSC. This means that in applying a pluralistic conceptualization of species to the Reduncini and other mammals we must define a species as:

> an interbreeding population that has diverged from related species and possesses a common specific mate recognition system (SMRS). This unique lineage of sexually-reproducing organisms experiences a birth and death and exists as a genetically exclusive population.

3.6.7 **Diversification in Reduncine species using the phylogenetic species concept**

The application of a phylogenetic species concept (PSC) is not without its difficulties and controversies. The PSC has gathered major support and revolutionized perspectives of biological diversity in several groups, especially birds (Cracraft 1997, Martin 1996). Attempts to overcome deficiencies of the BSC have fuelled much of the impetus for phylogenetic and historical perspectives to define species and their properties. An example of the application of a phylogenetic species concept is a recent revision of African tree frogs (Schiotz 1999), which reveals considerable biodiversity previously unrecognized. Another is the application of a phylogenetic species concept to extant birds (Cracraft 1997) in which hitherto hidden biodiversity is revealed. The implications of this refined knowledge in conservation are extreme (Peterson & Navarro-Siguenza 1999, Soltis & Gitzendanner 1999).

It is important to realize that many versions of the PSC have been proposed (as emphasized by Baum 1992, Baum & Donoghue 1995, Mayden 1997, Soltis & Gitzendanner 1999). Their derivation and application falls into one of two philosophies of systematics - pattern cladistics or phylogenetic systematics. Their differences have important implications for how a particular PSC characterizes biodiversity. Based on pattern cladism, a widespread application of the PSC is diagnostic, as originally stated by Cracraft in 1983:

> "...the smallest diagnosable cluster of individual organisms within which there is a parental pattern of ancestry and descent." (Cracraft 1983: 170)

The major problem with any diagnostic PSC is its subjectivity in recognizing diagnosable groups. They fail to define genetically-exclusive populations. A population perspective is an imperative requirement of a robust species concept. This was attempted by the BSC, is a strength of the RSC, and a failure of the diagnostic PSC. Nevertheless, all these concepts fall short in either reproductive inclusiveness (diagnostic PSC) or historicity (recognizing the species as a lineage - BSC and RSC). An important and recent development in phylogenetic systematics has been to recognize and quantify the historical dimension of species, focusing on their exclusivity (Baum 1992, De Queiroz & Donoghue 1990). This would seek out genetically-exclusive populations for objective characterization (*sensu* Baum & Donoghue 1995), and recognize their existence as historical lineages by describing them as phylogenetic species. Baum & Donoghue (1995) emphasize the importance of genetic exclusivity in applying a phylogenetic species concept to populations. This ideally requires elucidation of gene trees using molecular characters, but exclusivity of a lineage can be established from comparisons of morphological and behavioural characters. It cannot be overemphasized that this "history-based" approach is fundamentally different from the diagnostic PSC advocated by Cracraft (1983, 1997) and pattern cladists (e.g. Nixon & Wheeler 1990). Baum & Donoghue (1995: 566) define species under a history-based PSC as ".as basal, exclusive taxa; that is, taxa containing within them no subgroups that are themselves exclusive.", such that a species is:

> "a basal group of organisms all of whose genes coalesced more recently with each other than with those of any other organisms outside the group." (Baum & Donoghue 1995: 567)

This theoretical framework of this species concept focuses on the genealogical history of populations rather than on the presence or absence of characters as applied in diagnostic PSC. Characters are used to characterize history-based phylogenetic species, but are fallible evidence for the existence of a species, rather than its defining attributes. Ideally, reconstructions of gene coalescence are needed to characterize species using this concept, but morphological characters can equally be used (Baum & Donoghue 1995).

The first step toward an objective characterization of reduncine species applied the RSC (in actual fact a secondary species concept - Mayr 1957, Mayden 1997) to the fine-scale properties of a species in a time-limited context. This focused on characterization of Specific Mate Recognition Systems (SMRS). The characters associated with these in a reduncine population are likely to be associated with genetic exclusivity of particular lineages. Nevertheless, through vicariance, evolution of a genetically exclusive population of reduncines may occur without modification of the SMRS. Characterization of evolutionary lineages in the Reduncini requires a species concept that accommodates an entity extended through time. Here, application of a historical PSC (following Baum & Donoghue 1995) that utilizes molecular and morphological characters of reduncines would characterize exclusive populations in terms of their phylogenetic relationships.

3.6.8 **Conclusions and recommendations**

(a) In any taxonomy (applying the BSC or a more biologically-appropriate species concept), the taxonomic status of the reedbucks is currently too unclear to recognize unequivocal divisions between the northern or southern reedbucks (*R. occidentalis* and *R. arundinum*, respectively). This problem is compounded by the hazy understanding of exact ranges of the two populations within the Zambezi Basin. This particular problem can only be resolved by thorough review of museum specimens. This also applies to certain waterbuck populations – *crawshayi* and *penricei* are recognized as species distinct from the "*ellipsiprymnus*" in Zimbabwe and E Zambia. The precise status of the latter population, and those elsewhere in the Zambezi Basin requires review, as does that of *kondoensis*.

(b) In this phylogenetic context the ESC (Mayden 1997), rendered operational by the historical PSC and the RSC, recognizes at least 18 extant species of Reduncini within the Zambezi Basin (Table 3.1). Application of the PSC characterizes all allopatric populations of lechwe as distinct species. Equally, *senganus* and *vardoni* are kob species separated by the Muchinga Escarpment. It is most important to emphasize that this figure is tentative – it is especially weakened by dependence on morphospecies. Characterization of the true identities of the phylogenetic species in the Reduncini requires deeper understanding of their biogeography and phylogeny. It is likely that the figure is higher if other unstudied populations within the basin and surrounding wetlands are considered. This uncertainty particularly applies to lechwe, and waterbuck, puku and reedbuck populations in E Angola. In particular, the localized populations of *K.* "*leche*" and *K.* "*vardoni*" in C Angola are singled out for urgent study.

(c) Possible divergence between the "red" lechwe in the drainage systems of the Okavango and Linyanti deserves consideration. I hypothesize that *K. amboellensis* in the Cubango (extending into W Caprivi) and *K. notatus* in the Linyanti (and higher up the Luiana and Cuando rivers) could be distinct from topotypical *K. leche* of the Okavango Delta, each evolved allopatrically within its respective drainage system. Although these populations might appear contiguous, this may not have been so in the recent geological past considering tectonic modifications.

(d) The database of characters and specimens for Reduncini available to me is too incomplete to revise the Reduncini at present. Given the scope and complexity of this problem, it has only been possible to carry out a tentative overview of the reduncine populations – as summarized above – to attempt some synthesis of the patterns of their diversity within the Zambezi Basin, and so account for its origin.

(e) Recalling the imperative to "carve nature at her historical joints", and so reveal relevant evolutionary products, the need to resolve the taxonomy of all extinct and extant Reduncini requires an exhaustive revision. This will need to include morphological, behavioural and (especially) molecular characters at a continental scale with recourse to the type material of all described taxa. Nothing short of a thorough systematic review can solve the current uncertainties and complexities. The key in such an investigation may prove to be the use of molecular characters in cladistic analyses to resolve a phylogeny, especially for parapatric and sympatric species. The sitatunga populations, extending from the Okavango-Caprivi through Barotseland and across N Zambia to Lakes Bangweulu and Mweru (with an isolated population in C Angola occurring with puku and lechwe), also deserve the scrutiny of the philosophies and practices of modern systematics.

3.7 EVOLUTION OF REDUNCINE ANTELOPES IN THE ZAMBEZI BASIN

3.7.1 **Evolutionary changes and vicariance**

Integral to an objective characterization of biodiversity is to characterize the processes that have driven speciation. Speciation is an effect – a consequence – of processes that caused populations to diversify into distinct evolutionary lineages. New species form through different mechanisms, which include vicariance, sympatric speciation (perhaps driven by sexual selection) and genetic drift within certain demes in a population. In the case of reduncine antelopes, the mechanism of speciation has most likely involved changes in the SMRS of fragmented populations caused by directional selection. The most likely explanation is that a combination of climatic change and tectonic movements caused vicariance of reduncine populations across the basin. The greatest degree of vicariance has occurred on the African peneplain where the drainage of the Upper Zambezi has shifted dramatically through the Tertiary and Quaternary. Equally importantly, natural and sexual selection operated within these populations in allopatry (and parapatry) to result in the evolution of specific SMRS in different populations.

As an agent of reduncine evolution, the impact of vicariance can be singled out. The shared genetic composition of a population would have been changed by natural selection and been sorted by environmental changes. Climate-induced changes, especially arid periods, would have shrunk a contiguous wetland (such as N Zambia and the southern portion of Shaba Province) into isolated fragments of aquatic habitat. Natural selection, within separated habitats under different environmental conditions, could have driven the evolution of species-specific adaptations for mating. Perhaps a major agent of such change would be sexual selection operating within the polygynous mating system of reduncine antelopes. A different SMRS – and thus species – could evolve as an effect of organismal reproduction in geographically isolated populations under the influence of directional selection. The overall result of vicariance was the origin of new populations – each persisted as a distinct species.

Environmental change through the late Tertiary and Quaternary has long been postulated as responsible for diversification of African vertebrates. Recent reviews of evolution in African mammals (Grubb 1978, 1982, 1983) have benefited from a far more complete biogeographical database then was available to researchers in the 1920s who first suggested that environmental changes drove diversification (e.g. Ruxton & Schwarz 1929). These more complete data have allowed recent authors to draw more comprehensive conclusions about other faunas (e.g. Carcasson 1964, Crowe & Crowe 1982, Hall & Moreau 1970, Moreau 1966, Snow 1978). Consideration of the expansions and contractions of forest, savanna and semiarid habitats across Africa, before and through the Pleistocene, has been central to all these reviews of biotic evolution in the Afrotropical realm. As discussed above, Grubb (1978) provided a thorough overview of Afrotropical mammals at a continental scale, and applied the biological species concept to distinguish superspecies. A refined analysis is still required that needs to utilize thorough, fine-grained biogeographical datasets in conjunction with molecular data to reconstruct gene trees and more robust phylogenies, using an evolutionary species concept.

3.7.2 **Evolution of wetlands through the late Tertiary**

These previous reviews (with partial exception of Ansell 1960a) adopted a rather coarse-grained approach at a continental scale, and have also tended to focus on forests (Grubb 1978, 1982, 1983, Robbins 1978, Kingdon 1981). The evolution and biogeography of semi-aquatic mammals possibly differs from forest-dwelling and other terrestrial populations, that have primarily been influenced by climatic changes. The vicariance of aquatic habitats in Africa with respect to mammal evolution has received comparatively little attention, and the Reduncini are exceptional in their predilection for aquatic habitats. Equalling, if not exceeding, the climatic changes in impacts, there is considerable evidence that Africa's drainage systems and basins have been altered repeatedly. This has been caused by geomorphological agencies, including tectonic activity and capture of headwaters, and is especially true of the African erosion surface across what is today Zambia, Tanzania, E Angola, Botswana, N Mozambique and southern DRC. Situated on the ancient African plateau, the hydrology of the Zambezi and associated tributaries has changed repeatedly and radically (Partridge & Maud 1987, Thomas & Shaw 1988, 1990).

The African surface is ancient when considered in a geomorphological context – the African peneplain was established early, soon after Gondwanaland had split up. Its formation began in the Mesozoic, and has been partially eroded through two Post-African events for at least 35 million years. The drainage across the continent exploited zones of crustal weakness surrounding the cratons of more ancient rocks (Partridge & Maud 1987). Slight alterations of this comparatively level surface by tectonic events has radically modified drainage patterns across the subcontinent across a range of spatial scales (Main 1992, Skelton 1994, Thomas & Shaw 1988, 1990).

Burgeoning data point to the importance of vicariance in having generated a significant portion of global biodiversity. The resultant biogeographical pattern is frequently associated with allopatric populations exhibiting little morphological divergence (Dimmick *et al*. 1999). This is true of the Reduncini and other Afrotropical mammals where numerous allopatric populations (traditionally and variously interpreted as super- or subspecies) have evolved since the Pleistocene. These biogeographic patterns deserve wider and more detailed attention and their elucidation is critical to understand the evolutionary processes which generated the region's biodiversity. The implications for conservation decisions and activities cannot be over emphasized.

3.7.3 Evidence from other Zambezian mammal species

The Zambezian drainage has been radically altered over the past five million years (Main 1992). Two major events can be singled out. Firstly, the connection between the Upper Zambezi and Limpopo was closed by the end of the Pliocene (5 Mya), as concluded by Thomas & Shaw (1988, 1990). Their respective fish faunas vary more than that of an equivalent comparison of the Upper Kafue, Upper Zambezi and Okavango, the fish faunas of which are very similar (Skelton 1994). This would not have influenced reduncine evolution, given recent speciation. Secondly, the capture of the Upper Zambezi, Upper Kafue and other Upper Zambezi tributaries by the Middle Zambezi, which is the more likely agency of reduncine evolution.

Notable patterns exhibited in the distributions of Reduncini within the Zambezi Basin parallel those of other large mammals. (Figure 3.7, Table 3.4). The predominant pattern is one of vicariant species distributions – this especially applies to organisms whose capabilities of dispersal were minimal during vicariant disturbances. The common consequence for such populations would have been widespread extinction with local persistence of fragmented populations. Within the Zambezi Basin, additional patterns of divergence and disjunct distributions are exemplified in several populations of closely related populations of mammals (Figure 3.8). Particularly pertinent are certain endemic mammals of the Luangwa Valley, including Thornicroft's Giraffe, *G. thornicrofti* and Cookson's Wildebeest, *C. cooksoni*. Other large herbivores, including two closely related sable antelopes (*Hippotragus niger* and *H. anselli*), exhibit a similar biogeographical pattern (Groves 1983). The distributions of the two sun squirrels, *Heliosciurus mutabilis* and *H. gambianus*, are also divided by the Muchinga Escarpment (Ansell 1978).

Also noteworthy is that a distinct population of Tsessebe, *Damaliscus lunatus* is restricted to the Kasanka Flats and Mpika area south of Lake Bangweulu (Ansell 1978, Bell and Grimsdell 1973). This population is separated by hundreds of kilometres from a southwestern population (occurring from N Botswana, through W Zambia (west of the Upper Zambezi) into E Angola). The Bangweulu population of *D. lunatus* is perhaps more closely related to *D. l. jimela* (Matschie, 1892) of East Africa (where it is commonly called the topi). I hypothesize that vicariance between the Bangweulu and west Barotse populations of *D. lunatus* followed the alteration of Upper Zambezi drainage – a portion of the original Chambeshi and other south easterly flowing rivers were captured by the Kafue and Lusemfwa, the latter being tributaries of the Middle Zambezi and Luangwa, respectively. This event followed either tectonic activity or headwater capture, or both Tsessebe exploit the ecotone between savanna and floodplain; and would have been distributed along the course of the Chambeshi-Upper Kafue to its confluence with the Zambezi. It is pertinent to record that the distinctly allopatric distribution of *Damaliscus lunatus* (*sensu lato*) across the Upper Zambezi-Kafue-Chambeshi cannot be easily discounted as the result of a historical decline.Without exception, historical evidence (Dollman 1921, Grimwood *et al*. 1958, Knowles Jordan & Ansell 1959, Letcher 1910) all emphasizes (and indeed puzzles over) the anomalous distribution of tsessebe across what can now be recognized as the Upper Zambezi, Upper Kafue and Chambeshi-Luapula axis.

Further evidence lies in the distributions of primates. A distinct biogeographical pattern can be singled out for baboons and forest guenons, with two assemblages separated across an axis extending from the Chambeshi to Shesheke and Okavango (hereafter the Chambeshi-Okavango axis). This axis follows a NE-SW trend, and in Zambia coincides with the drainage of the

Figure 3.7. Proposed evolution of the drainage systems across the Upper Zambezi Basin and its environs, and the resultant vicariance of lechwe antelopes. Hatching depicts possible zones where populations have diverged into their present allopatric distributions. Recent historical declines are not depicted. Evolutionary species of lechwes are depicted by numbers:
1 *leche* (Okavango Delta); 2 *amboellensis*; 3 *notatus*; 4 "leche – busanga"; 5 "leche – Upemba"; 6 "leche – Luando"; 7 *smithemani*; 8 *robertsi*; 9 *kafuensis*.

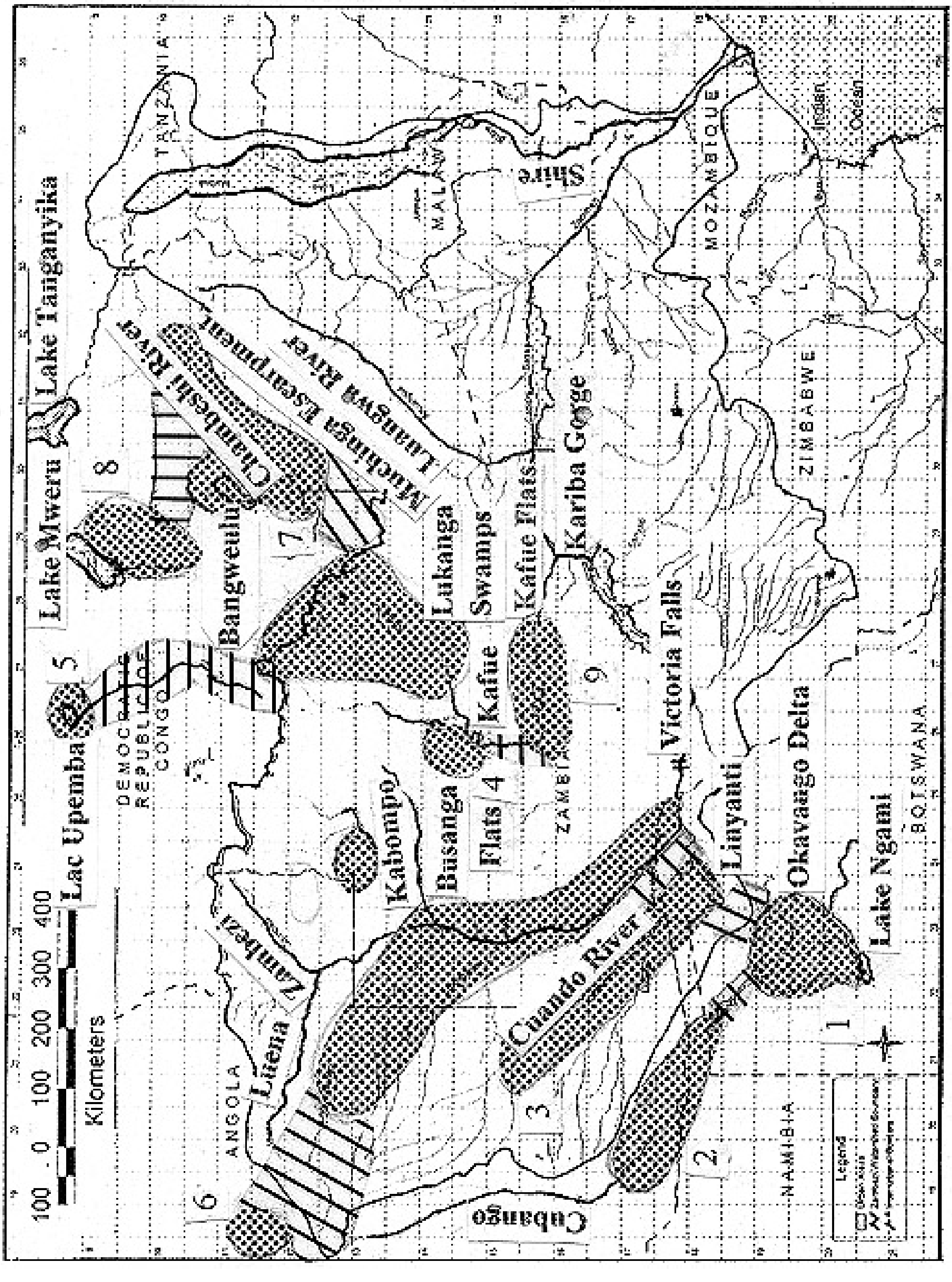


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Table 3.4. Checklists of wetland antelopes occurring in the principal wetlands of the Zambezi Basin and its environs. Although not strictly adapted to wetlands, tsessebe, giraffes and oribi are included as their biogeography correlates closely with that of reduncines (X - taxon occurs in locality; ? - occurrence uncertain; E? - occurrence uncertain, but if present then endangered).

Category	Bangweulu	Mweru	Barotse	Okavango	Chobe/ Linyanti	Kafue Flats	Lower Shire	Luangwa Valley	Zambezi Delta
Reduncines									
Redunca arundinum Southern Reedbuck	?	?	?	?	?	?	?	?	?
R. occidentalis Northern Reedbuck	X	X	X	?	?	?	?	?	?
Kobus crawshayi Crawshay’s Waterbuck	X	X	X		?	X			
K. ellipsiprymnus Common Waterbuck				X	X	X	X	X	?
K. kondoensis Kondo Waterbuck	?	?						?	
K. penricei Penrice’s Waterbuck				?	X				
K. kafuensis Kafue Lechwe						X			
K. leche Red Lechwe			X		X				
K. robertsi Roberts’ Lechwe		X							
K. smithemani Black Lechwe	X								
K. senganus Senga Puku							E?	X	
K. vardoni Puku	I	I	I		I	I			

Category	Bangweulu	Mweru	Barotse	Okavango	Chobe/ Linyanti	Kafue Flats	Lower Shire	Luangwa Valley	Zambezi Delta
Other Species									
Giraffae thorncrofti Thorncroft's Giraffe								X	
G. angolensis Angolan Giraffe			X	X	X				
Damaliscus lunatus Tsessebe			X	X	X				
D. "*lunatus*"-bangweulu Bangweulu Tsessebe	X								
Tragelaphus spekei Sitatunga	X	X	X	X	X				

Figure 3.8. Distributions of certain species of large herbivores: wildebeest (*Connochaetes taurinus* and *C. cooksoni*), tsessebe (*Damaliscus lunatus*), giraffe (*Giraffae angolensis* and *G. thornicrofti*). Information compiled from Ansell (1978) and Ansell & Dowsett (1988). Historical declines are not distinguished.

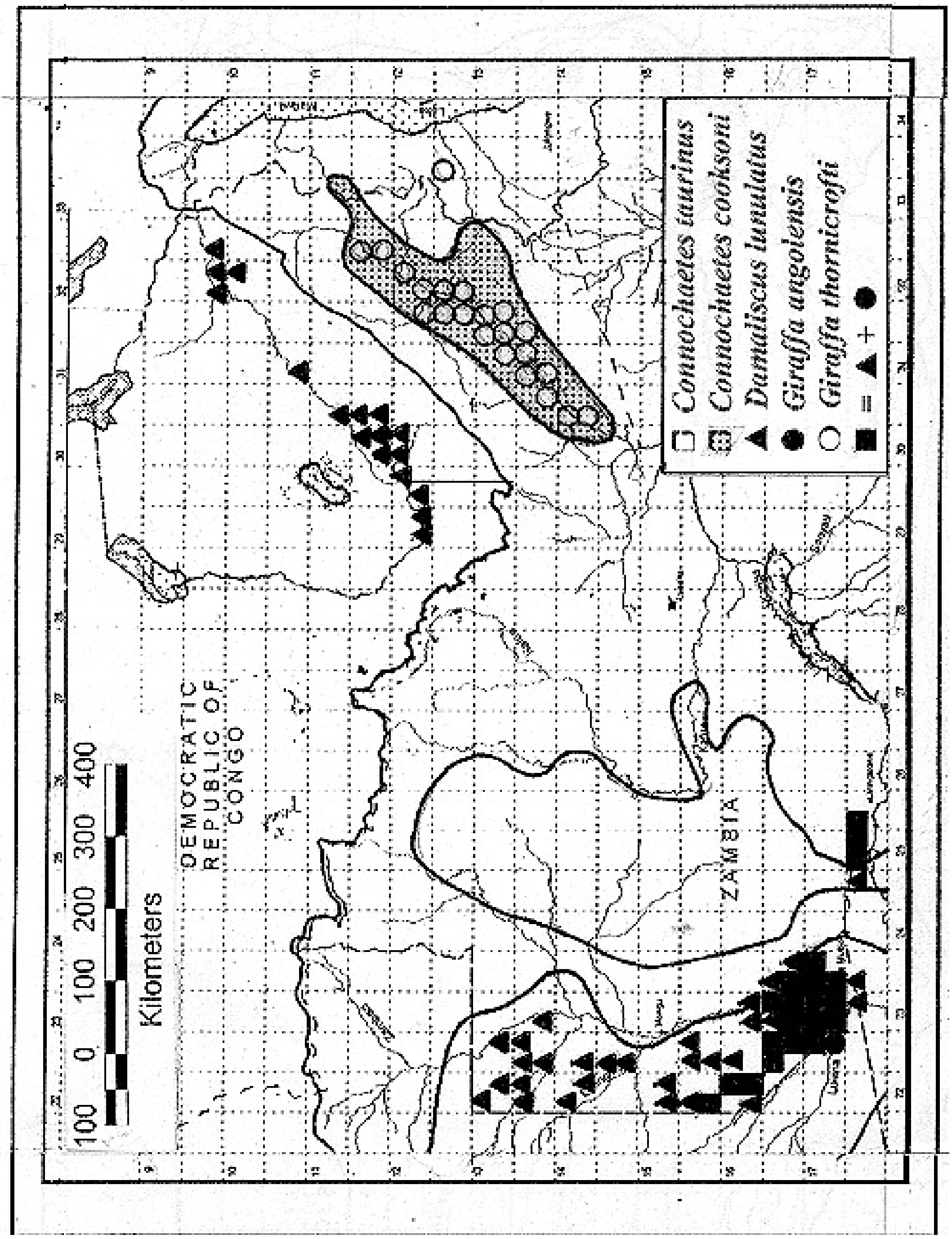
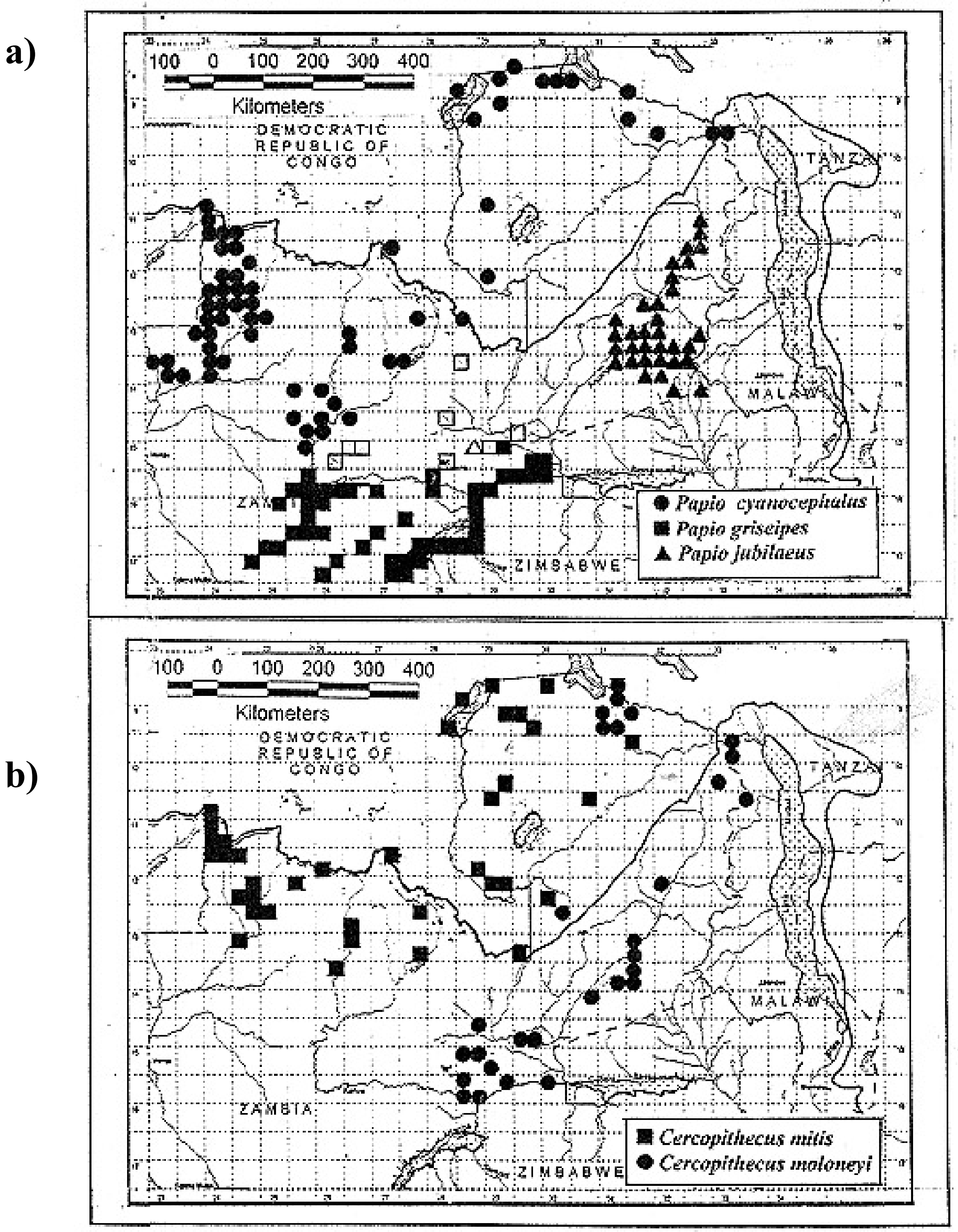


Figure 3.9. Distributions of three evolutionary species of (a) baboon (*Papio cynocephalus*, *P. griseipes* and *P. jubilaeus*) and (b) two evolutionary species of forest monkey (*Cercopithecus mitis* and *C. moloneyi*) demonstrating allopatric distributions (data from Ansell 1978). While *P. jubilaeus* only occurs east of the Muchinga Escarpment, *P. griseipes* and *C. moloneyi* are separated from related populations by the former course of the Upper Zambezi and Chambeshi drainage systems. Open symbols represent localities for which the species identity is in doubt.



Chambeshi and Upper Kafue rivers. Blue monkey, *Cercopithecus opisthostictus* Sclater, 1893 and yellow baboon, *Papio cynocephalus* (Linnaeus, 1766) occur to the north, and chacma baboon, *P. ursinus* (Kerr, 1792) and *C. moloneyi* (Sclater, 1894) are restricted to the south of this Chambeshi-Okavango axis (Figure 3.9). This relationship is also seen in the speciation pattern of *K. kafuensis* (see below, and Figure 3.3), separated from more northerly lechwe populations of the Upper Kafue (Busanga and Lukanga Swamps). Significantly, the divergence between *Papio griseipes* and *P. jubilaeus* – two allopatric populations of baboons (both occurring south of the Chambeshi-Okavango axis) – occurs along the Muchinga Escarpment (Figure 3.9a).

These major changes in Africa's mammal fauna are parallelled to a lesser extent in the divergences represented in many species of extant mammals occurring in and around the modern Zambezi Basin. The Upper Zambezi, notably the Barotse floodplain, appears to be a major geographical barrier (not only to many large mammals, but amphibians and reptiles too) between mesic and xeric species. Pertinent examples are *Connachaetes taurinus*, *Giraffae angolensis,* and *D. lunatus* (Figure 3.8), as well as *K. crawshayi* and *K. vardoni* (Figures 3.2 and 3.4). The contemporary annual flooding regime may prevent lateral dispersal, but it does not explain why dispersal did not occur during arid periods in the late Pleistocene – only tens of thousands of years ago. The existence of apparently recently-diverged taxa (exemplified by tsessebe) suggests that some dispersal has occurred and/or vicariance has been recent. The likely mechanism is that tectonic activity altered the geographical pattern of drainage across an axis extending from the Bangweulu-Chambeshi drainage system into the modern Okavango-Makgadikgadi. The Chambeshi and Upper Zambezi are hypothesized to have flowed into this inland lake – the Makgadikgadi. Several mammals with a predilection for open savanna (such as alcelaphine antelopes) and/or aquatic grasslands (reduncine antelopes) would then have exhibited a more continuous distribution.

As with reduncines, these resultant products of this diversification have been typically interpreted as superspecies (Grubb 1978). The situation is obviously ripe for a radical revision of these zoogeographical patterns using the refined concepts and methods of phylogenetic systematics. Although the pattern of speciation has been traditionally termed allopatric (or parapatric), the more appropriate term is dichopatric (following Cracraft 1984) in order to recognize that the major process of diversification for evolution of reduncines and other large mammals across the Zambezi Basin has resulted from vicariance, and not competitive exclusion.

3.7.4 Diversification of Reduncine antelopes in the Zambezi Basin

The divergence exhibited among extant representatives of the Reduncini strongly suggests that speciation was not simply caused by a single disturbance event, and neither were these disturbances a simple result of one agency. It appears that several species originated across a shifting mosaic of islands of wetland in a sea of predator-rich savanna. A similar pattern of allopatric speciation is exemplified by the giraffe, wildebeest and tsessebe, large herbivores of open savanna. The resultant pattern of diversity in modern reduncines is today a fragmented mosaic. In historical times, much of this biogeographic mosaic of reduncines within the Zambezi Basin has been destroyed by human depredations and impacts over the past two centuries. Preliminary scrutiny of the lechwes reveals that at least four species occur within Zambia alone, and possibly the populations of Barotseland, Busanga Flats, Caprivi and the Okavango are genetically distinct. There are also populations (designated as *K. l. leche*, Ansell 1978, Ansell & Banfield 1980) represented by specimens in the Royal Museum of Central Africa, Tervuren, Belgium from the Shaba Province of the DRC. These are mainly from the environs of Lake Upemba (Schouteden 1947). Their precise taxonomic status has yet to be established (Ansell & Banfield 1980; see species accounts above).

The marked difference between the distributional patterns of lechwe versus waterbuck in modern Zambia suggests one of two scenarios regarding diversification (Figure 3.10): (a) populations of these two groups diverged in response to two separate episodes of vicariance, or (b) the founder population(s) responded differently to the same environmental changes. Examples illustrate the possible role of these processes in the major vicariant events hypothesized:

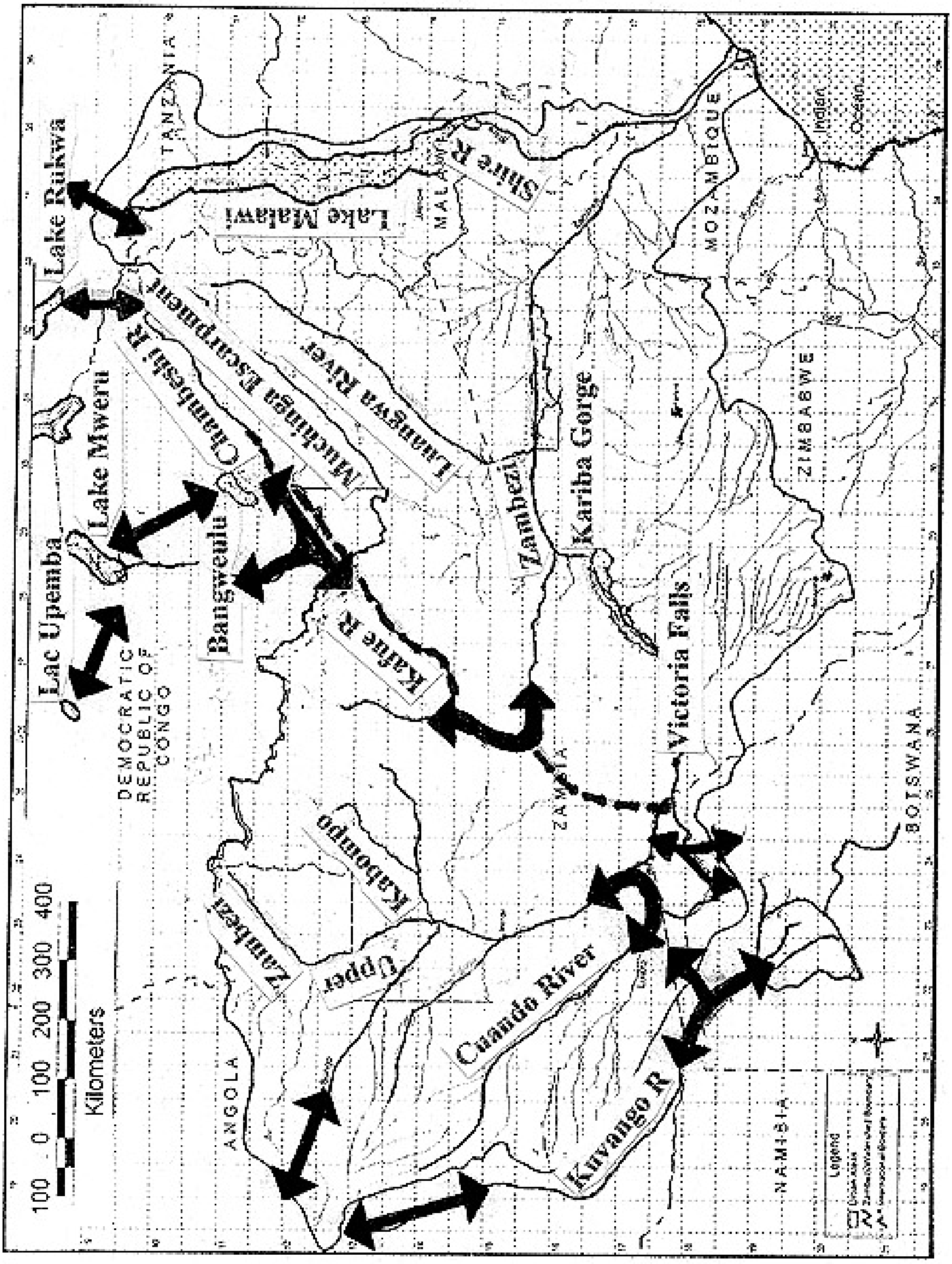
(a) Allopatric speciation followed on formation of the Muchinga Escarpment. This probably resulted in divergence of distinct pairs of species, including *K. crawshayi* and *K. ellipsiprymnus*; *K. vardoni* and *K. senganus*. Modern distributions of Zambian waterbuck suggests that their speciation was comparatively recent – *K. crawshayi* occurs across northern Zambia and southern DRC, but not west of the Zambezi, while *K. ellipsiprymnus* is confined to southern and eastern Zambia, the Luangwa and Middle Zambezi valleys. The two populations are marginally sympatric along the Lusemfwa River, a tributary of the Luangwa (Figure 3.2). The Muchinga Escarpment forms a significant boundary between the larger part of these populations (Ansell 1978, see below).

(b) *Kobus kafuensis* appears to be an allopatric isolate from a more wide-ranging population of *K.* "*leche*", whose descendants today occur only in the Busanga Flats and parts of the Upper Zambezi. In fact, *K. kafuensis* is the only lechwe that occurs marginally south of the present Upper Zambezi drainage system. Its divergence occurred long after capture of the Upper Kafue River by the Middle Zambezi (during the Miocene, Skelton 1994) and most likely as the Kafue Flats became established comparatively recently. A preliminary analysis of lechwe morphometrics (Ansell & Banfield 1980) suggested that *kafuensis* is the most derived, and thus most recent, taxon. Its large horns especially point to the origin of a unique SMRS. As for other populations, the taxonomic status of the Busanga and more westerly populations of *K.* "*leche*" require objective characterization.

(c) The Luapula River captured the Upper Chambeshi in the Pliocene (Dixey 1955, Skelton 1994) and the Bangweulu Basin formed thereafter, but the subsequent timing of changes in drainage patterns in N Zambia is unclear. It was then that *K. smithemani* and *K. robertsi* evolved in N Zambia with the evolution of a distinct SMRS in parapatric or allopatric populations. A likely physical agent of vicariance was tectonic changes across the Mweru and Bangweulu basins (and associated drainage systems) that perhaps influenced the Upemba region of the southern Congo Basin. This caused vicariance of a more contiguous lechwe population(s). It remains to be established which is the daughter species of these populations. The smaller size of *smithemani*, compared to *leche, robertsi* and *kafuensis*, suggests that it is more derived and evolved from an ancestor similar to *robertsi* or *leche*.

(d) There is circumstantial evidence, based on patterns of extant Reduncine diversity, that a separate vicariance event occurred in the E Caprivi across the Chobe, Linyanti, Luiana and Upper Zambezi, perhaps extending beyond north of Sesheke and east of Kazungula. This region corresponds to the boundary between distributions of *vardoni, crawshayi* and *penricei*, and the occurrence of an isolated population of *vardoni*. The taxonomic status of lechwe in the Linyanti and Cuando, as possibly distinct from topotypical *K. leche* in the Okavango Delta and *K. amboellensis* of the Cubango, adds additional, albeit tenuous, evidence. The edges of distributions of species of birds, reptiles and amphibians also correspond to this region. Most pertinently, the biogeographical patterns of reduncine diversity in this region points to the existence of a hotspot of evolutionary divergence.

Figure 3.10. Geographical depiction of the two principal agents hypothesized to have driven diversification of the reduncine antelopes across the Zambezi Basin and its environs since the late Pliocene (~2 Mya). Cross-hatching depicts the Muchinga Escarpment; arrows represent zones of allopatric speciation; thick dashed line represents approximate course of former Chambeshi-Upper Kafue tributary of the Zambezi.



(e) Compared to lechwe, reedbuck and waterbuck are less susceptible to vicariant disturbances as they are not so rigidly dependent on their aquatic habitats. An interesting attribute of the behaviour of puku could be relevant to their biogeography. These antelopes often disperse long distances (Ansell 1978, Ansell & Dowsett 1988), whilst the range of established populations are remarkably stable (as along the Chobe floodplain). Possibility of gene flow across the respective ranges of *vardoni* and *senganus* could have diluted and even obviated vicariant changes to ancestral populations. This behaviour may have camouflaged divergent evolution within these populations, a situation which can only be resolved with genetic studies. It is also significant that Howard (1986a) records long distance dispersal by southern reedbucks in Natal, South Africa.

(f) As already emphasized, it is not possible to distinguish unequivocal divisions between the northern and southern reedbuck (*R. occidentalis* and *R. arundinum*, respectively), should these forms withstand close scrutiny. This problem is compounded by hazy understanding as to where the two forms actually occur within the Zambezi Basin. It is, nonetheless, noteworthy that the boundary between the two forms corresponds (as recognized by Ansell, 1971) to the Zambian plateau where *Kobus* and other clades of vertebrates exhibit recent and considerable diversification. The zone of possible vicariance in *Redunca* may lie in northern Zambia and neighbouring Tanzania, across the headwaters of the Luangwa and Chambeshi rivers extending into the Rukwa depression, where *R. thomasi* (of uncertain taxonomic status) was described from the Songwe River.

(g) Although evidence is vague, a zone of biological diversification across the northeastern edge of the Zambezi Basin is analogous to the E Caprivi. As judged from incomplete data on antelope distributions, this zone would encompass the headwaters of the Luangwa and Chambeshi rivers, and extend north east across the East African rift system into the Rukwa depression. The Rukwa Valley is noted for the occurrence of *K. vardoni*, typically associated with the Upper Zambezi Basin, and both *R. arundinum* and *R. redunca*, at the southern limits of the latter's distribution. An isolated population of lechwe (believed to have been *K. smithemani*) occurred in this area at the northern margin of the Luangwa Valley (Lyell 1913), but is now extinct (Ansell 1971). This complex of reduncine populations likely resulted from recent vicariance associated with tectonic activity in the East African rift.

I suggest that this diversification resulted from a combination of determinants – tectonic events, with these geological and geomorphological processes interacting with climatic changes during the Pleistocene. One candidate is the capture of the Upper Zambezi at Katombora, associated with which were modifications of the drainage of the Chobe and associated system. This had formerly drained southwards into the central Kalahari but was now captured by the Middle Zambezi immediately west of Kazungula. The late Pleistocene was also a time of aridification, when regional climate was cooler and drier. Thus, at least two physical agents likely drove reduncine speciation, and positive feedback could have occurred. The drying-out of wetlands on the Zambezian-Congo Plateau (the African erosion surface) may have activated movement in existing fault systems and so initiated local tectonic activity. In consequence, this may have altered drainage patterns. The result would have contributed to vicariance of wetland biota.

The overall pattern exhibited in reduncine diversification approximates the evolutionary model of punctuated equilibria (Eldredge & Gould 1972). Originally proposed by Eldredge (1971), the punctuated equilibrium model is actually an elaboration, as a temporal analogue, of Mayr's allopatric model of speciation. Following rapid speciation in small vicariant populations, reduncine populations have persisted comparatively unchanged within their ranges. The fossil data available for *Kobus* and *Redunca* also support this model of stasis punctuated by allopatric speciation (Figure 3.1). Following Erwin (1991), the Reduncini are a clade of evolutionarily vibrant lineages that have recently evolved and whose evolution could persist if lineages are not extirpated by human agencies. Their habitats are sites of significant conservation concern given their recent evolution, which has quite possibly involved other biota.

The diversification of Zambezian Reduncini appears to have occurred comparatively recently during the late Pleistocene (Figure 3.1), with their extant diversity resplendent in many closely-related populations (traditionally termed superspecies, Grubb 1978). This is especially true of the lechwes. Their allopatric distributions are possibly a consequence of these antelope's high fidelity to floodplains. I suggest the model that best describes the evolution of Zambezian reduncines is one of species stasis rapidly altered by environmental changes which caused vicariance. This hypothesis is similar to the Turn Over Pulse Hypothesis, which has been used to explain mammal diversification across the continent somewhat earlier in the Tertiary and at much larger scales (Vrba 1985, 1992). Evidence for this is also abundantly represented in fossil record of pigs and primates (including hominids). These corresponded to global fluctuations in climate at the Miocene-Pliocene (5Mya) and Pliocene-Pleistocene (~2Mya) boundaries.

A more detailed model for evolution of Zambezi reduncines is still required, integrating more precise information about geomorphological changes through the Pleistocene into the Holocene. Existing models (notably Skelton 1994 on evolution of fish faunas) are too coarse-grained in their spatial and temporal dimensions, and treat the history of evolutionary change across the Zambezi Basin as proceeding through three linear stages. It was probably not that straightforward, given influences of arid periods and finer-grained vicariance of drainage systems, but this can only be tested with more precise biogeographical analyses using genetic studies of indicator species. Reduncines, especially lechwes are special candidates for finer-grained analysis of this more recent evolution in the region. Studies of their divergence need to be correlated with data pointing to fluctuations in extinct wetlands and those still existing across the basin. I suggest data from carbon deposits in sediments and pollen cores, allied with other palaeoecological research, might aid elucidation of where major lechwe habitats occurred in the comparatively recent geological past.

The susceptibility of reduncine antelopes to these physical modifications of the African erosion surface that forms the Zambezian plateau can only be surmised today. The high habitat fidelity of these aquatic antelopes suggests that the consequences were radical. The response of *K. smithemani* to an abnormal flooding of the Bangweulu area in 1936-1938 illustrates the susceptibility, especially of lechwe, to disruption of their habitats, a susceptibility that introduces the possibility of extinctions. Since species turnover is a function of both extinction and diversification, it is not unlikely that many populations of reduncines declined to extinction when tumultuous events modified wetland habitats. An extremely poor fine-grained fossil record - and remote chances of fossilization - render elucidation of this history difficult from morphological characters. Molecular characters, including construction of gene trees, are the obvious solution, but no matter how complete, can only paint a partial historical chronicle. In this respect, I predict that more detailed studies of the genetic parameters of reduncine diversification will reveal even greater extant diversity than has been pointed out in this review.

3.8 CONSERVATION

Conservation of reduncine antelopes in the Zambezi Basin involves at least three issues. One is the challenge and practice of recognizing and conserving healthy representatives of reduncine species in the region. Much attention has already been paid to this in the review. The second involves the application of scientific knowledge about reduncines to make informed conservation decisions, where reduncine species and the patterns of their evolution are used to indicate sites which support important biodiversity and/or are zones of recent and continuing evolution. Third is the relevance and value of using certain populations of reduncines to support and implement conservation activities. In this latter role, reduncines are flagship or umbrella species. It is important not to confuse these three issues (Caro & O'Doherty 1999). Two or more of these issues might be complementary in a particular conservation project, but they must be teased out and recognized so as to avoid confusion and inappropriate applications.

The reduncines have experienced huge reductions in their population through the 20th century as a result of human depredations. The historical decline of puku in Zambia exemplifies the problem, which has reached its extreme in the extinction of allopatric populations of lechwe (most notoriously *K. robertsi*). Hughes (1933) concluded that puku formed "a thin red line" along the edges of Zambian wetlands, especially vulnerable to hunting, and emphasized that these populations were already suffering major depredations in the early decades of the 20th century. In drawing attention to Hughes' admonition, Vesey Fitzgerald (1961) emphasized that it is these antelopes dependent on open grasslands that are especially prone to human depredation, and cites puku, lechwe and tsessebe as showing huge declines in the ranges and densities of their populations. The case of Kasanka dambo in Kasanka National Park demonstrates that "a thin red line" of puku can be restored with adequate protection.

3.8.1 **Maintenance of populations**

The crux of conserving any species *in situ* is to maintain sufficient habitat. This is the first and obvious step. Any management plan must address the maintenance of viable populations which are not subject to excessive depredation. The disturbance regime (for example the Kafue Flats, Schuster 1980) must be maintained to provide the appropriate cues which determine reproductive and other behaviour. The critical requirements are to reduce human depredation and excessive competition with domestic herbivores. In practice, protected areas of reduncine habitats are essential. As in southern Bangweulu (Thirgood *et al.* 1994), hunting must be prohibited in such core zones, but managed in surrounding buffer and utilization zones.

An important management tool in conservation programmes in Africa is to develop community-based conservation projects, where humans living in and around conservation areas benefit directly from the wildlife therein. It is important to acknowledge that existing programmes remain experiments, and their longevity appears precarious considered against threats of alternative land use practices, and especially unsustainable trends in human population levels.

Kingdon (1982) has emphasized the potential of reduncine antelopes for utilization, as have other authors (East 1989a, 1989b, Grimsdell & Bell 1975). The recovery of lechwe on the Busanga Flats, Caprivi and Bangweulu demonstrate that reduncine antelopes, especially lechwe, can recover rapidly from comparatively low populations. This reproductive potential needs to be considered in conservation management plans for any wetland where they occur, and testifies to considerable chances of success, but only if unsustainable exploitation, unsuitable land use and deleterious habitat modification can be halted.

Research and monitoring has demonstrated that *K. smithemani*, and *K.* "*leche*" on the Busanga Flats (Bell & Grimsdell 1973, Howard & Chabela 1987), have a remarkably high intrinsic rate of population growth. A major determinant of this life history variable is the very high survivorship of neonates coupled with a relatively young age of first reproduction in females. To this high population increase can be added the productive habitat exploited by lechwe (Ansell 1957, Bell & Grimsdell 1972, Grimsdell & Bell 1976, Robinette & Child 1964). Female puku also reproduce at a young age; 66% of calves marked in a study conceived in their first year (Rosser 1987). Howard (1986b) records that fecundity of female southern reedbuck is increased by a post-partum oestrus.

Although many authorities have repeatedly suggested that reduncines, especially lechwe, are suitable for sustainable exploitation, caution is advisable in implementing such programmes. In past centuries, certain African tribes exploited lechwe on a regular basis. Many of these were characterized by coordinated hunts where the antelope were driven with beaters and speared, or captured with dogs. If this historical offtake was sustainable, it is no longer following the introduction of modern hunting technology, national communication systems, and a massive, burgeoning population of rural humans. The consequences have been catastrophic. The exponential declines of lechwe populations in the Caprivi, Kafue Flats and Bangweulu in the past decades speak for themselves. So does the acute reduction in ranges of puku and "red" lechwes from large areas of the Upper Zambezi.

Exploitation of any population can only succeed in the long term if it is tightly managed, such that quotas are adhered to, and the resource is monitored to detect changes and trends in populations. This adds significant costs in the form of skilled personnel and aerial census. It is worth emphasizing that signatories to the Convention on Biological Diversity (to which the riparian states are party) are beholden to perform these activities in the long term within their countries. The large, unique wetlands more than justify this expenditure toward biodiversity conservation. The crux is the commitment and policing of such policies, despite inevitable political changes and burgeoning human demands. Ideally, exploitation of populations of reduncines needs to be coupled with tourism, and with more integrated and thus productive land use. Zambezian wetlands supporting unique reduncine species are especially suited to exclusive, high-paying tourism given the aesthetic attributes of the landscape and other charismatic species, such as Shoebills, in northern Zambia. Alongside sitatunga and shoebills, reduncines are flagship species to attract and maintain conservation support and interest, and in so doing aid development of their habitats as exclusive, international tourist destinations. Economic benefits could be considerable if the resource and the ecological integrity of the landscape is maintained.

3.8.2 **Reduncines as indicator species**

The patterns of diversification exhibited in the reduncine antelopes of the Zambezi Basin provide sober lessons for the assessment of biodiversity. The major part of this review has tried to elucidate the evolution and current taxonomic status of the various populations. The existence of these isolated populations points to the existence of significant wetlands which have persisted through, and also been formed by, significant climatic and tectonic changes. They open up questions about other evolutionary species, especially invertebrates and fishes currently unknown but restricted to the same areas.

The previous section has emphasized that the Reduncini form an evolutionarily vibrant clade of species that might still continue to diverge. Their existence points to a conservation priority in defining conservation areas for Zambezian biodiversity which focus not only on the representation of pattern, but equally on the maintenance of representative landscapes which generated (and continue to maintain) the biodiversity of which reduncine antelopes are part. As Cowling *et al.* (1999) emphasize, the consideration of evolutionary and ecological processes in conservation planning is vital but very challenging, not least because we know so little about these processes.

3.8.3 Reduncines as "umbrella" species in conservation

Like many large mammals, it would appear that a reduncine antelope requires a relatively large ecological neighbourhood in which it can obtain ecological resources to survive and reproduce. This requires designation and maintenance of extensive landscapes. Certain reduncines are popular flagships for conservation in the region. These include the reedbuck of Marromeu and especially the black and Kafue lechwe of Zambia.

The use of any umbrella, or flagship, species needs to be kept within the context of the reality of the overwhelming adversity facing all biodiversity conservation projects. There is a risk that conservation of the target species becomes an overriding rationale for conservation activities and funding. The reality is that the ecological integrity (undeniably a slippery definition in its own right) holds precedence to maintain the habitats where both charismatic and less apparent organisms have evolved and persist. Conservation of reduncine antelopes requires two major investments. One hinges on maintaining their aquatic and surrounding habitats. The second requires reducing human depredations on populations of these antelopes. Ultimately, this requires the synergistic management of all biodiversity and the drainage systems where these biota have evolved.

3.9 CONCLUSIONS AND RECOMMENDATIONS

1. The vicariant patterns of recent diversification in reduncine antelopes render them useful indicators to identify important biodiversity in the Zambezi Basin and further afield. Examples are the occurrence of *K. robertsi* and *K. smithemani* in N Zambia and *K. kafuensis* in the Kafue Flats, both likely to be correlated with recent geomorphological evolution within the Upper Zambezi drainage. Indication of recent evolution and rapid changes in the gradient of biodiversity across certain landscapes are highlighted by changes in reduncine distributions in at least two regions of the Zambezi Basin – the include the E Caprivi and Kazungula, and possibly the headwaters of the Chambeshi and Luangwa extending into the Rukwa Valley of SE Tanzania.

2. The Reduncini comprise a clade of evolutionarily vibrant populations. Their biogeography pointst to zones of recent and on-going evolution. Objectively applied, knowledge of their biogeography and evolution can identify representative and significant landscapes in the Zambezi Basin where evolutionarily significant populations have evolved. As they currently illustrate, the occurrence of fragmented and parapatric populations of reduncines across a large portion of the basin indicates sites for priority assessment and maintenance of aquatic biodiversity in areas where the different species occur. Overall, the pattern and timing of reduncine evolution across the Zambezi Basin indicates that a pulse of diversification has occurred across south-central Africa with special impacts on wetland biodiversity. Available evidence points to this pulse having been recent, rapid and geographically extensive in its occurrence across the Upper Zambezi. Whether caused by tectonic and geomorphological changes, climatic fluctuations, or both, the implications for biology and conservation of a knowledge of its history are profound. The more detailed analysis should be expanded into a search for historical changes in significant wetlands across the modern Upper Zambezi, Chambeshi and Kafue systems and adjacent catchments. Nevertheless, this use of large vertebrates as indicators and surrogates must be applied cautiously in biodiversity conservation

given the gravity of conservation decisions. It is critical to involve other datasets, including those for herpetofauna, fish and especially invertebrates, in a synthesis.

3. Considering their charismatic status and associated public attention, it is indeed surprising that considerable scientific work remains to elucidate the taxonomy of many large Afrotropical herbivores. This deficiency is exemplified in the Reduncini, whose phylogenetic status also requires clarification. A detailed review of the systematics of the Reduncini is required in order to assess and structure conservation planning for all genetically distinct populations. Such a study should include field assessments of existing populations to obtain tissue samples and complete gaps in museum collections.

4. Recent and radical declines, extinctions and growing threats to reduncine antelopes across the Zambezi Basin illustrate an acute conservation crisis. The impacts on most of these large mammals have been extreme, with a sweeping loss of biodiversity across the Upper Zambezi during the 20th century. As exemplified by the lechwe, reduncine antelopes have been lost from huge areas of their original habitats, which have become increasingly dominated by humans and developed for agriculture. It is especially noteworthy that at least one significant population – Roberts' Lechwe, *Kobus robertsi* – has become extinct; an inaccurate taxonomy no doubt contributed to its decline (*K. robertsi* was originally dismissed as an aberrant form of *K. leche*.) The lesson from this example is salutary. Given the great diversity represented among extant reduncine antelope of south central Africa, all discrete populations should be treated as full species with respect to conservation management until their phylogenetic status is conclusively resolved.

5. A field survey of critically threatened reduncine populations is required. This should focus on the southern Congo Basin, eastern and central Angola and, especially, northern Zambia (north of Lake Bangweulu). These surveys cannot exclude the southern Congo Basin and neighbouring Tanzania, and should include an exploration of the former range of *Kobus robertsi* and attempt to establish whether any individuals still persist. The need for this survey is urgent.

6. The potential of reduncine antelopes for controlled exploitation has barely been explored (despite the case of *K. smithemani*). This potential is characterized by their rapid growth rates and high reproductive potential. An adult reduncine antelope yields tasty meat and valuable hides. Males of all species are sought after by trophy hunters. Any such scheme needs to be properly designed and managed by professional ecologists, with conservation of at least one core source area where no cropping occurs. Such schemes are unlikely to succeed in marginal aquatic habitats, or where reduncines compete heavily for forage with other large herbivores.

7. This review has only presented preliminary conclusions. These are actually hypotheses based on incomplete datasets, correlated with equally incomplete historical evidence to provide partial answers to questions of what species of Reduncini occur where, their taxonomy and evolution. Comprehensive and detailed data about reduncine biogeography and diversity (collected and analysed as suggested above) will be invaluable to evaluate and map Afrotropical biodiversity in the continent's wetlands – in the Zambezi Basin, its environs, and elsewhere. These data on such charismatic vertebrates must be meshed with more taxonomically-representative knowledge of the region's biodiversity. The need to understand reduncine diversification and the processes which caused these antelopes and other populations to evolve is important. It points to evolutionary and ecological processes which need to be

maintained, and conceptual tools and datasets to identify representative components of extant biodiversity in the wetlands and other landscapes of Africa.

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CHAPTER 4
SMALL MAMMALS OF THE ZAMBEZI WETLANDS

Fenton Cotterill

4.1 INTRODUCTION

Small mammals make up a significant proportion of the mammal fauna of the Zambezi Basin. With the exception of the poorly known otter-shrew, *Potamogale velox* (known only from Mwinilunga District in NE Zambia), there are no specialized mammals occurring in the basin that are entirely dependent on wetlands. Yet wetlands are important habitats for small mammals; floodplains support fluctuating populations of rats and mice, as do riparian forests and woodlands, and shrews exploit the abundance of invertebrates found there. Bats are particularly well-adapted to exploit insect prey foraging over floodplains and open water, provided roosts are available on wetland margins.

The small mammal fauna of the Zambezi Basin is incompletely known. This deficiency applies to all groups (bats, insectivores and rodents). Most wetland habitats have been poorly surveyed, if at all. The main information available is limited to distributions and taxonomy, with very little known of different species' natural history and ecology. Knowledge of the small mammals of Barotseland is based primarily on specimens collected (mostly by W.F.H. Ansell) through the 1940s and into the 1970s. This taxonomic and biogeographical data for small mammals was included in Ansell's *Mammals of Zambia* (Ansell 1978). Smithers and Tello (1976) compiled an analogous treatment for Mozambique, the mammal fauna of which is one of the least known of all African countries. This deficiency of information is exemplified by the Zambezi Delta. Pioneering studies of African mammals were initiated on the lower Zambezi by R.H. Peters in the mid-19th century. Many larger mammals, together with some bats and rodents, were described to science by him. Examples include the porcupine (*Hystrix africaeaustralis*), Lichtenstein's hartebeest (*Sigmoceros lichtensteinii*), and the red squirrel (*Paraxerus palliatus*). Nevertheless, there have been no further scientific studies of small mammals of the Lower Zambezi and its delta. Small mammals were surveyed in some protected areas in Mozambique through the 1960s and early 1970s. This activity did not extend to Marromeu, where research was limited to monitoring of large mammals (summarised in Cumming *et al*. 1994) in the Marromeu Buffalo Reserve and surrounding hunting areas (coutadas).

This chapter presents the results of two surveys of important wetlands in the Zambezi Basin – Barotseland and the Zambezi Delta. The contributions of these new data to improved knowledge of the small mammal faunas of these areas are discussed in a national and regional context.

4.2 BAROTSELAND SMALL MAMMALS SURVEY

4.2.1 **Introduction**

As part of the Biodiversity Foundation for Africa/Zambezi Society wetlands biodiversity assessment project, a field survey of the small mammals of some of the wetlands of Barotseland, Western Zambia was carried out between 2-12 November 1998. The author was accompanied by Mr Aleck Ndlovu, technician in the Department of Mammals, Natural History Museum in Bulawayo. The trip was done in conjunction with a wetland bird survey (see Appendix 5.1).

Mammalian nomenclature follows Wilson and Reeder (1993), except for *Pipistrellus* where Hill and Harrison (1987) are followed.

4.2.2 **Methodology**

Owing to vehicle problems, only two sites were sampled – both dambos. The first site was 7 km west of Ndanda School, north of Mongu in a lower drainage valley classified as a wet riverplain R2 by Jeanes & Baars (1991). The woodlands near settlements had been modified, but extensive and dense tall stands of miombo occurred to the south. The second site was Litoya dambo next to a village near a large permanent pool also situated in a wet riverplain. The margins of the dambo were densely settled and cultivated; few livestock were seen. Woodlands near villages exhibited considerable modification with much regrowth and evidence of felling. This last site provided many bats but few terrestrial mammals.

4.2.3 **Results**

Total number of species collected was 26 (Table 4.1), representing a collecting effort of 43 net nights and 14 harptrap nights. The majority of bats were netted, with 34 bats captured in harptraps. Only five terrestrial mammals were collected, using snap traps baited with peanut butter and rolled oats, over 300 trap nights in eight days, while two rodents were collected in the pitfall trap arrays. Some invertebrates (insects, spiders and scorpions) and over 50 specimens of frogs and reptiles were also collected in the pitfalls and in swamps and pools near Ndanda School. All this material has been deposited in the Bulawayo Natural History Museum.

4.2.4 **Discussion**

Western Zambia has been poorly collected with respect to small mammals (Ansell 1978). Nonetheless, the occurrence of all these species is not unexpected. The bat fauna, as judged by captures in nets and harptraps, is dominated by vespertilionids and molossids. I suspect these bats roost in hollows and crevices in trees and under exfoliating bark in the tall woodlands bordering the Litoya and Ndanda dambos. The success in sampling of bats was the focus on permanent water bodies around which the bats congregated to drink and forage. This sampling strategy has also proved successful in Zimbabwe, especially during the hot, dry season in October and November. The high abundance of *C. pumila* at Litoya may reflect the occurrence of a large colony in a building in the vicinity, perhaps at the school.

The series of *Chaerephon chapini*, *Mops niveiventer*, *Laephotis botswanae, Pipistrellus anchietai* and *Scotoecus albigula* are of significant scientific taxonomic importance as such series are uncommon. The former, Africa's smallest molossid bat, is not common, with the Ndanda collection being the third recorded locality in Zambia. *M. niveiventer* and *L. botswanae* are known from a few scattered localities in Zambia and E Angola, with *L. botswanae* known from further south (Cotterill 1996).

House bats of the genus *Scotoecus* include some of Africa's most poorly known bats. Too few specimens have been collected to establish species boundaries with confidence. For example, *S. albofuscus* is only known from three specimens from the southern African subregion; two individuals from Zinave in central Mozambique (Smithers & Tello 1976) and one specimen collected near St Lucia in South Africa (Kearney & Taylor 1997). The series of *Scotoecus albigula* secured on this expedition is quite possibly the largest available from any single locality. These new specimens have been compared with the three specimens preserved in Bulawayo. Cranially, they are identical to a specimen of *S.* cf. *albigula* from the Luangwa Valley and conform to the key and data in Hill (1974). As far as I am aware, the photographs obtained are also the first taken of this species. No further conclusions can be drawn on their taxonomic status until the specimens in the UK are examined. A similar situation applies to the unidentified specimens of *Pipistrellus* and *Scotophilus*.

Table 4.1. List of mammals collected in western Zambia, November 1998, by collecting site.

Species	**Litoya**	**Ndanda**	**Remarks**
Family Pteropididae			
Epomophorus dobsoni		X	
Epomophorus gambianus	X	X	
Family Molossidae			
Mops midas Midas free-tailed bat	X		locally common
Mops condylura Angola free-tailed bat	X	X	common
Mops niveiventer White-bellied free-tailed bat	X	X	locally common
Chaerephon chapini Long-crested free-tailed bat		X	rare
Chaerephon pumila Little free-tailed bat	X	X	common
Chaerephon nigeriae Nigerian free-tailed bat	X	X	locally common
Family Vespertilonidae			
Scotophilus borbonicus Lesser house bat	X	X	common
Scotophilus dinganii Yellow house bat		X	common
Scotophilus sp.	X		undescribed species, also known from SE Zimbabwe
Scotoecus albigula		X	rare
Laephotis botswanae Botswana long-eared bat		X	rare
Pipistrellus capensis Cape pipistrelle	X	X	common
Pipistrellus melckorum Melck's pipistrelle		X	rare
Pipistrellus somalicus Somali pipistrelle	X	X	common
Pipistrellus anchietai Anchieta's pipistrelle	X	X	locally common
Pipistrellus rusticus Rusty bat	X	X	common
Pipistrellus kuhli Kuhl's pipistrelle		X	rare
Pipistrellus nanus Banana bat		X	common
Pipistrellus sp.	X	X	
Glauconycteris variegata Butterfly bat		X	
Family Rodentia			
Cryptomys damarensis Damara molerat	X	X	common on Kalahari sand
Dasymys incomtus Water rat		X	
Saccostomys campestris Pouched mouse		X	
Tatera leucogaster Bushveld gerbil		X	

Overall, the significance of these new biogeographical data can be judged from the distribution maps given in Ansell (1978). In addition, important life history data was obtained for many of the species of bats collected – most females had recently given birth and were lactating, or births were imminent.

The molerats were collected from colonies which occur along the edges of the dambos: their burrows extended into the open grassland. These specimens were trapped with modified Hickman traps (Hickman 1979) baited with potato, and were identified as Damara molerat, *Cryptomys damarensis*, which is widespread on Kalahari sands in south central Africa. This species was encountered at both Litoya and Ndanda. Fresh mounds, presumed to have been dug by *C. damarensis*, were seen elsewhere in Mongu District and between Senanga and Sesheke on the west bank of the Zambezi.

The paucity of rodents and insectivores encountered during the survey is an interesting result. I suggest that their absence is the result of human depredations and activities such as fire. The sampling period may also have coincided with dispersals and/or declines in rodent populations.

It is obviously difficult to assess the representativeness of data collected during this survey. Although only the eastern margins of the Barotse floodplain were sampled, I am confident that the two localities of Litoya and Ndanda represent the landscapes along the eastern extent of the floodplain. I suspect that the insectivorous bats in the region roost in woodlands and forage and drink over the neighbouring floodplain and dambos. Further surveys are required, especially within the floodplain proper and in the northern part of Barotseland.

4.2.5 Other observations

The Lozi farmers living along the Ndanda and Litoya dambos confirmed the lack of small mammals. They said these are frequently hunted for food. Evidence of springhares was seen.

Little evidence of large mammals was seen. Droppings of reedbuck, *Redunca arundinum*, were noted in the Ndanda dambo approximately 8 km west of Ndanda School. We were told about the occurrence of lechwe along the Luena Flats and also further west along the Litoya dambo near the Zambezi, but this could not be confirmed.

4.3 ZAMBEZI DELTA SMALL MAMMAL SURVEY

4.3.1 Introduction

This report provides details of a collection of 15 species of small mammals from the Marromeu District of central Mozambique made between 24 July and 7 August 1999. The author was accompanied by Mr Alec Ndlovu of the Natural History Museum in Bulawayo. The mammal survey team constituted part of a larger multidisciplinary party.

Little information is available on the mammals of the Marromeu District. Pioneering studies of African mammals were initiated in the environs of the lower Zambezi by R.H. Peters in the mid-19th Century: many of the more conspicuous larger mammals, together with some bats and rodents, were described to science by him as a result. Examples include the porcupine (*Hystrix africaeaustralis*), Lichtenstein's hartebeest (*Sigmoceros lichtensteinii*) and the red squirrel

(*Paraxerus palliatus*). Little further in the way of scientific studies of terrestrial mammals occurring along the Lower Zambezi and its delta has occurred since.Surveys of small mammals were completed for some protected areas in Mozambique some years ago, but did not include Marromeu. The major authority remains the *Mammals of Moçambique* (Smithers & Tello 1976) which collated existing knowledge at that time. With the exception of some monitoring of large mammals (summarised in Cumming *et al*. 1994) in the Marromeu Buffalo Reserve and surrounding hunting areas (coutadas), no scientific collections of small mammals had previously been made in the environs of the Zambezi Delta and Marromeu floodplain.

4.3.2 **Methods**

Small mammals were collected in the Marromeu district of central Mozambique from two sites, supplemented by some work in the town of Marromeu itself. One site was in Coutada 11 on the western edge of the floodplain. The bulk of collecting was carried out within a 2 km radius of the base camp on the ecotone between floodplain, palm savanna and forest. The second site was near the administrative centre of Malingapansi in the southern section of the delta along the Rio Micelo (18º40'36"S / 36º06'17"E). This is situated in an agro-ecolandscape in which remnants of fringing riparian forest and palm savanna had persisted.

A collapsible harp trap and standard 4 tier mistnets (12 x 2 m) were used for bats. These were set near the ground, and also suspended higher in the canopy in attempts to intercept flying bats. Snap traps, baited with peanut butter and rolled oats, were set in microhabitats (near grass tussocks, holes, hollow trees, under fallen logs etc). A total of 45 snap traps were deployed. Modified Hickman traps (Hickman 1979) were used to capture mole rats.

Pitfall trap arrays were set in two sites to trap rodents and shrews, as well as amphibians, small reptiles and invertebrates. Each array consisted of 20 litre PVC plastic buckets set in the ground, and interconnected by barriers of plastic sheeting. Plastic sheets were held in place with steel pegs and the bottom edge of the plastic buried in the soil. Some invertebrates (insects, spiders and scorpions) were collected in the pitfalls and have been deposited in the Natural History Museum of Zimbabwe.

Nomenclature follows Wilson & Reeder (1993), except in the case of *Pipistrellus* which follows Hill & Harrison (1987).

4.3.3 **Results**

Specimens collected

Specimens of 15 species were collected from the Marromeu wetland and Zambezi Delta (Table 4.2). All represent significant new locality records in Mozambique. The special significance of two species of fruit bats are discussed below. Nevertheless, these results are disappointing given the sampling effort. A total of only five terrestrial mammals were collected from Coutada 11. This was despite a trapping effort over nine days of 45 snaptraps (405 trap nights). These snap traps only captured one four-toed elephant shrew (*Petrodomus tetradactylus*) and one rodent. Similarly, the use of two pitfall arrays over eight nights collected a total of one shrew and one rodent. Trapping success was even lower near Malingapansi, where the majority of rodents were collected by the local community. These results were disappointing considering the sampling effort in apparently mammal rich habitat.

Captures of bats were also disappointing despite a sampling effort of 40 net nights, with the harp trap operating for seven nights. The large collection of molossids (notably *Mops condylura*) was taken in Marromeu, where large colonies of *M. condylura* and *Chaerephon pumila* have colonized the roofs of houses. *M. condylura* typically roosts in hollow trees, as evident in five specimens collected by a member of the local community in Coutada 11 from their daylight roost in a large tree.

Table 4.2. Small mammal species collected in Marromeu District, Mozambique between 24 July and 7 August 1999.

Taxon	Marromeu	Coutada 11	Malingapansi
Order Insectivora (Shrews)			
Crocidura luna, Dollman, 1910 Grey-brown musk shrew		X	
Order Chiroptera (Bats)			
Eidolon helvum (Kerr, 1792) Straw-coloured fruit bat	X		
Epomophorus crypturus Peters, 1852 Peters' epauletted fruit bat		X	X
Epomophorus wahlbergi (Sundevall, 1846) Wahlberg's epauletted fruit bat		X	X
Lissonycteris angolensis goliath Bergmans, 1997 Harrison's fruit bat		X	
Pipistrellus somalicus (Thomas, 1901) Somali pipistrelle		X	
Pipistrellus nanus (Peters, 1852) Banana bat		X	
Mops condylura (A. Smith, 1833) Angolan free-tailed bat	X	X	
Chaerephon pumila (Cretzschmar, 1830) Little free-tailed bat	X		
Order Rodentia (Squirrels, Rats and Mice)			
Cryptomys darlingi (Thomas, 1895) Darling's mole rat		X	
Mastomys natalensis (A. Smith 1834) Natal Multimammate mouse			X
Mus minutoides A. Smith, 1833 Pygmy mouse		X	
Aethomys chrysophilus (de Winton, 1897) Red veld rat		X	X
Rattus rattus (Linnaeus, 1758) House rat			X
Order Macroscelidea (Elephant Shrews)			
Petrodomus tetradactylus Peters, 1846 Four-toed elephant shrew		X	

A brief pulse of activity occurred near the base camp in Coutada 11, but lasted approximately one hour. Very few bats were captured despite erection of nets into the canopy. The harp trap only captured one *Pipistrellus somalicus*. More success was obtained with fruit bats, especially in the vicinity of fruiting trees: both at Malingapansi and Coutada 11. Nevertheless, capture should have been much higher overall.

A series of four-toed elephant shrews (*Petrodomus tetradactylus*) were collected by the local community further inland (near the headquarters of Coutada 11). Local inhabitants also said that this elephant shrew occurred in the vicinity of Malingapansi, but none were seen. The preferred habitat of this species is the understorey of dry, evergreen forest. *P. tetradactylus* is widely distributed across coastal Mozambique, extending eastwards where suitable habitat is available.

Several colonies of molerats were encountered in Coutada 11. Sustained trapping over several days near the base camp yielded two specimens with two others being captured by members of the local community. Although provisionally identified as *Cryptomys darlingi*, these might represent a taxonomically distinct population, for which the name *bierai* is available. Molecular studies (including mitochondrial DNA and karyology) are necessary to resolve this possibility.

Visual records of mammals

Specimen-based records were supplemented by records for 14 species based on either direct sightings or identification of spoor or scats (Table 4.3). Spoor of some antelope species was recorded in Coutada 11. Visual records were also obtained for warthog (*Phacocheorus aethiopicus*), bushbuck (*Tragelaphus scriptus*), buffalo (*Syncerus caffer*), oribi (*Ourebia ourebi*) and reedbuck (*Redunca arundinum*). Spoor and scats were also seen of Lichtenstein's Hartebeest (*Sigmoceros lichtensteinii*), red duiker (*Cephalophus natalensis*) and water mongoose (*Atilax paludinosus*).

Troops of samango monkey (*Cercopithecus mitis erythrarchus*) were seen and heard in Coutada 11 near the base camp on the floodplain and near the main hunting camp. A troop of this species was also seen near the mouth of the Zambezi Delta in mangrove forests approximately 2 km inland from the Indian ocean (W.R. Branch, *pers. comm.*). Troops of vervet monkey (*Cercopithecus aethiops*) were seen approximately 3 km SE of Malingapansi in a patch of mixed palm forest, including mango trees.

The calls of thick-tailed bushbaby (*Otolemur crassicaudatus*) were heard near the base camp in Coutada 11. A smaller galago (presumed to be *Galagoides zanzibaricus*, Grant's nightape) was also observed in the vicinity. A red squirrel (*Paraxerus palliatus*) was observed in forest edge along the base camp in Coutada 11.

In addition, the safari operator in Coutada 11 reported the occurrence of elephant (*Loxodonta africana*), sable (*Hippotragus niger*), suni (*Neotragus moschatus*) and blue duiker (*Cephalophus monticola*) in the hunting area. Details of visual records of larger mammal species are maintained in a log book by hunters.

Table 4.3. Mammals for which visual records were obtained in Marromeu District, Mozambique between 24 July and 7 August 1999.

Taxon	Coutada 11	Delta area
Order Primata (Primates)		
Otolemur crassicaudatus (E. Geoffroy, 1812) Thick-tailed bushbaby	X	X
Galagoides zanzibaricus granti (Thomas & Wroughton, 1907) Grant's nightape	X	_
Cercopithecus mitis erythrarchus (Peters, 1852) Samango monkey	X	X
Cercopithecus aethiops (Linnaeus, 1758) Vervet monkey	_	X
Order Carnivora (Carnivores)		
Atilax paludinosus (G. Cuvier, 1829) Water mongoose	X	X
Panthera pardus (Linnaeus, 1758) Leopard	X	_
Order Tubulidentata (Antbears)		
Orycteropus afer (Pallas, 1766) Antbear	X	_
Order Ungulata (Antelopes, Pigs)		
Phacochoerus aethiopicus (Pallas, 1766) Warthog	X	_
Syncerus caffer (Sparrman, 1779) Buffalo	X	_
Redunca arundinum (Boddaert, 1785) Southern Reedbuck	X	_
Ourebia ourebi (Zimmermann, 1783) Oribi	X	_
Sigmoceros lichtensteini (Peters, 1849) Lichtenstein's hartebeest	X	_
Order Rodentia (Squirrels, Rats and Mice)		
Paraxerus palliatus (Peters, 1852) Red squirrel	X	_
Hystrix africaeaustralis (Peters, 1852) Porcupine	X	_

4.3.4 Significance of collected specimens

The mammal fauna of Mozambique is poorly known. The most up-to-date review remains Smithers & Tello (1976). Although, J. Tello, K. Tinley and colleagues collected small mammals from some protected areas in Mozambique through the 1960s into the early 1970s, these surveys concentrated on Gorongosa and Zinave National Parks. Few specimens, if any, were collected from the Zambezi

Delta and Marromeu. The nearest collecting activities to the delta were by R.H. Peters in the middle of the 19th century. In 1908, Austin Roberts (later the famous curator in Transvaal Museum) and F. Vaughan Kirby collected some mammals north west of Chinde and near Quelimane in 1908 (Brain 1998). These were mostly from the vicinity of Vila Pereira and Nhamacurra, some distance north of the Lower Zambezi.

The results of this expedition to Marromeu were disappointing. Far higher returns on mistnetting for bats and trapping for small terrestrial mammals were expected. This is probably because mammal activity had not re-commenced after the dry season with the rise in ambient temperatures. Nonetheless, some of the specimens obtained represent significant contributions to scientific knowledge of the species they represent. These are discussed in turn.

Harrison's Fruit Bat, *Lissonycteris angolensis goliath*

The single specimen of the fruit bat, *Lissonycteris angolensis goliath*, collected in Coutada 11 is an interesting record. This is a significant range extension from the Eastern Highlands in eastern Mozambique near the Zimbabwe border. The taxonomic distinctiveness of this population was only recently established (Bergmans 1997). The identity of this specimen is not in doubt as it has been compared with the holotype and paratypes in the Natural History Museum, Bulawayo. Few specimens are known of this recently-described fruit bat. This is the second known locality of the species from Mozambique, which has previously only been recorded from the vicinity of Chimoio. The only other known specimens have been collected in eastern Zimbabwe (Gleneagles, Nyanga and the Haroni-Rusitu forest). Although originally described as a subspecies, the allopatric distribution of this population suggests that full specific status is likely. *L. a. goliath* is significantly larger than fruits bats of the topotypical population restricted to west Africa. The specific status of *L. goliath* is conferred if an evolutionary species concept (recognising the phylogenetic distinctiveness of the allopatric population as an evolutionary lineage) is applied.

Straw-coloured Fruit Bat, *Eidolon helvum*

The permanent occurrence of *Eidolon helvum* in the town of Marromeu is of significant interest. The bats, estimated to number in their hundreds, roost in a large mango tree near the sugar refinery in eastern Marromeu close to the south bank of the Zambezi. The large, adult mammal collected was sexually active, and considerable fighting over roost space was observed. This strongly suggests that the colony was reproductively active. Small, permanent colonies of *Eidolon helvum* have been reported in Malawi (Ansell & Dowsett 1988). The Marromeu colony has been in residence at least since 1978 (B. Chande, pers. comm.). To the best of my knowledge, this is the only permanent colony of *Eidolon helvum* in southern Africa. Its conservation is of obvious importance. This large bat is migratory, and its range is centred on moist forests of west and central Africa. Individuals migrate widely from this region, and range across the subcontinent. It was previously believed that reproduction only occurred in equatorial regions, and only migratory individuals occurred in southern Africa (Smithers 1983).

Paucity of Small Mammals

The most likely explanation for the paucity of terrestrial mammals noted in this survey is the phenology of the environment. The floodplains may only provide suitable habitats for rodents once flooded grasslands have receded. This would occur later in the year (September through December) with populations continuing to increase through the wet season. In this case, populations would be localized and reduced by the end of the wet season.

Some evidence for this situation is illustrated in the characteristics of rodents captured near Malingapansi, notably multimammate mice (*Mastomys natalensis*). A large series of *M. natalensis* was collected by members of the local community in the environs of Malingapasi. This species is commensal with humans, and especially abundant in agroecolandscapes. Mice of the genus *Mastomys* are capable of high fecundity, and their rapid growth rates and early age of breeding account for population explosions. Many of these specimens captured in Malingapansi were juveniles and subadults, which suggest that a population explosion of *Mastomys* was underway in the area. In addition, 4 subadult specimens of the commensal house rat, *Rattus rattus* was collected in newly completed buildings in Malingapansi.

Based on experience in Zimbabwe and southern Zambia, most bats exhibit a seasonal decline in activity. Highest captures occur during the warmer months of the hot, wet season (September-April) when bats are reproductively active. During the cool, dry season (May-August) insectivorous bats tend to forage intermittently, and their metabolic demands are lower compared to when breeding.

4.3.5 Conclusions and suggestions

There remains considerable potential to improve scientific knowledge of the small mammals of the Marromeu wetland and Zambezi Delta, as for all the region's biodiversity. This will only accrue through further surveys. The most suitable season to survey small mammals in the Marromeu District is most likely in November, or possibly later during the summer months. Sampling through November into December will most likely provide the highest returns on sampling effort. Captures of rodents and shrews should also improve at this time.

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CHAPTER 5
WETLAND BIRDS OF THE ZAMBEZI BASIN

Peter Mundy

5.1. INTRODUCTION

A wetland bird (or waterbird), as defined here, is one that is ecologically dependent on water and/or marshy habitats, i.e. it is a wetland species that spends its life in and around these habitats for feeding (e.g. Osprey), breeding (e.g. Carmine Bee-eater), or both (e.g. Long-tailed Wagtail) (Latin names can be found in Table 5.1 - see page 217 - and Table 5.2 - see page 226). Unfortunately, there is some confusion among ornithologists as to the definition of a waterbird. The very recent publication by Underhill *et al*. (1999) uses the families from Pelecanidae to Laridae and defers to Rose & Scott (1997) for their definition. These latter authors use a "family" or "whole-taxa" approach, from Gaviidae to Rynchopidae (32 families), while admitting to the "minor anomalies" that this produces of omitting a "few wetland birds" such as kingfishers and raptors. Nevertheless, Rose & Scott (1997) repeat the Ramsar Convention definition of water*fowl* ("birds that are ecologically dependent upon wetlands"), but restrict it to the above-mentioned families. Meanwhile Maclean (1993: li-lii) adds wagtails to his grouping of "waterbirds", and the African Waterfowl Census (Dodman *et al*. 1997: 244-247) adds birds of prey, including owls, to the Rose and Scott list.

The accurate approach, of course, is to look at the individual species themselves, whatever family they may belong to. In this way, species from otherwise waterfowl families may not be waterbirds, e.g. Cattle Egret and White Stork which in the main are dry grassland species, and species from non-waterfowl families may be waterbirds, e.g. Fish Eagle and Swamp Boubou. Thus water*birds* include all water*fowl,* but not vice versa. This distinction seems clear and sensible to me, but has been blurred by the above authors.

Quite likely there will be some disagreement over any chosen list of the waterbirds of the Zambezi Basin because the list depends on how one 'weighs' or categorises the potential species. For example, some might want to include the Black-rumped Buttonquail and Grimwood's Longclaw (K. Hustler, pers. comm.), whereas I consider these as being not closely enough connected with water. I have therefore taken a 'strict' approach to a species when deciding whether or not to define it as a waterbird. My list now contains 178 species from 40 families, and is a revised version of that to be found in the Phase 1 Final Report (Timberlake 1998), which contained 167 species. From that earlier list I have deleted nine species which are mainly birds of dry grassland, and have added 20 others, for example the White-cheeked Bee-eater (which had previously been overlooked) and various warblers.

Clearly then, a waterbird as defined here is a *fresh*water bird. By definition, seabirds (or birds dependent on salt water) have been omitted. Again, a few species may be controversial. For example, the Lesser Black-backed Gull is included because it is sometimes found inland on freshwater, but the Sooty Tern is excluded because it is only (and rarely) found inland when blown there by cyclones in the Mozambique channel (Couto & Jana 1999). In principle, of course, seabirds are excluded because the Zambezi Basin is a freshwater habitat.

A 'strict' approach has also been taken to the boundaries of the Zambezi Basin, using the current watershed delimitations (Matiza *et al.* 1995: 2). Thus the Okavango and Bangweulu Swamps are omitted.

This chapter deals with certain aspects of the wetland birds (178 species) of the Zambezi Basin. It should be noted in passing, however, that to date 570 bird species have been identified in the four main wetlands, and the basin as a whole probably supports about 800 species (K. Hustler, pers. comm.). Many of these are forest and woodland birds, some are aerials, etc. Several species are, or should be, the subject of taxonomic investigation. But such aspects are not considered where they concern non-waterbirds. Following a review of the rather limited previous work on the waterbirds of the Zambezi Basin and a brief look at certain aspects of zoogeography, detailed checklists of wetland birds and their distribution are presented. There follows a consideration of species and areas of conservation interest; a broader remit of grassland birds in general is included because of south-central Africa's significance in this regard. Finally, several conclusions are suggested. The chapter finishes by highlighting the conservation status of species that are of particular interest.

For the sake of completeness, it should be mentioned that waterbirds in the Zambezi Basin will of course use other wet habitats in addition to the large wetlands of particular interest to this project. For example: (a) Zimbabwe, and to a lesser extent Malawi and Zambia, hold many (indeed thousands, ALCOM/FAO database) artificial dams of one hectare or more in extent, including lakes Kariba (Donnelly & Donnely 1983) and Cabora Bassa; (b) there are countless dambos or vleis within the basin which, at least in Zambia and Zimbabwe (e.g. Whitlow 1985), add up to a considerable extent of wetland, unfortunately much threatened by damming and agriculture; (c) there are also many temporary pans, usually lasting for less than a year, which are havens for breeding waterbirds such as ducks (Godfrey 1992); and (d) there are many rivers and streams flowing into the Zambezi itself, the riverine fringes of which are particularly important to species such as African Finfoot and Half-collared Kingfisher.

5.2. REVIEW OF PREVIOUS WORK

An older generation of ornithologists has mapped most of the species of sub-Saharan Africa in terms of specimens collected (Hall & Moreau 1970, Snow 1978), and these near-continental maps include the Zambezi Basin. However, for the passerines (Order Passeriformes, with waterbirds in six families – small perching-and-singing birds) only "resident" species were mapped, all palaearctic migrants being excluded (Hall & Moreau 1970). In addition, the maps were compiled from "specimens and from literature" and from a "few well-authenticated sight-records". For the non-passerines (many orders, with waterbirds in 33 families – generally larger birds) mapping was restricted to those species "known to breed" (Snow 1978). Several "purely or predominantly" marine families were excluded, resulting in species such as Crab Plover and African Skimmer being omitted, as were all palaearctic migrants. However, for the non-passerines, "sight records [were] freely admitted for large and conspicuous species". Thus these atlases excluded 47 species of waterbirds that are included on the list for the Zambezi Basin (Table 5.1, page 217). Finally, at the map scale used of 1:36 million each symbol covers about one-half of a degree square; a resolution which today is generally considered to be too coarse.

Nevertheless, these two atlases were pioneering achievements and remain essential to biodiversity assessments. They heralded the modern passion for atlases of countries (e.g. Penry 1994) or regions (Harrison *et al.* 1997 is unique in this regard). The first such atlas of the new genre was for Natal in South Africa (Cyrus & Robson 1980). Such atlases, it must be emphasised, almost entirely use sight and call records due to the greatly improved identification skills of bird watchers over the last two decades, brought about both by field guides (for example, in our region, Aspinwall & Beel 1998, Newman 1996, Newman *et al.* 1992 and Sinclair *et al.* 1997) and by audio tapes of calls. Various of these atlases also indicate months of occurrence, breeding, and an index of abundance. But to this day none uses all the field data collected that could be presented, i.e. distribution, seasonality (dates), breeding, abundance (actual numbers), and age structure where possible.

In January 1991 the African Waterfowl Census (AWC) was launched and several countries participated. The aims were to count waterfowl (not all waterbirds!) at wetlands annually in January and July. By 1997, counts were being made in 28 countries on the African mainland (Dodman *et al.* 1997); included were all the countries in the Zambezi Basin except for Angola. Families of birds from grebes to the African Skimmer, including birds of prey and the Marsh Owl, were counted. Thus the AWC list excluded no less than 44 species which are considered to be waterbirds in the Zambezi Basin. It should be clear that the main problems with the AWC are the extreme difficulty of having observers at all important wetlands, and of the observers counting all the birds (even just the conspicuous ones) at any one large wetland. Nevertheless it is a start, and three of the aims are: (a) to provide a monitoring scheme, (b) to describe distributions, and (c) to learn of seasonal changes in distribution and numbers. Parts of the Kafue Flats consistently produce large numbers of waterbirds. Incidentally, one should note in passing that an earlier scheme in South Africa – the African Waterfowl Enquiry (Anon. 1954, 1972) – fell away years before the AWC was started. Some information from the AWC was used in a duck atlas (Scott & Rose 1996) and will be used in a forthcoming wader atlas.

Perhaps as part of the original Enquiry, there was a great deal of waterfowl ringing done in southern Africa, but most of it was "decades ago" (Underhill *et al.* 1999). For example, this recent review notes that 13,189 Sacred Ibis had been ringed, of which 96% were ringed by 1973 – several of the ringed birds were recovered (i.e. found dead) in the Zambezi Basin. Ringing of waterbirds, such as waders (plovers and sandpipers), terns and warblers, still continues, albeit at a low ebb.

Ornithologists in South Africa also made many studies on waterfowl, particularly ducks. There has been much less interest further north, though studies in Zambia by Douthwaite (1977, 1978), in Zimbabwe by Jarvis (1984), Hustler (1996, 1997) and Hustler & Marshall (1996), and in areas to the south by Borello *et al.*(1998), Stowe & Becker (1992) and Tree (1979), are examples. There is in fact tremendous scope for biological studies on the waterbirds of the Zambezi Basin, and not just in terms of distribution and numbers, but in the equally intriguing aspects of food, micro-habitat preferences and sympatry. Detailed surveys along most of the Zambezi have been done for the Rock Pratincole (Williams *et al.* 1989) and African Skimmer (Coppinger *et al.* 1988) and within Zimbabwe for the Carmine Bee-eater (Mundy *et al*. 1994), and on certain wetlands for the Wattled Crane (e.g. Howard & Aspinwall 1984). These surveys also considered the impacts of various threats on the species.

5.3. ASPECTS OF ZOOGEOGRAPHY

Information on waterbirds in the Zambezi Basin must still be regarded as incomplete due to the difficulty of fully exploring the extensive wetlands. This caveat also applies historically – some species which are being increasingly recorded, such as the European Marsh Harrier and Black-tailed Godwit (K. Hustler, pers. comm.), may genuinely be increasing or may not have been noticed in the past. In addition, the Chobe-Linyanti and Lower Shire areas are well investigated, and certainly better known than the Barotse floodplain and Zambezi Delta. Whereas many of the larger non-passerine waterbirds can be confidently seen from the air (e.g. Beilfuss & Allan 1996 for the Zambezi Delta), and even have their populations estimated in the manner of large mammals (e.g. Wattled Crane), this is impossible for the smaller birds. There is much to be learned of the distributions of all the waterbirds across all the wetlands of the Zambezi Basin, and this must especially apply to Angola which contains 18% of the basin.

Of perhaps greater interest are the occurrence of 'isolated' populations of particular species, restricted to certain areas or wetlands. All these need taxonomic investigation as to their specific or subspecific status. The Ethiopian Snipe, for example, which is widely distributed, has a longer bill (by one-third) than its counterpart further south, and the Red-shouldered Widow, also widespread in the basin, may be specifically distinct from the southern type (K. Hustler, pers. comm.). It seems possible too that the Black-backed Cisticola of the Barotse floodplain is a separate species.

Particularly striking instances are provided by two other cisticola warblers. The Cloud Cisticola is a bird usually of grasslands in South Africa, but has an isolated population in the plains (floodplain?) grassland of the Upper Zambezi and over the watershed in Angola (Hall & Moreau 1970). The Levaillant's or Lesser Black-backed Cisticola also has an isolated population in Barotseland as well as elsewhere in the basin such as on the Zimbabwe highveld. Its taxonomic status is under investigation (K. Hustler, pers. comm). Indeed the cisticolas or grass warblers as a group surely offer a most interesting perspective on bird evolution, especially in view of their apparent morphological uniformity. All but one of the 40 species live in Africa (Garcia 1985). The group was last examined nearly a century ago (Lymes 1930) and is therefore ready for a modern treatment. Not known to be migrants, or even nomads, these little brown birds have evolved into habitat specialists with a wide range of calls and displays.

That a few species of waterbird (e.g. Slaty Egret, Maccoa Duck) are quite restricted in their wetlands of choice comes as something of a surprise in view of birds' obvious mobility due to flight. Most waterbirds, as expected, are widely distributed, being able to move from one wetland to another with ease; flamingos and Wattled Cranes are conspicuous examples. Most waterbird species also undertake movements of some sort (see Underhill *et al.* 1999) and these must be related to the state of the habitat and depth of water. After rain in the catchment and flooding, shoreline habitat disappears and waders (plovers and sandpipers) must move. Conversely, other species arrive into the flooded grassland, especially secretive ones such as bitterns, rails and flufftails. The palaearctic migrants that occur in the basin during the austral summer presumably have the widest tolerances, because they are not breeding and can therefore move whenever necessary. The Corncrake is one such example (Stowe & Becker 1992). The selective factor at work on all waterbird species, then, is one of being able to move and search – perhaps over long distances – in the wake of habitat loss due to drying-out or flooding.

5.4 DETAILED CHECKLISTS

A revised list of the waterbirds of the Zambezi Basin is presented in Table 5.1. There are 178 species in 40 families, with a few having many species: Ardeidae (17 species), Anatidae (18), Rallidae (15), Charadriidae (13), Scolopacidae (21, all but one being palaearctic migrants) and Sylviidae (12). These are the waterbird families *par excellence*.

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Table 5.1 Checklist of wetland bird species recorded in wetlands of the Zambezi Basin: Barotse floodplains (Bar), Chobe-Linyanti swamps (Cho), Lower Shire marshes (LSh), Zambezi Delta (ZD), and in any other areas (Other). Family names are indicated in heavy type.

* = threatened species, either globally or regionally

Family/Common names	**Scientific name**	**Bar**	**Cho**	**LSh**	**ZD**	**Other**
Podicipedidae						
Dabchick (Little Grebe)	*Tachybaptus ruficollis*	X	X	X	X	X
Great Crested Grebe	*Podiceps cristatus*					X
Pelecanidae						
White Pelican	*Pelecanus onocrotalus*	X	X	X	X	X
Pink-backed (Grey) Pelican	*Pelecanus rufescens*	X	X	X	X	X
Phalacrocoracidae						
Reed (Long-tailed) Cormorant	*Phalacrocorax africanus*	X	X	X	X	X
White-breasted Cormorant	*Phalacrocorax carbo*	X	X	X	X	X
Anhingidae						
African Darter	*Anhinga melanogaster*	X	X	X	X	X
Ardeidae						
Grey Heron	*Ardea cinerea*	X	X	X	X	X
Goliath Heron	*Ardea goliath*	X	X	X	X	X
Purple Heron	*Ardea purpurea*	X	X	X	X	X
Great White Heron (Egret)	*Egretta alba*	X	X	X	X	X
Little Egret	*Egretta garzetta*	X	X	X	X	X
Yellow-billed Egret	*Egretta intermedia*	X	X	X	X	X
Black Egret	*Egretta ardesiaca*	X	X	X	X	X
Slaty Egret *	*Egretta vinaceigula*	X	X			X
Squacco Heron	*Ardeola ralloides*	X	X	X	X	X
Madagascar Squacco (Pond) Heron *	*Ardeola idae*			X		X
Rufous-bellied Heron	*Butorides rufiventris*	X	X	X	X	X
Green-backed Heron	*Butorides striatus*	X	X	X	X	X
Black-crowned Night Heron	*Nycticorax nycticorax*	X	X	X	X	X
White-backed Night Heron	*Gorsachius leuconotus*	X	X	X		X
Little Bittern	*Ixobrychus minutus*	X	X	X	X	X
Dwarf Bittern (Rail Heron)	*Ixobrychus sturmii*	X	X	X	X	X
Bittern	*Botaurus stellaris*	X				X
Scopidae						
Hamerkop	*Scopus umbretta*	X	X	X	X	X
Balaenicipitidae						
Shoebill Stork *	*Balaeniceps rex*					X

Family/Common names	Scientific name	Bar	Cho	LSh	ZD	Other
Ciconiidae						
Black Stork	*Ciconia nigra*		X	X	X	X
Woolly-necked Stork	*Ciconia episcopus*	X	X	X	X	X
Open-billed Stork	*Anastomus lamelligerus*	X	X	X	X	X
Saddle-billed Stork	*Ephippiorhynchus senegalensis*	X	X	X	X	X
Marabou Stork	*Leptoptilos crumeniferus*	X	X	X	X	X
Yellow-billed Stork (Wood Ibis)	*Mycteria ibis*	X	X	X	X	X
Plataleidae						
Sacred Ibis	*Threskiornis aethiopicus*	X	X	X	X	X
Glossy Ibis	*Plegadis falcinellus*	X	X	X	X	X
Hadeda Ibis	*Bostrychia hagedash*	X	X	X	X	X
African Spoonbill	*Platalea alba*	X	X	X	X	X
Phoenicopteridae						
Greater Flamingo	*Phoenicopterus ruber*	X	X	X	X	X
Lesser Flamingo *	*Phoenicopterus minor*	X		X	X	X
Anatidae						
White-faced Duck	*Dendrocygna viduata*	X	X	X	X	X
Fulvous Duck	*Dendrocygna bicolor*	X	X	X	X	X
White-backed Duck	*Thalassornis leuconotus*					X
Egyptian Goose	*Alopochen aegyptiacus*	X	X	X	X	X
Yellow-billed Duck	*Anas undulata*	X	X	X		X
African Black Duck	*Anas sparsa*			X		X
Cape Teal	*Anas capensis*	X	X			X
Hottentot Teal	*Anas hottentota*	X	X	X	X	X
Red-billed Teal	*Anas erythrorhyncha*	X	X	X	X	X
Pintail	*Anas acuta* (PM)		X		X	
Garganey	*Anas querquedula* (PM)			X	X	
European Shoveller	*Anas clypeata* (PM)					X
Cape Shoveller	*Anas smithii*		X		X	X
Southern Pochard	*Netta erythrophthalma*	X	X	X	X	X
Pygmy Goose	*Nettapus auritus*	X	X	X	X	X
Knob-billed Duck	*Sarkidiornis melanotos*	X	X	X	X	X
Spur-winged Goose	*Plectropterus gambensis*	X	X	X	X	X
Maccoa Duck	*Oxyura maccoa*		X			X
Accipitridae						
African Fish Eagle	*Haliaeetus vocifer*	X	X	X	X	X
European Marsh Harrier	*Circus aeruginosus* (PM)			X		X
African Marsh Harrier	*Circus ranivorus*	X	X	X	X	X

Family/Common names	**Scientific name**	**Bar**	**Cho**	**LSh**	**ZD**	**Other**
Pandionidae						
Osprey	*Pandion haliaetus* (PM)	X	X	X		X
Phasianidae						
Harlequin Quail	*Coturnix delegorguei*	X	X	X	X	X
Blue Quail	*Coturnix adansonii*			X	X	X
Gruidae						
Wattled Crane *	*Bugeranus carunculatus*	X	X		X	X
Grey Crowned Crane	*Balearica regulorum*	X	X		X	X
Rallidae						
African Water Rail	*Rallus caerulescens*	X	X	X	X	X
Corncrake *	*Crex crex* (PM)					X
African Crake	*Crex egregia*	X	X	X		X
Black Crake	*Amaurornis flavirostris*	X	X	X	X	X
Spotted Crake	*Porzana porzana* (PM)		X			X
Baillon's Crake	*Porzana pusilla*					X
Striped Crake	*Aenigmatolimnas marginalis*					X
Red-chested Flufftail	*Sarothrura rufa*	X	X		X	X
Streaky-breasted Flufftail	*Sarothrura boehmi*					X
White-winged Flufftail *	*Sarothrura ayresi*					X
Purple Gallinule (Swamp Hen)	*Porphyrio porphyrio*	X	X	X	X	X
Lesser Gallinule	*Porphyrula alleni*	X	X	X	X	X
Moorhen	*Gallinula chloropus*	X	X	X		X
Lesser Moorhen	*Gallinula angulata*	X	X	X	X	X
Red-knobbed Coot	*Fulica cristata*	X	X	X		X
Heliornithidae						
African Finfoot	*Podica senegalensis*		X	X		X
Jacanidae						
African Jacana (Lily-trotter)	*Actophilornis africanus*	X	X	X	X	X
Lesser Jacana	*Microparra capensis*	X	X	X	X	X
Rostratulidae						
Painted Snipe	*Rostratula benghalensis*	X	X	X		X
Haematopodidae						
European Oystercatcher	*Haematopus ostralegus* (PM)				X	
Charadriidae						
Ringed Plover	*Charadrius hiaticula* (PM)	X	X	X	X	X
White-fronted Plover	*Charadrius marginatus*	X	X	X	X	X
Chestnut-banded Plover	*Charadrius pallidus*		X			X
Kittlitz's Sandplover	*Charadrius pecuarius*	X	X	X	X	X

Family/Common names	**Scientific name**	**Bar**	**Cho**	**LSh**	**ZD**	**Other**
Three-banded Plover	*Charadrius tricollaris*	X	X	X	X	X
Mongolian Plover (Lesser Sandplover)	*Charadrius mongolus* (PM)					X
Sand Plover (Greater Sandplover)	*Charadrius leschenaultii* (PM)					X
Caspian Plover	*Charadrius asiaticus* (PM)	X	X	X		X
Grey Plover	*Pluvialis squatarola* (PM)	X	X	X	X	X
Blacksmith Plover	*Vanellus armatus*	X	X	X	X	X
White-crowned Plover	*Vanellus albiceps*	X	X	X	X	X
Senegal Wattled Plover	*Vanellus senegallus*	X	X	X	X	X
Long-toed (White-winged) Plover	*Vanellus crassirostris*	X	X	X	X	X
Scolopacidae						
Ruddy Turnstone	*Arenaria interpres* (PM)	X				X
Terek Sandpiper	*Xenus cinereus* (PM)	X		X		X
Common Sandpiper	*Tringa hypoleucos* (PM)	X	X	X	X	X
Green Sandpiper	*Tringa ochropus* (PM)	X		X	X	X
Wood Sandpiper	*Tringa glareola* (PM)	X	X	X	X	X
Spotted Redshank	*Tringa erythropus* (PM)			X		
Redshank	*Tringa totanus* (PM)			X		
Marsh Sandpiper	*Tringa stagnatilis* (PM)	X	X	X	X	X
Greenshank	*Tringa nebularia* (PM)	X	X	X	X	X
Knot	*Calidris canutus* (PM)					X
Curlew Sandpiper	*Calidris ferruginea* (PM)	X	X	X	X	X
Little Stint	*Calidris minuta* (PM)	X	X	X	X	X
Sanderling	*Calidris alba* (PM)	X		X	X	X
Ruff/Reeve	*Philomachus pugnax* (PM)	X	X	X	X	X
Great Snipe *	*Gallinago media* (PM)	X		X		X
Ethiopian Snipe	*Gallinago nigripennis*	X	X	X	X	X
Black-tailed Godwit	*Limosa limosa* (PM)					X
Bar-tailed Godwit	*Limosa lapponica* (PM)			X		X
Curlew	*Numenius arquata* (PM)	X				X
Whimbrel	*Numenius phaeopus* (PM)			X	X	
Grey Phalarope	*Phalaropus fulicarius* (PM)					X
Recurvirostridae						
Avocet	*Recurvirostra avosetta*	X	X	X		X
Black-winged Stilt	*Himantopus himantopus*	X	X	X	X	X
Dromadidae						
Crab Plover	*Dromas ardeola* (PM)				X	
Burhinidae						
Water Dikkop	*Burhinus vermiculatus*	X	X	X	X	X

Family/Common names	Scientific name	Bar	Cho	LSh	ZD	Other
Glareolidae						
Red-winged Pratincole	*Glareola pratincola*	X	X	X	X	X
Rock (White-collared) Pratincole *	*Glareola nuchalis*		X			X
Laridae						
Lesser Black-backed Gull	*Larus fuscus* (PM)	X		X		X
Grey-headed Gull	*Larus cirrocephalus*	X	X	X	X	X
Gull-billed Tern	*Gelochelidon nilotica* (PM)					X
Caspian Tern	*Hydroprogne caspia*	X	X		X	X
Lesser Crested Tern	*Sterna bengalensis* (PM)				X	
Whiskered Tern	*Chlidonias hybridus*	X	X	X	X	X
White-winged Tern	*Chlidonias leucopterus* (PM)	X	X	X	X	X
Rynchopidae						
African Skimmer *	*Rynchops flavirostris*	X	X	X	X	X
Cuculidae						
Black Coucal	*Centropus bengalensis/grillii*	X	X	X		X
Coppery-tailed Coucal	*Centropus cupreicaudus*	X	X			X
White-browed Coucal	*Centropus superciliosus*	X	X	X	X	X
Tytonidae						
Grass Owl	*Tyto capensis*				X	X
Strigidae						
Marsh Owl	*Asio capensis*	X	X	X	X	X
Pel's Fishing Owl	*Scotopelia peli*		X	X		X
Caprimulgidae						
Natal (Swamp) Nightjar	*Caprimulgus natalensis*	X	X			X
Alcedinidae						
Pied Kingfisher	*Ceryle rudis*	X	X	X	X	X
Giant Kingfisher	*Ceryle maxima*	X	X	X	X	X
Half-collared Kingfisher	*Alcedo semitorquata*		X		X	X
Malachite Kingfisher	*Alcedo cristata*	X	X	X	X	X
Mangrove Kingfisher	*Halcyon senegaloides*				X	
Meropidae						
Olive Bee-eater	*Merops superciliosus*		X	X		X
Blue-cheeked Bee-eater	*Merops persicus* (PM)	X	X	X	X	X
Southern Carmine Bee-eater *	*Merops nubicoides*	X	X	X	X	X
White-fronted Bee-eater	*Merops bullockoides*	X	X	X	X	X
White-cheeked Bee-eater	*Merops variegatus*	X				X
Hirundinidae						
Wire-tailed Swallow	*Hirundo smithii*	X	X	X	X	X

Family/Common names	Scientific name	Bar	Cho	LSh	ZD	Other
European Sand Martin	*Riparia riparia* (PM)	X	X	X		X
African (Brown-throated) Sand Martin	*Riparia paludicola*	X	X	X	X	X
Banded Martin	*Riparia cincta*	X	X	X		X
Sylviidae						
Basra Reed Warbler	*Acrocephalus griseldis* (PM)			X	X	
European Reed Warbler	*Acrocephalus scirpaceus* (PM)	X		X		
Sedge Warbler	*Acrocephalus schoenobaenus* (PM)	X	X	X	X	X
Cape Reed (Lesser Swamp) Warbler	*Acrocephalus gracilirostris*	X	X	X	X	X
Greater Swamp Warbler	*Acrocephalus rufescens*	X	X			X
African Sedge (Little Rush) Warbler	*Bradypterus baboecala*	X	X	X	X	X
Moustached Warbler	*Melocichla mentalis*			X	X	X
Pale-crowned Cisticola	*Cisticola brunnescens*	X				X
Red-faced Cisticola	*Cisticola erythrops*	X	X	X	X	X
Black-backed Cisticola	*Cisticola galactotes*	X	X	X	X	X
Chirping Cisticola	*Cisticola pipiens*	X	X			X
Levaillant's Cisticola	*Cisticola tinniens*	X				X
Motacillidae						
African Pied Wagtail	*Motacilla aguimp*	X	X	X	X	X
Long-tailed Wagtail	*Motacilla clara*	X		X		X
Pink-throated Longclaw	*Macronyx ameliae*	X	X			X
Malaconotidae						
Swamp Boubou	*Laniarius bicolor*	X	X			
Marsh Tchagra	*Tchagra minuta*			X	X	X
Ploceidae						
Yellow Weaver	*Ploceus subaureus*			X	X	X
Brown-throated Weaver	*Ploceus xanthopterus*	X	X	X	X	X
Red-headed Quelea	*Quelea erythrops*			X	X	X
Red Bishop	*Euplectes orix*	X	X	X	X	X
Golden Bishop	*Euplectes afer*	X	X			X
Red-shouldered Widow	*Euplectes axillaris*	X	X	X	X	X
Estrildidae						
Common Waxbill	*Estrilda astrild*	X	X	X	X	X
Orange-breasted Waxbill	*Sporaeginthus subflavus*	X		X	X	X
Totals	178 species	133	129	132	118	166

N.B. Water*fowl* are generally considered to be all those families up to and including the African Skimmer, whereas water*birds* include any that are ecologically dependent on water.
(PM)= Palaearctic Migrant; i.e. a species that breeds (in the northern summer) in Europe, Russia and Asia, but spends the northern winter in Africa as a non-breeding migrant. There are 43 in this list.

In a list of this nature, no distinction has been made between common and rare species, or between residents and intra-African migrants. Each is simply recorded as present, whether from only one sighting or from many. It should be emphasised that the lists are almost entirely made up of *sightings* of birds rather than specimens. Birds can be easily identified both by sight and call by an experienced observer, and usually there is no need to take specimens. A list like this in fact unduly emphasises the *vagrant* species, because bird watchers can be relied upon to document the unusual rather than the commonplace. A vagrant can be defined as a species that is totally unexpected in an area – such as the Sooty Tern. By contrast, the Lesser Black-backed Gull, which can be expected, is in fact *rare*. It should be obvious that there is a big difference between rarity and vagrancy.

The list of waterbirds in Table 5.1 shows their distribution among the four IUCN wetland sites, and a fifth column indicates occurrence in any other wetland in the Zambezi Basin. It will be seen that there is a surprisingly similar number of species recorded (so far) in the four main wetlands: moving downstream these are 133, 129, 132 and 118 species, respectively. For the first three the checklists are at about 80% of the total waterbird total for the basin (one presumes that the list for the Zambezi Delta is likely to improve), but the lists do differ in their specific composition. It can certainly be said that the Lower Shire hosts nothing of importance (including threatened species) that cannot also be found in one or other of these wetlands. It should also be said that while the palaeartic migrants show differences in species distributions across the basin, none of these can be viewed as significant. A few are marine (e.g. Crab Plover) and therefore are expected to occur only in the Zambezi Delta, some are secretive (e.g. Bittern) and their supposed absence from an area may not be real, and many are simply nomadic on their wintering grounds in Africa and could simply turn up anywhere given enough time. The important differences should be looked for among the residents. Thus several species show a 'patchy' distribution, for example Slaty Egret, Rock Pratincole, Coppery-tailed Coucal, Mangrove Kingfisher, a few cisticola warblers, Swamp Boubou and Marsh Tchagra.

In terms of families, five species of ducks are also patchily distributed – for them, no one of the selected study sites hosts them all, although they are probably all found on the Kafue Flats. No general pattern among the waterbirds can be perceived; each of the major wetlands supports a slightly different species composition. Nevertheless, the Barotse floodplain, the Chobe-Linyanti swamps and the Zambezi Delta are all important in their own right both for biodiversity and for threatened species, such that all warrant protection (and further exploration).

5.4.1 **Barotse Floodplains**

The list was compiled by Peter Leonard with an additional few species by Kit Hustler from his visit in November 1998 (Appendix 5.1) and others from the visit in March and August 1999 by Paul Van Daele and Bob Stjernstedt (Appendix 5.2). It is based on the Zambian Bird Atlas project (R.J. Dowsett & D.R. Aspinwall, in prep.), which uses half-degree-squares of 30' by 30' in size. Greater resolution is not possible at this stage (see also Aspinwall & Beel 1998). Such an HDS measures c. 53 km x 56 km, an area of nearly 3000 km^2. According to Leonard, the Barotse floodplains and Luena Flats are contained within the six HDS (1422D, 1423C, 1522B, 1523A, 1523C, 1623A). Hustler also visited a seventh HDS (1423D), which is correct according to Aspinwall & Beel (1998).

A total of 133 species of wetland birds has been recorded so far. Of these, the Slaty Egret, Lesser Flamingo, Wattled Crane and Great Snipe are in a threatened category (Collar *et al.* 1994).

5.4.2 Chobe-Linyanti Swamps

The list was compiled by Wendy Borello, who used Borello & Borello (1997), Harrison *et al.* (1997) and Penry (1994) as her sources. In addition, other species have been added from Koen (1988) and Branfield (1990). The swamps and floodplains are along the border areas of the Caprivi Strip, between Botswana and Namibia. The Kwando/Linyanti/Chobe swamps, from 18°S: 23°15'E through to the Ngoma bridge at 17°55'S: 24°45'E, occur in twelve quarter-degree squares (QDS) (1823A2, A4, B2, B3, B4, C4; 1724C4 [Lake Liambezi], D3; 1824A1, A2, A3, B1). In this region a QDS measures c. 27 x 27 km, an area of 740 km^2. On the Namibian side bird distribution was mapped according to QDS, but in Botswana HDS were used, both by the southern African atlas (Harrison *et al.* 1997) and by Penry (1994).

A total of 129 species has so far been recorded for this area. Of these, only the Slaty Egret and Wattled Crane are in a threatened category.

5.4.3 Lower Shire Marshes

The list was compiled by Dale Hanmer. These marshes – Elephant, Bangula and Ndinde – run south along the Shire River from Chikwawa at about 16°S: 34°45'E, for 135 km to the Mozambique border. They occupy part of seven QDS (1634B2, B4; 1635A3, C1, C2, C4; 1735A2).

A total of 132 species are wetland-dependent. Of these, the Madagascar Squacco Heron, Lesser Flamingo, Great Snipe and Basra Reed Warbler are in a threatened category.

5.4.4 Zambezi Delta

The list was compiled using Beilfuss & Allan (1996), Clancey (1996), Hall & Moreau (1970), Hanmer (1976), Singini (1996) and Snow (1978). The basic list was taken from Hanmer (1976), who lived upstream from the delta proper at Mopeia on the Cuacua distributary. In addition to these authors, Carlos Bento added 12 species from observations on waterbirds in the period 1995-1999, Appendix 5.3), and Bill Branch added seven more from his visit in July-August 1999. Altogether the checklist now comprises 358 species. It is presumed that the delta offers exciting possibilities for further discoveries.

No precise localities exist for the birds on the list, certainly not within a specified QDS. But accurate atlas work is beginning in this region by Vincent Parker working on the second stage of his Mozambique bird atlas which will cover the area between the Save and Zambezi Rivers, and by Carlos Bento beginning a study of Wattled Cranes in the delta itself. All recorded species are from the 'mainland', but presumably there are seabirds that fly and even fish close to and perhaps within the delta, for example the Sooty Tern. As yet there are no records for these species, save general maps such as in field guides; Newman (1996), for example, indicates that at least 11 species occur offshore from the delta. The costal parts of the delta no doubt have brackish water in varying degrees, which presumably encourage seabirds to forage inland from time to time.

A total of 118 species are wetland-dependent (and more are expected). Of these, Lesser Flamingo, Wattled Crane and Basra Reed Warbler are in a threatened category.

There is a huge area of papyrus in the northern part of the delta, and this habitat raises the possibility of the Shoebill or Whale-headed Stork occurring there. The species is known to "occasionally wander further south" from Bangweulu (Aspinwall & Beel 1998), and therefore into the Zambezi Basin, and there is "one confirmed record for the Nyika Plateau" (Newman *et al.* 1992).

5.4.5 Museum collections

The collection at the Natural History Museum (Bulawayo) was examined by Audrey Msimanga and Boneface Magwizi for specimens of water-dependent species. A list of 429 specimens of 82 species was prepared, of which 221 specimens of 61 species are from the Zambezi Basin *sensu stricto*. Other specimens may be found from the four specific wetlands in the Gaborone, Livingstone and Maputo museums, and perhaps even further afield in the British Museum.

5.5 CONSERVATION STATUS

South-central Africa has large areas of grassland and much of this is on "seasonally waterlogged soils" (White 1983) forming the dambos, floodplains and Kalahari pans that we call the wetlands of the Zambezi Basin. By virtue of flight, grassland or wetland birds may have many areas that they can visit and therefore there are few serious constraints on their distributions within the basin. This biome of grassland (i.e. no trees or bushes), which becomes wetland when waterlogged, comprises grass and sedge species, including reeds, bulrushes, and even papyrus in places. It is likely that birds adapt mostly to the physiognomic features of a habitat, i.e. short or long grass, dry or wet, rather than to the vegetation composition as such. This probably applies very much to the palaearctic migrants, which are spending their (northern) winter in sub-Saharan Africa, in their non-breeding season. Birds such as the Corncrake and Great Snipe, for example, could arrive anywhere in suitable wet habitat. As it is the austral summer and rainy season, marshy habitats are very widespread.

5.5.1 Species of conservation concern

In the moist southern savannas of Africa the grassland biome is said to be the "richest grassland avifauna" in the world (M.P.S. Irwin, pers. comm.). Table 5.2 (overleaf) lists 95 species of birds of both dry and wet grasslands, of which the larks (six species), warblers (19 species, with 11 cisticolas or grass-warblers), motacillids (ten species) and weavers (14 species, with eight being bishops and widows) comprise one-half. Eight species are regional (i.e. south-central African) endemics, and all occur in the Upper Zambezi zone (see Timberlake 1998: 9-15). Nearly all these "grassland" species are in that zone (90), with lesser numbers being found in the Middle Zambezi (71) and even less in the Lower Zambezi (60). The grasslands and wetlands of the upper zone, upstream of the Victoria Falls but mostly from the source of the Zambezi to the Barotse floodplains, therefore host a considerable – and significant – avian biodiversity. When distinct populations of widespread species are also included, such as the Black-backed Cisticola (K. Hustler, pers. comm.), the Cape Wagtail (Hustler 1993) and the Long-tailed Widow (Craig 1993), then clearly the significance is increased.

There are eight globally threatened waterbird species which occur in the Zambezi Basin, and three regionally threatened species (Table 5.3 - see page 229). All such species deserve attention, but as argued above, the two palaearctic migrants (Corncrake and Great Snipe) cannot claim any serious concern due to the problem of not knowing where they might be from day to day. The Corncrake, at least, is threatened by mechanized agriculture in Europe (Crockford *et al.* 1996) rather than anything in the Zambezi Basin. In addition, the Lesser Flamingo has its residency outside the basin and only moves through it to and from Mozambique, and perhaps to East Africa (Borello *et al.* 1998), while the Madagascar Squacco Heron is an intra-African migrant that is said not to breed on the mainland. The White-winged Flufftail, the only globally Endangered species in the list, is a presumed vagrant to the basin (to the best of our knowledge so far) from its stronghold in South Africa, so little if anything can as yet be done for this species.

Table 5.2 Grassland (including wet grassland) bird species of south-central Africa.

* = south-central Africa endemic; PM = palaearctic migrant
† = species occurring as isolated populations

Common Name	**Scientific Name**	**Upper/Middle/ Lower Zambezi**		
Red-wing Francolin	*Francolinus levaillantii*	UZ		
White-throated Francolin †	*Francolinus albogularis*	UZ		
Common Quail	*Coturnix coturnix*	UZ	MZ	LZ
Harlequin Quail	*Coturnix delegorguei*	UZ	MZ	LZ
Blue Quail	*Coturnix adansonii*	UZ	MZ	LZ
Kurrichane Buttonquail	*Turnix sylvatica*	UZ	MZ	LZ
Black-rumped Buttonquail	*Turnix hottentota*	UZ	MZ	LZ
Red-chested Flufftail	*Sarothrura rufa*	UZ	MZ	LZ
Long-toed Flufftail	*Sarothrura lugens*		MZ	LZ
Streaky-breasted Flufftail	*Sarothrura boehmi*	UZ	MZ	LZ
White-winged Flufftail	*Sarothrura ayresi*		MZ	
African Rail	*Rallus caerulescens*	UZ	MZ	LZ
Corncrake (PM)	*Crex crex*	UZ	MZ	LZ
African Crake	*Crex egregia*	UZ	MZ	LZ
Striped Crake	*Aenigmatolimnas marginalis*	UZ	MZ	LZ
Lesser Moorhen	*Gallinula angulata*	UZ	MZ	LZ
Purple Gallinule	*Porphyrio porphyrio*	UZ	MZ	LZ
Lesser Gallinule	*Porphyrula alleni*	UZ	MZ	LZ
Denham's Bustard	*Neotis denhami*	UZ	MZ	
White-bellied Korhaan †	*Eupodotis senegalensis (cafra*)	UZ		
Black-bellied Korhaan	*Eupodotis melanogaster*	UZ	MZ	LZ
Wattled Plover	*Vanellus senegallus*	UZ	MZ	LZ
Crowned Plover	*Vanellus coronatus*	UZ	MZ	LZ
Ethiopian Snipe	*Gallinago nigripennis*	UZ	MZ	LZ
Great Snipe (PM)	*Gallinago media*	UZ	MZ	LZ
Temminck's Courser	*Cursorius temminckii*	UZ	MZ	LZ
Yellow-throated Sandgrouse †	*Pterocles gutturalis*	UZ	MZ	
Coppery-tailed Coucal *	*Centropus cupreicaudus*	UZ	(MZ)	LZ
Grass Owl	*Tyto capensis*	UZ	MZ	LZ
Marsh Owl	*Asio capensis*	UZ	MZ	LZ
Natal Nightjar	*Carimulgus natalensis*	UZ		
White-cheeked Bee-eater	*Merops variegatus*	UZ		

Common Name	**Scientific Name**	**Upper/Middle/ Lower Zambezi**		
Angola Lark *	*Mirafra angolensis*	UZ		
Rufous-naped Lark	*Mirafra africana*	UZ	MZ	LZ
Red-capped Lark	*Calandrella cinerea*	UZ	MZ	LZ
Pink-billed Lark †	*Spizocorys conirostris*	UZ		
Chestnut-backed Finch-lark	*Eremopterix leucotis*	UZ	MZ	LZ
Grey-backed Finch-lark	*Eremopterix verticalis*	UZ	MZ	
Banded Martin	*Riparia cincta*	UZ	MZ	LZ
Red-breasted Swallow	*Hirundo semirufa*	UZ	MZ	LZ
Black-and-rufous Swallow *	*Hirundo nigrorufa*	UZ		
Grey-rumped Swallow	*Pseudhirundo griseopyga*	UZ	MZ	LZ
White-rumped Babbler †	*Turdoides leucopygius*	UZ	MZ	
Capped Wheatear	*Oenanthe pileata*	UZ	MZ	LZ
Sooty Chat	*Myrmecocichla nigra*	UZ		
Stonechat	*Saxicola torquata*	UZ	MZ	LZ
African Marsh Warbler	*Acrocephalus baeticatus*	UZ	MZ	LZ
Cape Reed Warbler	*Acrocephalus gracilirostris*	UZ	MZ	LZ
Greater Swamp Warbler	*Acrocephalus rufescens*	UZ		
European Sedge Warbler (PM)	*Acrocephalus schoenobaenus*	UZ	MZ	LZ
European Reed Warbler (PM)	*Acrocephalus scirpaceus*	UZ		LZ
African Sedge Warbler	*Bradypterus baboecala*	UZ	MZ	LZ
Broad-tailed Warbler	*Schoenicola brevirostris/platyura*	UZ	MZ	LZ
Moustached Warbler	*Melocichla mentalis*	UZ	MZ	LZ
Fan-tailed Cisticola	*Cisticola juncidis*	UZ	MZ	LZ
Desert Cisticola	*Cisticola aridula*	UZ	MZ	
Cloud Cisticola †	*Cisticola textrix*	UZ		
Ayres's Cloud Cisticola	*Cisticola ayresii*	UZ		
Pale-crowned Cisticola †	*Cisticola brunnescens*	UZ	MZ	
Black-backed Cisticola	*Cisticola galactotes*	UZ		LZ
Levaillant's Cisticola †	*Cisticola tinniens*	UZ	MZ	
Croaking Cisticola	*Cisticola natalensis*	UZ	MZ	LZ
Chirping Cisticola *	*Cisticola pipiens*	UZ	(MZ)	
Black-tailed Cisticola *	*Cisticola dambo*	UZ		
Stout Cisticola	*Cisticola robusta*	UZ		
Swamp Flycatcher	*Muscicapa aquatica*	(UZ)		
Cape Wagtail *	*Motacilla capensis (simplicissima)*	UZ		
Yellow Wagtail	*Motacilla flava*	UZ	MZ	LZ

Common Name	**Scientific Name**	**Upper/Middle/ Lower Zambezi**		
Grassveld Pipit	*Anthus cinnamomeus*	UZ	MZ	LZ
Buffy Pipit	*Anthus vaalensis*	UZ	MZ	LZ
Plain-backed Pipit	*Anthus leucophrys*	UZ	MZ	LZ
Short-tailed Pipit	*Anthus brachyurus*	UZ	MZ	
Yellow-throated Longclaw	*Macronyx croceus*			LZ
Pink-throated Longclaw	*Macronyx ameliae*	UZ	MZ	LZ
Fulleborn's Longclaw *	*Macronyx fuelleborni*	UZ	(MZ)	
Grimwood's Longclaw *	*Macronyx grimwoodi*	UZ		
Swamp Boubou	*Laniarius bicolor*	UZ		
Brown-throated Weaver †	*Ploceus xanthopterus*	UZ		LZ
Masked Weaver	*Ploceus velatus*	UZ	MZ	LZ
Thick-billed Weaver †	*Amblyospiza albifrons*	UZ	MZ	LZ
Red Bishop	*Euplectes orix*	UZ	MZ	LZ
Golden Bishop	*Euplectes afer*	UZ	MZ	
Red-shouldered Widow	*Euplectes axillaris*	UZ	MZ	LZ
White-winged Widow	*Euplectes albonotatus*	UZ	MZ	LZ
Red-collared Widow	*Euplectes ardens*		MZ	LZ
Long-tailed Widow †	*Euplectes progne*	UZ		
Yellow-backed Widow	*Euplectes macrourus*	UZ	MZ	LZ
Marsh Widow	*Euplectes hartlaubi*	UZ	MZ	
Red-headed Quelea	*Quelea erythrops*	UZ		LZ
Cardinal Quelea	*Quelea cardinalis*		MZ	
Cuckoo Finch	*Anomalospiza imberbis*	UZ	MZ	LZ
Orange-breasted Waxbill	*Sporaeginthus subflavus*	UZ	MZ	LZ
Quail Finch	*Ortygospiza atricollis*	UZ	MZ	
Locust Finch	*Ortygospiza locustella*	UZ	MZ	LZ
Black-chinned Quailfinch	*Ortygospiza gabonensis*	UZ		
	Totals	**90**	**71**	**60**

Adapted from M.P.S. Irwin, pers. comm.
Note: Entries in brackets indicate very restricted distributions in that zone.

Table 5.3 Globally and regionally threatened waterbird species in the Zambezi Basin.

Species	**Pop.** [1]	**Category**[2]	**Threats** [4]	**Status**
White-winged Flufftail	V	End	agriculture	?
Slaty Egret	RB	Vul	reed cutting	OK
Wattled Crane	RB	Vul	agriculture, hunting, flood regime, (poisons)	OK ?
Corncrake	PM	Vul	agriculture	?
Madagascar Squacco Heron	IM (V)	Nt	?	?
Shoebill [5]	RB	Nt	agriculture, hunting	OK ?
Lesser Flamingo	N	Nt	?	?
Great Snipe	PM (V)	Nt	?	?
Black-winged Pratincole	PM	Nt	?	?
Rock Pratincole	IMB	regional [3]	flood regime	OK
African Skimmer	IMB	regional	flood regime, hunting	negative
Carmine Bee-eater	IMB	regional	flood regime, hunting	OK ?

Notes:

1. Population status: resident breeder (RB), intra-African migrant breeder (IMB), palaearctic migrant (PM), nomad (N) and vagrant (V).
2. Global categories are: Endangered (End), Vulnerable (Vul) and Near-threatened (Nt).
3. Regional = major population in south-central Africa.
4. Pollution is assumed to occur in the basin, in terms of agriculture and sewage run-offs, as well as pesticides. The possible impacts are unknown on any of these species, though all must surely encounter pollutants.
5. The Shoebill Stork has been seen in the Zambezi Basin *sensu stricto* only as a wanderer to central Zambia (Aspinwall & Beel 1998). It occurs in the Bangweulu swamps, but not in the Okavango swamps (as erroneously mapped by Maclean 1993).

This leaves us with six threatened species which need attention, all of which are in fact conspicuous and relatively easy to count and monitor. Their distributions are:

Slaty Egret	south-west part of the basin.
Wattled Crane	most major wetlands, and some minor dambos.
Shoebill	Bangweulu Swamps, occasionally to the south-west.
Rock Pratincole	Zambezi River, on rock stacks.
African Skimmer	Zambezi River, sandy islands and bars.
Carmine Bee-eater	Zambezi River and some tributaries, on 'cliffs' of river banks.

It is clear from Table 5.3 that the Wattled Crane is vulnerable to the most threats, in fact it suffers from all likely threats. There are five: (a) agriculture of one sort or another (including cattle grazing, subsistence agriculture such as market gardens, reed cutting, water usage); (b) hunting or poaching for food or the possible trade in live birds; (c) changes in flood regime caused by the dams on the Zambezi and Kafue River which alter water levels; (d) pollution (though so far no impacts are yet known on these species); and (e) poisoning from pesticides, invariably by accident. This is why the Wattled Crane was highlighted in Timberlake (1998) as a 'flagship' species. If attention is focused upon it, then other species are likely to benefit as a result.

Only the African Skimmer is believed to be in decline. Its chicks are hunted as bait for fishing; nesting is disturbed by tourism; and changed flood regimes (generally lower water levels) allow the sandy islands to become overgrown by trees and bushes, especially *Faidherbia albida*. This can be seen on the Zambezi River below Kariba gorge. However, the Carmine Bee-eater may also be in decline (Feather 1997) as will be the Rock Pratincole if the proposed Batoka dam goes ahead (Childes & Mundy 1998). The impact of the various major dams (Kariba, Cabora Bassa), as far as the birds are concerned, is felt almost entirely by those three species that are riverine in their habitat (i.e. the last three listed above). The Wattled Crane suffers this impact only on the Kafue Flats, which are downstream of the Itezhi-Tezhi dam, and in the Zambezi Delta.

It is possible to help these species, inasmuch as flood-gates can be opened in particular relation to the birds breeding season, but probably only in years with high inflow to the dams. This was requested in 1999 from the Kariba dam (L. Maasdorp, pers. comm.), though little water release took place. However, the gates were opened on 25 February 2000. It can be stated categorically, however, that the Rock Pratincole, African Skimmer and Carmine Bee-eater will have problems in surviving along the Zambezi River downstream of the Kariba dam wall. Indeed, both the skimmer and bee-eater will certainly have declined due to the effects of the dam in reducing river flow; the skimmer will be left 'high and dry' and the bee-eater will have its breeding places under-cut (Mundy *et al.* 1994). The Wattled Crane is certain to be affected due to the lower water levels and unnatural fluctuations in level – there is presumably a lesser area inundated these days by the Zambezi and the Kafue rivers, and therefore a lesser food supply for the cranes. Also the lower water levels will limit the area available for crane nesting in both floodplains. For successful conservation of these species detailed attention must be paid to new flood regimes from periodic opening of the dam floodgates (see Appendix 5.3 and also Volume IV Chapter 2).

The other group of species that requires particular attention in the Zambezi Basin is that group which is restricted to the basin by virtue of being endemics (see Table 5.2) or by being present as isolated populations. Species of interest and concern in this last group are: White-throated Francolin, White-bellied Korhaan, Yellow-throated Sandgrouse, Pink-billed Lark, White-rumped Babbler, Cloud Cisticola, Pale-crowned (Pectoral-patch) Cisticola, Levaillant's Cisticola, Brown-throated Weaver, Thick-billed Weaver, Long-tailed Widow, Lemon-breasted Canary and Lesser Seed-cracker. The total number of species of conservation concern now totals 27, comprising six "threatened" species (RB and IMB in Table 5.3), eight "regional endemics" (Table 5.2), and 13 "isolated-populations" of wider ranging species. Of course there are other threatened species found in forest, woodland or montane habitats within the Zambezi Basin (see Collar *et al.* 1994), but these have been excluded, as have others of purely taxonomic interest.

5.5.2 **Areas of conservation interest**

Some waterbirds are easy to monitor, as indicated by the success of the biannual African Waterfowl Censuses, but there are also those species that inhabit marshes and flooded tall grassland which can be almost impossible to detect. That is the enigma with this group of birds. So far it is known, as stated above, that the highest diversity resides on the Barotse floodplains and upstream. At the same time it is also known that the greatest abundances of waterbirds in terms of sheer numbers reside on the Kafue Flats (e.g. Dodman *et al.* 1997). Such floodplain and marsh areas are far richer in bird numbers and in bird diversity than are the open waters of the lakes and dams in the basin (Lakes

Malawi, Kariba and Cabora Bassa). The Kafue Flats also support hundreds to thousands of Wattled Cranes on a regular basis, unlike the Zambezi Delta.

In this regard of "important bird areas", the Southern African Bird Atlas (Harrison *et al.* 1997) is of fundamental importance. It altogether superseded an earlier one for Botswana alone (Penry 1994). At the same time, it is very much to be regretted that the promised atlases for Zambia (R.J. Dowsett & D.R. Aspinwall, in prep.) and Malawi (R.J. Dowsett, in prep.) are not yet to hand. Both have been promised for years. Fortunately, atlas work in Mozambique is progressing well, that for the southern third of the country having just been published (Parker 1999). Vincent Parker has now shifted his attention to the central third of the country, i.e. the region between the Save and Zambezi Rivers. By contrast, Angola remains a big blank.

Again, southern Africa has led the way (with Ethiopia) in producing an atlas of important bird areas (Barnes 1998). Ten of the areas listed fall within the Zambezi Basin, with seven of them being wetlands or having wetlands in them. In Namibia, the eastern Caprivi wetlands have high bird diversity (Simmons *et al.* 1998), while nearby in Botswana, the Linyanti Swamp area holds probably the same diversity (Tyler & Bishop 1998). In Zimbabwe, the four important wetland areas are the middle Zambezi valley, Batoka Gorge, Lake Chivero, and the seasonal pans in the Hwange National Park (Childes & Mundy 1998).

From the perspective of birds, then, the Barotse floodplain and the Chobe-Linyanti swamps are the most important for biodiversity, especially when considering endemics, whereas Kafue Flats seems to be the most significant for sheer numbers. The Zambezi Delta is somewhat of an unknown so far. The Lower Shire marshes show a high diversity in Table 5.1, but host nothing that does not occur elsewhere; the area has greatly deteriorated due to sugarcane cultivation practices. As yet, firm opinions cannot be made for all the wetlands in the Zambezi Basin until the Zambia, Malawi and central Mozambique atlases are published. It would therefore, at this stage, be worthwhile to put effort into publishing these atlases rather than into surveying more wetlands.

5.6. CONCLUSIONS

(a) Mapping of waterbird distributions in the Zambezi Basin will be greatly aided when the atlases for Zambia, Malawi, and central Mozambique are published. The definition of 'waterbird' must be properly comprehensive, but the literature shows that it must be carefully drafted.

(b) Large wetlands in the shape of floodplains and swamps allow bird diversity to evolve. The Barotse wetland is the most important in this respect. The Zambezi Delta adds a few species that like brackish conditions.

(c) By and large the palaearctic migrants that depend on wetlands can look after themselves – having flown to south-central Africa from the north they can easily move from one wetland to another because they are not breeding.

(d) Important habitat for the diversity of small birds and for populations of threatened species is provided by three of the large wetlands, i.e. Barotse floodplains, Chobe-Linyanti and the Zambezi Delta, and also by the Kafue Flats for the Wattled Crane. The Lower Shire is dispensable in this respect.

(e) The basin is very important for grassland birds in general. Several species, such as the Black-rumped Buttonquail, will move between dry and wet grasslands, thus blurring the distinction between the two in terms of these birds.

(f) Several species at least (Ethiopian Snipe, Cloud Cisticola, Black-backed Cisticola, Levaillant's Cisticola, Cape Wagtail and Red-shouldered Widow) need to be the focus of taxonomic investigation so as to determine their true status.

(g) Due to their mobility because of flight, and driven by habitat change from fluctuating water levels, many waterbirds are widespread in the basin. Mobility is clearly one of their methods of survival.

(h) Rather few biological studies (outside of distribution and movements) have been done on waterbird species.

(i) For threatened species (and their wetlands) particular attention should be given to improving the flood regimes from the dams (i.e. releasing water) in an effort to improve conditions for the Rock Pratincole, African Skimmer, Carmine Bee-eater and also the Wattled Crane.

(j) The 'flagship' bird species for the Zambezi Basin are the Wattled Crane (around 90% of its population is thought to live in south-central Africa) and Slaty Egret (endemic to the basin plus the Okavango Swamps).

5.7 ACKNOWLEDGEMENTS

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CHAPTER 5 : APPENDIX 1
BIRD SURVEY OF THE BAROTSE FLOODPLAIN, NOVEMBER 1998

Kit Hustler

1. INTRODUCTION

This report provides details of a field trip undertaken from 2-12 November 1998 to the Mongu District of western Zambia. The itinerary of sampling and data collected are detailed. During the trip I was accompanied by Vincent Katanekwa, Director of the Livingstone Museum and an ornithologist.

Surveys were carried out at two sites: Ndanda dambo (14°56'23" S / 23°42'59" E) northeast of Mongu and Litoya dambo (15°40'12" S; 23°20'00" E) south of Mongu. Ndanda dambo was in a lower drainage valley (classified as a Wet River Plain (R2) by Jeanes & Baars 1991). The woodlands near settlements in this area have been modified but were quite extensive and dense away from habitation. Litoya dambo is classified as the same vegetation type. The margins of this dambo are intensively settled with patches of cultivation within the dambo itself.

2. METHODOLOGY

Field observations were made with 10 x 40 binoculars and all birds sighted in the observation areas were recorded. Data were collected by walking along and in the drainage lines and actively searching for the birds that might have been there. Tape recordings were used in some instances in an attempt to attract certain species closer to us either to confirm their occurrence in the area and to obtain good views of the bird or to collect a specimen. Night birds were recorded on the basis of their vocalisations, as were a number of the pipits, larks and cisticolas. Tape recordings were made of some of the species for later analysis, but familiarity with the songs of some of the more cryptic species was used to detect their presence in the field.

In all cases observations were made within 3 km of the co-ordinates given for the localities of specimens collected, which are Ndanda (14°54'39"S / 23°38'15"E and 14°56'23"S / 23°42'59"E) and Litoya (15°40'12"S / 23°20'00"E).

3. RESULTS

3.1 Species sighted

Birds seen during the survey are listed in Table 1. During the exercise, a number of new species were added to the Zambian Atlas square lists; these are indicated with asterisks in the table.

3.2 Specimens collected

Few birds were collected as we had limited ammunition of the correct type and we had limited time to skin and prepare those specimens we did collect. Those that were collected were obtained for a specific purpose or if an unexpected opportunity arose. All bird specimens collected are housed in the Livingstone Museum. Specimens are described below.

Cisticola tinniens – An unknown and undescribed population of this species occurs in the wet dambos that flow into the Zambezi in western Zambia. Initially discovered by Dylan Aspinwall during field work for the Zambian Bird Atlas, there are no specimens in any of the regions museums from this population. A pair was collected at Ndanda, but unfortunately the male bird was not recovered from the rank vegetation into which it flew. No more specimens were collected. Fieldwork on this species concentrated on determining densities of the birds, getting representative recordings of their vocalisations and the location of a nest.

Cisticola galactotes – This species is in the process of being described as a full species (*luapula*) and is essentially an upper Zambezi endemic. Tape playback experiments were initiated, density estimates calculated for a number of dambos and a nest was located. One bird was collected at Ndanda.

Cisticola pectoralis – This species occurred in some numbers in the wet dambos and is the subject of some taxonomic debate. A male was collected and genetic material recovered for future analysis. The songs of these birds were identical to those given on commercially available tapes of the bird songs of the region. One interesting facet of the behaviour of some of these birds was territorial males calling from the ground on a short perch. Normally this species undertakes an extended aerial display. One bird was collected at Ndanda.

Euplectes axillaris – A female bird was collected and the specimen shows some interesting plumage differences from more southerly populations. There is a suggestion that the central African populations are not *axillaris* but something else, and it is hoped that the genetic material collected will some way to solving this argument. One bird was collected at Ndanda.

Anthus leucophrys – A recently fledged chick still being fed by its parents was collected at 14º54'39" S / 23º38'15" E. The juvenile plumage of this species is undescribed and a good sequence of the song of a displaying bird was recorded. This bird was collected.

Caprimulgus europeus and *C. mossambicus* – Both species were caught in nets set for bats over a pool of water at Ndanda. There are few records of *europeus* from Zambia.

Apus sp. – Two swifts from a large flock were collected at Litoya, and genetic material retained from both of them. They are assumed to be European Swifts *Apus apus*, on migration, but this is subject to confirmation.

4. DISCUSSION

Valuable data were obtained on the densities and ecological separation of four cisticolas in the wet dambo habitats we visited, and will form part of a submitted paper in due course.

New information was obtained on the behaviour of the Swamp Nightjar (*Caprimulgus natalensis*) and a male bird was followed for an extended period during a moon-lit night. During this time, good tape recordings were obtained of his calls and he was observed to run away from us on the ground. This species has long legs for a nightjar and it has been speculated that it moves well on the ground, although never proven until now.

At one of the dambos we examined a large flock of Black-winged Pratincoles (*Glareola nordmanni*) which appeared just on midday and had disappeared by the following morning. The estimated number is between 10-15,000 birds. There were so many that it looked like quelea at some stages, with large numbers of birds sitting on the ground and then getting airborne when they were disturbed. Large numbers of birds spiralled up in the thermals like vultures and were in flocks of up to 2000 individuals. The birds seemed to leave in large groups but arrived in loose flocks. Large concentrations of birds have been seen in Zambia before (an estimated 1 million birds; Aspinwall & Conant 1977) but it has undergone a contraction of range in South Africa in recent times (MacLean & Herremans 1997). One estimate of the global population is of 20,000 individuals (Rose & Scott 1994), but a large flock estimated at between 250,000 and 750,000 birds was seen in South Africa in 1991 (du Plessis 1995).

Conspicuous by their absence were the game birds (francolins and guineafowl) and doves. While I have no data to support these assertions, it is likely that these groups have been largely eliminated by the local population in this area. The only guineafowls seen were semi-domesticated birds with the characteristic pale head.

From a bird point of view, the diversity of habitats is staggering. On the floodplain itself, the number of oxbow lakes of different sizes, depths and vegetation structure alone make for a large number of different habitats which would suit different bird species preferentially. The presence/absence of fish, *Phragmites* and papyrus reedbeds further adds to the complexity of habitats that are suitable for birds. The distance away from water and the proximity of water to the surface of the wetlands is also important, and provides different habitats at different times of the year. The water level is determined by the level of the flood water and it is known that there are large-scale movements of birds associated with water as it rises and falls, and this would affect the presence/absence of a large variety of water birds and other species which are associated with the floodplain. This gives a large permutation of different habitats in which birds could be found. Given their mobility, a large number of different permutations of these habitats should be visited before the attached lists given here could be considered as being close to complete. The intervening woodlands are also interesting and are an integral part of the factors determining the diversity of birds that occur in this area. They should also be investigated more thoroughly if the bird list for the area is going to be considered as anything close to complete.

The flood regime of the Zambezi on the wetlands is a very important factor and some birds are only present as the water begins to subside, but leave when the water gets too low or become restricted to areas of suitable habitat only. If these habitats are not visited and properly searched, then the species concerned will not be found. Likewise, some species arrive and breed in the suitable habitats created immediately after the floods, and then disperse widely across the continent. For this aspect of the avifauna to be properly censussed, an aircraft is needed to locate the breeding colonies quickly. A boat would then be needed to reach them in order to collect breeding data.

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Appendix 5.1 Table 1 List of birds associated with dambos of the Mongu area recorded in each HDS visited during the November 1998 survey. The first list is derived from the unpublished Zambian Bird Atlas (ZBA) with the adjacent list having the birds seen during the current survey (BFA). Records with an asterisk (*) indicate a new record for the square, those with a double asterisk (**) indicate a new record for the area. Nomenclature follows Benson *et al.* (1971).

Species	**1423D**		**1523A**		**1523C**		**Abundance/Habitat**
	ZBA	BFA	ZBA	BFA	ZBA	BFA	
Reed Cormorant *Phalacrocorax africanus*	1		1		1	1	1 bird seen once at a pool
Great White Egret *Egretta alba*			1	1	1		3 birds seen at the rice growing scheme
Grey Heron *Ardea cinerea*	1		1	1	1	1	occasional birds seen fishing in pools
Black-headed Heron *Ardea melanocephala*			1		1	1	one bird seen flying over
Purple Heron *Ardea purpurea*			1	1	1	1	scarce, but probably overlooked
Little Egret *Egretta garzetta*		1	1	1	1		occasional birds seen fishing in pools
Yellow-billed Egret *Egretta intermedia*		1	1	1	1		seen on 2 occasions
Cattle Egret *Ardeola ibis*	1	1	1	1	1	1	widespread
Rufous-bellied Heron *Butorides rufiventris*		1*	1	1	1		scarce, but probably overlooked
Black-crowned Night Heron *Nycticorax nycticorax*			1		1	1	one heard at night
Abdim's Stork *Ciconia abdimii*	1		1	1			small flock close to rice scheme
Hottentot Teal *Anas hottentotta*		1*	1		1		2 birds seen at pool in dambo
Spur-winged Goose *Plectropterus gambensis*	1	1	1		1	1	widespread, but in small numbers
Secretarybird *Sagittarius serpentarius*			1			1*	one seen feeding on dambo
Yellow-billed Kite *Milvus migrans*	1	1	1	1	1	1	frequently seen overhead
Black-shouldered Kite *Elanus caeruleus*	1	1	1		1	1	regularly seen hovering over dambos
Cuckoo Hawk** *Aviceda cuculoides*		1*		1*		1*	seen flying over every dambo
Tawny Eagle *Aquila rapax*			1			1*	1 bird hunting a dove on dambo
Wahlberg's Eagle *Aquila wahlbergi*	1	1	1	1	1	1	frequently seen soaring overhead

Species	**1423D**		**1523A**		**1523C**		**Abundance/Habitat**
	ZBA	BFA	ZBA	BFA	ZBA	BFA	
Brown Snake Eagle *Circaetus cinereus*	1	1	1		1	1	frequently soaring overhead or perched
Black-breasted Snake Eagle *Circaetus pectoralis*	1	1	1		1	1	frequently soaring overhead or perched
Bateleur *Terathopius ecaudatus*	1	1	1	1	1	1	occasionally seen soaring overhead
Steppe Buzzard *Buteo vulpinus*	1	1	1		1	1	frequently seen soaring or perch hunting in a dambo
Lizard Buzzard *Kaupifalco monogrammicus*	1	1	1	1	1		heard calling from the woodland edge
Ovambo Sparrowhawk *Accipiter ovampensis*		1*	1				one bird hunting finch-larks
Black Sparrowhawk *Accipiter melanoleucus*		1*	1				one bird flying overhead
African Marsh Harrier *Circus ranivorus*		1*	1	1	1	1	regular in all dambos surveyed
Lanner Falcon *Falco biarmicus*			1		1	1	hunting doves drinking in the dambo
European Hobby *Falco subbuteo*	1	1	1			1*	frequently seen overhead
Blue Quail *Coturnix chinensis*		1*	1				two birds only flushed
Helmeted Guineafowl *Numida meleagris*	1	1	1	1	1	1	only the domesticated form seen
Kurrichane Buttonquail *Turnix sylvatica*		1*	1			1*	single birds flushed from two dambos
African Rail *Rallus caerulescens*		1*	1		1		one bird heard
Purple Gallinule *Porphyrio porphyrio*		1*	1				one bird heard
Black-bellied Korhaan *Eupodotis melanogaster*	1	1					one male displaying
African Jacana *Actophilornis africanus*	1	1	1		1		scarce, two birds seen in one dambo
Crowned Plover *Vanellus coronatus*		1*	1		1		small group on dry dambo
Wattled Plover *Vanellus senegalensis*	1	1	1		1		frequently encountered on all dambos
Wood Sandpiper *Tringa glareola*	1	1	1		1		frequently encountered on all dambos
Greenshank *Tringa nebularia*		1*	1		1		one bird seen
Temminck's Courser *Cursorius temminckii*	1	1	1		1		group of 3 on a dry dambo

Species	**1423D**		**1523A**		**1523C**		**Abundance/Habitat**
	ZBA	BFA	ZBA	BFA	ZBA	BFA	
Red-winged Pratincole *Glareola pratincola*	1	1	1		1	1	frequently encountered on dambos and overhead
Black-winged Pratincole** *Glareola nordmanni*						1*	large flock on one dambo
Red-eyed Dove *Streptopelia semitorquata*	1	1	1	1	1		scarce; drinking from pools in dambos
Cape Turtle Dove *Streptopelia capicola*	1	1	1	1	1	1	scarce; drinking from pools in dambos
Namaqua Dove *Oena capensis*	1	1	1		1	1	scarce on two dambos
Green-spotted Dove *Turtur chalcospilos*	1		1	1	1		heard in woodland adjacent to dambos
Green Pigeon *Treron australis*	1	1	1				once heard in woodland by dambo
Cape Parrot *Poicephalus robustus*	1		1		1	1	once heard in woodland by dambo
Meyer's Parrot *Poicephalus meyeri*	1	1	1		1	1	heard in woodland adjacent to dambos
African Cuckoo *Cuculus gularis*	1	1	1	1	1	1	heard in woodland adjacent to dambos
Red-chested Cuckoo *Cuculus solitarius*	1	1	1	1	1	1	heard in woodland adjacent to dambos
Great Spotted Cuckoo** *Clamator glandarius*						1*	once seen in tree in middle of dambo
Black Cuckoo *Cuculus clamosus*	1	1	1		1		heard in woodland adjacent to dambos
Striped Cuckoo *Clamator levaillantii*	1	1	1		1		seen in stunted woodland in dambo; also heard in woodland adjacent to dambos
Jacobin Cuckoo *Clamator jacobinus*		1*	1				heard in woodland adjacent to dambos
Thick-billed Cuckoo** *Pachycoccyx audeberti*		1*					once heard in woodland
Klaas's Cuckoo *Chrysococcyx klaas*	1	1	1	1	1		often seen in stunted woodland in dambos; also heard
Black Coucal *Centropus grilli*		1*			1		one bird seen in rank vegetation in dambo
Coppery-tailed Coucal *Centropus cupreicaudus*	1	1	1		1	1	frequently seen in rank vegetation in dambos
Barn Owl *Tyto alba*			1	1	1	1	heard at night
Wood Owl *Ciccaba woodfordii*	1	1	1				heard at night
White-faced Owl *Otus leucotis*	1	1	1	1		1*	heard at night

Species	**1423D**		**1523A**		**1523C**		**Abundance/Habitat**
	ZBA	BFA	ZBA	BFA	ZBA	BFA	
Spotted Eagle Owl *Bubo africanus*	1	1	1		1		heard at night
Giant Eagle Owl *Bubo lacteus*	1		1	1		1*	heard at night
Marsh Owl *Asio capensis*	1		1		1	1	flushed from rank vegetation in dambo
European Nightjar** *Caprimulgus europeus*		1*					caught in net set over a pool in middle of dambo
Rufous-cheeked Nightjar *Caprimulgus rufigena*	1	1	1	1	1	1	heard calling from dambos
Swamp Nightjar** *Caprimulgus natalensis*		1*				1*	heard calling from dambos
Mozambique Nightjar *Caprimulgus fossii*	1	1	1	1	1	1	heard calling and caught in net set over pool in middle of dambo
Pennant-winged Nightjar *Macrodipteryx vexillarius*	1	1	1	1		1*	seen displaying over a dambo
European Swift *Apus apus*	1	1	1		1	1	scarce; large flocks seen drinking at pools in dambos
Little Swift** *Apus affinis*						1*	one flock drinking at pool in dambo
Pied Kingfisher *Ceryle rudis*	1	1	1		1	1	frequently seen at pools in dambos
Malachite Kingfisher *Alcedo cristata*	1	1	1		1	1	frequently seen at pools in dambos
Pygmy Kingfisher *Ispidina picta*	1	1	1				seen on dambo edge in woodland
Woodland Kingfisher *Halcyon senegalensis*	1	1	1		1		heard in woodland
European Bee-eater *Merops apiaster*	1	1	1	1	1	1	frequently seen over dambos
Blue-cheeked Bee-eater *Merops persicus*	1	1	1		1	1	frequently seen over dambos
Carmine Bee-eater *Merops nubicus*			1		1	1	scarce; one group over a dambo
White-fronted Bee-eater ** *Merops bullockoides*		1*					one group seen over a dambo
Little Bee-eater *Merops pusillus*	1	1	1		1		widespread in dambos
White-cheeked Bee-eater *Merops variegatus*	1	1	1		1		scarce; few birds in one dambo only
Swallow-tailed Bee-eater *Merops hirundineus*	1	1	1		1		occasionally over dambos but mainly on woodland edge
Lilac-breasted Roller *Coracias caudata*	1	1	1	1	1	1	frequently encountered in dambos

Species	**1423D**		**1523A**		**1523C**		**Abundance/Habitat**
	ZBA	BFA	ZBA	BFA	ZBA	BFA	
Purple Roller *Coracias naevia*		1*	1		1		encountered once on dambo
Broad-billed Roller *Eurystomus glaucurus*	1	1	1		1	1	frequently seen over dambos
Red-billed Woodhoopoe *Phoeniculus purpureus*	1	1	1		1		heard in woodland
Pale-billed Hornbill *Tockus pallidirostris*	1	1	1		1	1	seen overhead dambos and heard in woodland
Grey Hornbill *Tockus nasutus*	1	1	1		1		seen overhead dambos and heard in woodland
Crowned Hornbill *Tockus alboterminatus*	1	1				1*	seen overhead dambos and heard in woodland
Ground Hornbill *Bucorvus cafer*	1		1		1	1	heard once only
Yellow-fronted Tinkerbird *Pogoniulus chrysoconus*	1	1	1	1	1	1	often heard in woodland
Crested Barbet** *Tachyphonus vaillantii*				1*			once heard in woodland
Brown-backed Honeyguide *Protodiscus regulus*			1	1			once in woodland edge of dambo
Golden-tailed Woodpecker *Campethera abingoni*		1*	1		1		once heard in woodland
Rufous-naped Lark *Mirafra africana*	1	1	1	1	1	1	frequent on dambos
Flappet Lark *Mirafra rufocinnamomea*	1	1		1		1*	often heard in woodland
Fawn-coloured Lark *Mirafra africanoides*			1	1	1		few birds on a dambo
Chestnut-backed Finchlark *Eremopterix leucotis*		1*	1		1		small flock on a dambo
European Swallow *Hirundo rustica*	1	1	1	1	1	1	frequently seen in large flocks overhead dambos
White-throated Swallow *Hirundo albigularis*		1*	1				in mixed swallow flocks overhead dambos
Wire-tailed Swallow *Hirundo smithii*		1*	1		1		in mixed swallow flocks overhead dambos
Pearl-breasted Swallow *Hirundo dimidiata*		1*	1		1		in mixed swallow flocks overhead dambos
Mosque Swallow *Hirundo senegalensis*	1	1	1		1		in mixed swallow flocks overhead dambos
Lesser Striped Swallow *Hirundo abyssinica*	1	1			1		in mixed swallow flocks overhead dambos
South African Cliff Swallow *Hirundo spilodera*	1					1*	one bird in mixed swallow flock overhead dambo

Species	**1423D**		**1523A**		**1523C**		**Abundance/Habitat**
	ZBA	BFA	ZBA	BFA	ZBA	BFA	
House Martin *Delichon urbica*	1	1	1		1		in mixed swallow flocks overhead dambos
European Sand Martin *Riparia riparia*	1		1		1	1	in mixed swallow flocks overhead dambos
Banded Martin *Riparia cincta*		1*	1		1	1	in mixed swallow flocks overhead dambos
Black Cuckooshrike *Campephaga phoenicea*	1	1	1		1		often heard in woodland
Fork-tailed Drongo *Dicrurus adsimilis*	1	1	1	1	1	1	frequent on woodland edge and on trees in dambos
Black-headed Oriole *Oriolus larvatus*	1	1	1	1	1		often heard in woodland
Pied Crow *Corvus albus*	1	1	1	1	1	1	occasionally overhead dambos
Miombo Grey Tit *Parus griseiventris*	1	1	1		1		once in woodland on dambo edge
White-rumped Babbler *Turdoides leucopygius*		1*	1		1		one flock in rank vegetation of dambo
Black-eyed Bulbul *Pycnonotus barbatus*	1	1	1	1	1	1	frequent in woodland edge and on trees in dambos
Kurrichane Thrush *Turdus libonyana*	1	1	1		1		occasionally heard in woodland
Capped Wheatear *Oenanthe pileata*	1	1	1	1			few birds on drier portions of dambos
Arnot's Chat** *Thamnolaea arnoti*						1*	two birds in open on a dambo
Stonechat *Saxicola torquata*	1	1	1	1	1	1	frequent in moister ranker sections of dambos
Heuglin's Robin *Cossypha heuglini*	1	1	1		1		occasionally heard in woodland
White-browed Robin *Erythropygia leucophrys*	1	1	1		1		often heard in woodland
Central Bearded Robin *Erythropygia barbata*	1	1					once heard and seen in woodland
Cape Reed Warbler *Acrocephalus gracilirostris*		1*			1		one bird in rank vegetation in dambo
African Sedge Warbler *Bradypterus baboecalus*		1*	1				frequent in rank vegetation in dambo
Broad-tailed Warbler *Schoenicola platyura*	1	1	1		1		two birds displaying over rank vegetation in dambo
Icterine Warbler** *Hippolais icterina*		1*		1*			heard and seen in woodland twice
Garden Warbler *Sylvia borin*	1	1			1		once heard and seen in woodland

Species	**1423D**		**1523A**		**1523C**		**Abundance/Habitat**
	ZBA	BFA	ZBA	BFA	ZBA	BFA	
Willow Warbler *Phylloscopus trochilus*	1		1	1	1	1	often heard in woodland
Yellow-breasted Apalis *Apalis flavida*	1	1	1				often heard in woodland
Long-billed Crombec *Sylvietta rufescens*	1	1	1	1	1		often heard in woodland
Green-capped Eremomela *Eremomela scotops*	1	1	1	1	1		often heard in woodland
Bleating Warbler *Camaroptera brachyura*	1	1	1	1	1		frequent on woodland edge and dry rank vegetation in dambos
Fan-tailed Cisticola *Cisticola juncidis*	1	1	1		1	1	frequent on drier margins of dambos
Desert Cisticola *Cisticola aridula*	1	1	1		1	1	occasional on drier margins of dambos
Pale-crowned Cisticola *Cisticola pectoralis*	1	1	1		1	1	frequent on wet short grass of dambos
Red-faced Cisticola** *Cisticola erythrops*		1*					one heard in rank vegetation on dambo
Black-backed Cisticola *Cisticola galactotes*	1	1	1		1	1	frequent in wet rank vegetation on dambos
Levaillant's Cisticola *Cisticola tinniens*	1	1					localised and restricted to short grass/ rank vegetation ecotone on dambo
Croaking Cisticola *Cisticola natalensis*	1	1	1		1	1	frequent in rank vegetation of dambos
Tawny-flanked Prinia *Prinia subflava*	1	1	1		1	1	frequent in rank vegetation of dambos
Blue-grey Flycatcher *Muscicapa caerulescens*	1	1			1		one party seen on woodland edge
Spotted Flycatcher *Muscicapa striata*	1	1	1	1	1		frequent in woodland and on edge
Pallid Flycatcher *Bradornis pallidus*	1	1	1	1	1		frequent in woodland and on edge
Chinspot Batis *Batis molitor*	1	1	1		1		occasionally heard in woodland
Paradise Flycatcher *Terpsiphone viridis*	1	1	1	1	1	1	often heard in woodland
Cape Wagtail *Motacilla capensis*	1	1	1		1		frequent in wet situations in dambos
Grassland Pipit *Anthus novaeseelandiae*	1	1	1		1	1	frequent on drier sections of dambos
Miombo Pipit *Anthus nyassae*	1	1	1	1	1		frequent on woodland edge
Dark Plain-backed Pipit *Anthus leucophrys*	1	1	1		1	1	frequent on dambos in dry and wet situations

Species	**1423D**		**1523A**		**1523C**		**Abundance/Habitat**
	ZBA	BFA	ZBA	BFA	ZBA	BFA	
Buffy Plain-backed Pipit *Anthus vaalensis*	1	1	1	1	1		frequent on drier sections of dambos
Fulleborn's Longclaw *Macronyx fuelleborni*	1	1	1	1	1	1	frequent on drier sections dambos
Pink-throated Longclaw *Macronyx ameliae*	1	1	1		1		frequent on wet short grass sections of dambos
Lesser Grey Shrike *Lanius minor*	1	1	1	1	1	1	frequently perched on dambos
Red-backed Shrike *Lanius collurio*	1	1	1		1		occasionally seen perched on dambos
Fiscal Shrike *Lanius collaris*	1	1	1		1		occasionally seen perched on dambos
Puffback *Dryoscopus cubla*	1	1	1		1		often heard in woodlands
Brubru *Nilaus afer*	1	1	1		1		often heard in woodlands
Black-crowned Tchagra *Tchagra senegala*		1*	1		1	1	often heard in woodlands
Grey-headed Bush Shrike *Malaconotus blanchoti*	1	1	1		1		often heard in woodlands
Wattled Starling *Creatophora cinerea*			1	1	1		flock seen in dry part of dambo
Plum-coloured Starling *Cinnyricinclus leucogaster*	1	1	1		1		often heard and seen in woodland
Yellow-billed Oxpecker** *Buphagus africanus*		1*					one group seen on cattle in a dambo
Coppery Sunbird *Nectarinia cuprea*		1*	1		1		two pairs in rank vegetation in a dambo
Marico Sunbird *Nectarinia mariquensis*		1*	1	1	1	1	occasionally seen on woodland edge
Shelley's Sunbird** *Nectarinia shelleyi*				1*			one bird seen on woodland edge
White-bellied Sunbird *Nectarinia talatala*	1	1	1	1	1	1	frequently heard and seen on woodland edge
Scarlet-chested Sunbird *Nectarinia senegalensis*	1	1	1	1	1	1	frequently seen and heard on woodland edge
Black Sunbird *Nectarinia amethystina*	1	1	1		1	1	frequently seen and heard on woodland edge
Collared Sunbird *Anthreptes collaris*	1	1					pair seen on woodland edge
Yellow White-eye *Zosterops senegalensis*	1	1	1		1	1	frequently seen and heard on woodland edge
Southern Grey-headed Sparrow *Passer griseus*		1	1			1*	occasional on woodland edge

Species	**1423D**		**1523A**		**1523C**		**Abundance/Habitat**
	ZBA	BFA	ZBA	BFA	ZBA	BFA	
Thick-billed Weaver *Amblyospiza albifrons*		1*	1		1		small group of birds in rank vegetation of dambo
Spectacled Weaver *Ploceus ocularis*		1*			1		once heard and seen in isolated trees growing in dambo centre
Spotted-back Weaver *Ploceus cucullatus*	1	1	1		1		heard and seen at nests in isolated tree growing in dambo centre
Golden Weaver *Ploceus xanthops*	1	1	1		1		heard and seen in isolated trees growing in dambo centre
Red-billed Quelea *Quelea quelea*	1	1	1		1	1	frequently seen in small flocks on dambos
Red-shouldered Widow *Euplectes axillaris*	1	1	1		1	1	frequently seen in small groups in rank vegetation of dambos
Red-billed Firefinch *Lagonosticta senegala*	1	1	1	1	1		uncommon in dambos
Common Waxbill *Estrilda astrild*	1	1	1		1	1	uncommon in dambos
Quailfinch *Ortygospiza atricollis*		1*	1		1	1	uncommon in dambos
Red-billed Quailfinch *Ortygospiza gabonensis*		1*	1				one small flock seen in dambo
Orange-breasted Waxbill *Amandava subflava*		1*	1		1		one small flock seen in rank vegetation of dambo
Bronze Mannikin *Lonchura cucullata*	1	1	1		1	1	frequently seen on woodland edge
Pin-tailed Whydah *Vidua macroura*	1	1	1		1	1	occasionally seen in rank vegetation in dambos
Yellow-eye Canary *Serinus mozambicus*	1	1	1	1	1		often seen drinking in dambos
Black-throated Canary *Serinus atrogularis*	1	1	1		1		often seen drinking in dambo
Golden-breasted Bunting *Emberiza flaviventris*	1	1	1	1	1	1	frequent on woodland edge and drinking in dambos
Cinnamon-breasted Rock Bunting *Emberiza tahapisi*		1*			1		small group in middle of dry dambo
TOTAL **190**	129	161	162	62	146	90	

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CHAPTER 5 : APPENDIX 2
BIRD SURVEYS OF THE BAROTSE FLOODPLAINS

Paul Van Daele & Bob Stjernstedt

1. INTRODUCTION

This report presents data on bird distribution collected from 23-28 March and 25-29 August 1999 in the Bulozi Plains area of Barotseland. The first survey was conducted by Bob Stjernstedt and Paul Van Daele for the Biodiversity Foundation for Africa, and the second survey by Paul Van Daele alone. Sites visited are shown in Table 1.

Appendix 5.2 Table 1 Sites visited and locations.

Site	Latitude (S)	Longitude (E)
Ndau School	15°35'	22°57'
Simunyange Plain	15°26'58"	22°55'36"
Lui School	15°27'36"	23°51'12"
Litawa School	15°39'59"	23°35'00"
Silita Pan	15°20'36"	23°37'30"
Litoya Village	15°40'08"	23°19'57"
Lake Makapaela (Makakaela on map)	15°03'20"	23°13'20"
Mongu-Lealui	15°15'00"	23°03'10"
Lake Nalulao	15°03'20"	23°20'20"
Lake Liangandu	15°03'06"	23°20'06"
Lake Ngame	15°02'36"	23°19'15"
Ikabako Plain	15°08'18"	23°17'20"
Nangili School	14°52'34"	23°04'29"
Likapayi Village	14°49'22"	23°01'40"
Sandbanks near Nalonde (+7km N from there)	14°46'18"	23°01'31"
Nasange Village	14°51'22"	23°01'30"
Imwinda "harbour" branch of Zambezi	14°51'08"	23°01'03"
Chipela branch of Zambezi	14°50'21"	23°00'42"
Moolo stream (E point)	14°45'22"	23°05'28"
Moolo stream (W point) - Yanjoko Village	14°47'05"	23°02'51"
southern Barotse Plain	14°14'00"	23°15'00"

2. METHODOLOGY

In an attempt to produce comparable data, abundance of the species observed was written down on a daily basis per site. Table 2 shows the frequency categories.

2.1 March survey, including Ndau School transects

Field workers who want to repeat the effort in the future and collect data to monitor changes in bird numbers in the Ndau area should preferably include an abundance notation as shown in Table 2. During the March 1999 survey the water was relatively high. Good rains left the shoreline of the floodplain 20 m from the Ndau School ablution blocks. Data were collected along five routes (half-day excursions):

(a) Walk south from the Ndau School along the shoreline for about 3 km.
(b) Walk north from the Ndau School for about 1 km.
(c) Make a boat trip around the peninsula straight east (with mango trees) from the Ndau School to the first oxbow lake and explore an area further east of there for about 1 km.
(d) Make a boat trip to the dry season village straight east from the Ndau School and closest to it.
(e) Take the path straight west from the Ndau School to the Simunyange plain and follow the shoreline of that plain for about 1 km to the south.

Appendix 5.2 Table 2 Frequency categories used during the surveys.

Category	Code	No. of sightings
Abundant	A	30+
Common	C	36492
Frequent	F	6-10
Occasional	O	2-5
Rare	R	1

2.2 **August survey**

The August survey was in five half-day excursions, described below. Bird species seen were noted for each area along with an indication of abundance. Woodland species were not recorded.

(a) Drive 8 km in plain, from Mongu in direction of Lealui.
(b) Walk eastern shore of Lake Nalulao.
(c) Walk western shore of Lake Liangandu.
(d) Drive along Zambezi from near Nalondo (see coordinates) 7 km to the north.
(e) Drive along Moolo stream.

The southern Barotse Plain was recorded birds for one hour from the coordinates given above.

3. RESULTS

3.1 **March survey**

A checklist of the birds recorded from the area during the March 1999 survey is given as Table 3. Species seen are marked on a daily basis by locality. A total of 159 species were noted, 125 species alone in the Ndau sector. The total number of individual birds seen was low. Several factors may have played a role – logistical problems resulting in a low number of areas visited, poor weather conditions and high water levels.

Taking the poor observation circumstances into account, it is our view that the Ndau and possibly Mongu sectors do not have an exceptionally rich avifauna compared to the rest of the Barotse floodplain. Reports were given to us about "important" waterbird breeding colonies active at other times of year in or outside the Ndau/Mongu sectors. It seems advisable to conduct an aerial survey to pinpoint these waterbird sites and breeding areas prior to further research on the ground.

The woodlands between the Simunyange Plain and Ndau School were found to be rather poor in numbers and species of birds. It was only on the third day that the first Fork-tailed Drongo was recorded.

The Lui Valley was visited with a view of its possible conservation importance. It was explored from Lui School to Litawa School, about 90 km further north. Few waterbirds were seen and the whole area is heavily populated. We would suggest that conservation action in the Lui Valley has low priority.

East of the Barotse Floodplain the woodlands are dotted with pans, which are a particular feature of the Western Province Kalahari sands. The area could be a refuge for some species (several pans are renowned for their population of Great Crested Grebes, a restricted-range species in Zambia). Three pans were visited (Silita, Lushi and Lusiana). Only the Silita Pan contained water and was properly explored. It was found that livestock heavily utilizes these pans. We feel that the pans warrant further investigation of general biodiversity (e.g. waterbirds, amphibians, dragonflies) earlier in the year.

Appendix 5.2 Table 3 Bird data from the Bulozi Plains survey, March 1999 (Paul Van Daele & Bob Stjernstedt).

C	Common	F	Frequent	O	Occasional	R	Rare
Nd	Ndau School	Mg	Mongu	Sim	Simunyange Plain		
Lui	Lui Valley	Sil	Silita Plain	Lit	Litoya		

English Name	Species	Date (March 1999)								
		23	27	24	25	26	26	27	27	27
		Mg	Mg	Nd	Nd	Nd	Sim	Lui	Sil	Lit
Reed Cormorant	*Phalacrocorax africanus*	F	O	C	C	C				O
Black-crowned Night Heron	*Nycticorax nycticorax*	R								
Common Squacco Heron	*Ardeola ralloides*	F		C	C	C				
Rufous-bellied Heron	*Ardeola rufiventris*		R							
Cattle Egret	*Bubulcus ibis*	C		C	C	C		C		O
Green-backed Heron	*Butorides striatus*			R	F					
Black Egret	*Egretta ardesiaca*			R						
Little Egret	*Egretta garzetta*				R					
Great White Egret	*Egretta alba*	F		F						
Purple Heron	*Ardea purpurea*	R		O	R	O				
Grey Heron	*Ardea cinerea*	R		O						
Black-headed Heron	*Ardea melanocephala*	F		C	C	C		O		
Openbill Stork	*Anastomus lamelligerus*	C		O	C	O				
Abdim's Stork	*Ciconia abdimii*								R	
Fulvous Whistling Duck	*Dendrocygna bicolor*							O		
White-faced Whistling Duck	*Dendrocygna viduata*	F		F	F			O		
Spur-winged Goose	*Plectropterus gambensis*		A		F			O		
Knob-billed Duck	*Sarkidiornis melanotos*			R	O					
African Pygmy Goose	*Nettapus auritus*				R					
Red-billed Teal	*Anas erythrorhyncha*	O								
Southern Pochard	*Netta erythrophthalma*			O						
Honey Buzzard	*Pernis apivorus*									R
Black/Yellow-billed Kite	*Milvus migrans*				R					
African Fish Eagle	*Haliaeetus vocifer*			O	O					
Short-toed Eagle	*Circaetus gallicus*								R	
Bateleur	*Terathopius ecaudatus*				R				R	R
African Marsh Harrier	*Circus ranivorus*			F	F	F		O		O
Dark Chanting Goshawk	*Melierax metabates*									R

English Name	**Species**	**Date (March 1999)**								
		23 Mg	27 Mg	24 Nd	25 Nd	26 Nd	26 Sim	27 Lui	27 Sil	27 Lit
Gabar Goshawk	*Melierax gabar*			R	R					
Wahlberg's Eagle	*Aquila wahlbergi*				O		R			
Lesser Spotted Eagle	*Aquila pomarina*			R						
Long-crested Eagle	*Lophaetus occipitalis*				R					
Lesser Kestrel	*Falco naumanni*									O
Common Kestrel	*Falco tinnunculus*			R						
Red-billed Francolin	*Francolinus adspersus*			F						
Helmeted Guineafowl	*Numida meleagris*			O			O			
Red-chested Flufftail	*Sarothrura rufa*			R	R					
Black Crake	*Amaurornis flavirostris*			F	F					
Lesser Moorhen	*Gallinula angulata*			O	C	F				
Red-knobbed Coot	*Fulica cristata*	R								
African Jacana	*Actophilornis africanus*	C		C	C	C				
Kittlitz's Plover	*Charadrius pecuarius*								F	
Senegal Wattled Plover	*Vanellus senegallus*			F	F	F				C
White-crowned Plover	*Vanellus albiceps*	F								
Blacksmith Plover	*Vanellus armatus*			F	F	F				
Ethiopian Snipe	*Gallinago nigripennis*									R
Greenshank	*Tringa nebularia*								O	
Wood Sandpiper	*Tringa glareola*								O	
Grey-headed Gull	*Larus cirrocephalus*				R					
White-winged Black Tern	*Chlidonias leucopterus*			R						
African Mourning Dove	*Streptopelia decipiens*			C						
Cape Turtle Dove	*Streptopelia capicola*			F						
Red-eyed Dove	*Streptopelia semitorquata*			F						
Emerald-spotted Wood Dove	*Turtur chalcospilos*			F						
Schalow's Turaco	*Tauraco schalowi*			R						
Jacobin Cuckoo	*Clamator jacobinus*			R	O					
Striped Crested Cuckoo	*Clamator levaillantii*				R					
Emerald Cuckoo	*Chrysococcyx cupreus*				R					
Didric Cuckoo	*Chrysococcyx caprius*			R						
Coppery-tailed Coucal	*Centropus cupreicaudus*			C						
Senegal Coucal	*Centropus senegalensis*			O						
Burchell's Coucal	*Centropus superciliosus*			O						
African Scops Owl	*Otus senegalensis*			O	O					
Pearl-spotted Owlet	*Glaucidium perlatum*			R						
Barred Owlet	*Glaucidium capense*				R					
Fiery-necked Nightjar	*Caprimulgus pectoralis*				F		R			
Gaboon Nightjar	*Caprimulgus fossii*				C					

English Name	**Species**	**Date (March 1999)**								
		23	27	24	25	26	26	27	27	27
		Mg	Mg	Nd	Nd	Nd	Sim	Lui	Sil	Lit
African Palm Swift	*Cypsiurus parvus*			F						
European Swift	*Apus apus*				O					
Malachite Kingfisher	*Alcedo cristata*			C						
Senegal Kingfisher	*Halcyon senegalensis*				R					
Giant Kingfisher	*Megaceryle maxima*			R						
Pied Kingfisher	*Ceryle rudis*			C						
Little Bee-eater	*Merops pusillus*			C						
White-cheeked Bee-eater	*Merops variegatus*								O	
Blue-cheeked Bee-eater	*Merops persicus*			F						
European Bee-eater	*Merops apiaster*				O		O			
Southern Carmine Bee-eater	*Merops nubicoides*			O			O			
Lilac-breasted Roller	*Coracias caudata*				O		O			
African Grey Hornbill	*Tockus nasutus*			O			C			
Yellow-fronted Tinkerbird	*Pogoniulus chrysoconus*			O						
Black-collared Barbet	*Lybius torquatus*			R			O			
Cardinal Woodpecker	*Dendropicos fuscescens*			R			R			
Rufous-naped Lark	*Mirafra africana*						R			
Red-capped Lark	*Calandrella cinerea*								C	
Chestnut-backed Sparrow-Lark	*Eremopterix leucotis*								O	
European Sand Martin	*Riparia riparia*			F						
African Sand Martin	*Riparia paludicola*			O						
Grey-rumped Swallow	*Pseudhirundo griseopyga*				O		O			
Red-breasted Swallow	*Hirundo semirufa*				R					
Wire-tailed Swallow	*Hirundo smithii*			F	R					
European Swallow	*Hirundo rustica*				O		C		F	F
Mountain Wagtail	*Motacilla clara*			F						
Richard's Pipit	*Anthus richardi*				O					
Fnlleborn's Longclaw	*Macronyx fuellebornii*									O
Rosy-breasted Longclaw	*Macronyx ameliae*									O
Black Cuckoo-shrike	*Campephaga flava*						O			
Common Bulbul	*Pycnonotus barbatus*			C			F			
Heuglin's Robin	*Cossypha heuglini*				C					
White-browed Scrub Robin	*Erythropygia leucophrys*				C					
Stonechat	*Saxicola torquata*			C						
Little Rush Warbler	*Bradypterus baboecala*			R						
Sedge Warbler	*Acrocephalus schoenobaenus*			C						
Reed Warbler	*Acrocephalus scirpaceus*						R			
Great Reed Warbler	*Acrocephalus arundinaceus*			O						
Greater Swamp Warbler	*Acrocephalus rufescens*			F						

English Name	**Species**	**Date (March 1999)**								
		23	27	24	25	26	26	27	27	27
		Mg	Mg	Nd	Nd	Nd	Sim	Lui	Sil	Lit
Icterine Warbler	*Hippolais icterina*			R			R			
Long-billed Crombec	*Sylvietta rufescens*			F			C			
Willow Warbler	*Phylloscopus trochilus*			F	R					
Garden Warbler	*Sylvia borin*			O	R		R			
Pale-crowned Cisticola	*Cisticola cinnamomeus*									F
Fan-tailed Cisticola	*Cisticola juncidis*			C					F	F
Desert Cisticola	*Cisticola aridulus*						F		O	O
Rattling Cisticola	*Cisticola chiniana*				O		C			
Greater Black-backed	*Cisticola galactotes*			F	F					
Chirping Cisticola	*Cisticola pipiens*			C	C					
Tawny-flanked Prinia	*Prinia subflava*			C						
Yellow-breasted Apalis	*Apalis flavida*			C			O			
Bleating Bush Warbler	*Camaroptera brachyura*			C			C			
Spotted Flycatcher	*Muscicapa striata*			R			O			
Chinspot Batis	*Batis molitor*			O			C			
Paradise Flycatcher	*Terpsiphone viridis*			O	O		O			
White-rumped Babbler	*Turdoides leucopygius*			C	C					
Collared Sunbird	*Anthreptes collaris*			O						
Amethyst Sunbird	*Nectarinia amethystina*						O			
White-bellied Sunbird	*Nectarinia talatala*			O			C			
Purple-banded Sunbird	*Nectarinia bifasciata*						R			
Coppery Sunbird	*Nectarinia cuprea*				O		O			
Yellow White-eye	*Zosterops senegalensis*						R			
African Golden Oriole	*Oriolus auratus*						O			
Eastern Black-headed Oriole	*Oriolus larvatus*						C			
Lesser Grey Shrike	*Lanius minor*			R						
Southern Puffback	*Dryoscopus cubla*						C			
Brown-headed Tchagra	*Tchagra australis*			O			O			
Black-crowned Tchagra	*Tchagra senegala*			O						
Swamp Boubou	*Laniarius bicolor*			O						
Orange-breasted Bush Shrike	*Malaconotus sulphureopectus*			O						
Grey-headed Bush Shrike	*Malaconotus blanchoti*			O						
White Helmet Shrike	*Prionops plumatus*						C			
Fork-tailed Drongo	*Dicrurus adsimilis*						O			
Pied Crow	*Corvus albus*			C						
Greater Blue-eared Starling	*Lamprotornis chalybaeus*			O	F					
Wattled Starling	*Creatophora cinerea*				F					
Grey-headed Sparrow	*Passer griseus*			O						
Spectacled Weaver	*Ploceus ocularis*			F						

English Name	**Species**	**Date (March 1999)**								
		23	27	24	25	26	26	27	27	27
		Mg	Mg	Nd	Nd	Nd	Sim	Lui	Sil	Lit
Large Golden Weaver	*Ploceus xanthops*			F						
African Masked Weaver	*Ploceus velatus*			C	C					
Red Bishop	*Euplectes orix*			C						
Red-shouldered Whydah	*Euplectes axillaris*			C						
Brown Firefinch	*Lagonosticta rufopicta*			O						
Common Waxbill	*Estrilda astrild*			F						
Quail Finch	*Ortygospiza atricollis*			O			C			
Bronze Mannikin	*Lonchura cucullata*				O					
Village Indigobird	*Vidua chalybeata*			O	O					
Pin-tailed Widow	*Vidua macroura*			R	O					

Note: Sequence and nomenclature follows Dowsett & Forbes-Watson (1993), Checklist of the Birds of the Afrotropical and Malagasy Regions.

3.2 **August survey**

A checklist of the birds recorded from the area during the August 1999 survey is given as Table 4. Species seen are marked on a daily basis by locality. A total of 98 species were seen from all habitats, 69 species alone in the Luena sector.

In the Mongu sector big *Acacia* trees served as roosts for Great White Egret, Little Egret, Openbill Stork and Black Egret. The puddles and wet depressions attract a number of waterfowl, notably Wattled Crane (and ten Slaty Egrets on 22 Aug 1998).

Lake Makapaela, Lake Nalulao, Lake Liangandu and Lake Ngame were all visited with a view to establishing the importance of the remaining pans and to check on the current presence of the Great Crested Grebe (*Podiceps cristatus*) in the area. The grebes may have disappeared from the area east of Limulunga. Villagers confirmed there were no other wet pans north of the Lusaka-Mongu road. The area south of this road was explored in March and no grebes were found there either.

Lake Nalulao held only 700 White-faced Whistling Ducks (not shown in Table 4). The lake gives the impression of a gravel pit with no floating vegetation and barely any vegetation along the shoreline. The nearby twin Lake Liangandu is by far the most interesting of the lakes visited, including open water, floating vegetation and waterlilies, shallow grassy marsh, some *Typha* beds along southern shore, muddy areas, etc. A diversity of habitats may be found with a diverse avifauna. However, the lake was quite difficult to explore and all observations were made from the shoreline. There seem to be no threats to the birds, although fishermen are quite active on this lake and all cattle from the area come here to drink.

Several consecutive droughts had a severe impact on Lake Makapaela, Lake Ngame and several other pans in the area. Since 1983 water levels have gone down gradually. The lakes used to hold water for the whole year, but now Lake Makapaella and Lake Ngame are only partially filled in January-February. By August the lakes are dry again, in spite of good rains during the last two years.

The Luena sector holds an interesting combination of wetland birds. Relative to the rest of the Barotse floodplain, the sandbanks, lagoons and oxbows form a rich combination of habitats with an equally diverse avifauna. Skimmers, White-crowned Plover and Blacksmith Plovers were all found breeding in numbers. Most exciting was a possible breeding record of the Avocet (*Recurvirostra avocetta*). This constitutes only the second record for Zambia. No eggs or young were seen, but it seemed clear one bird was sitting on eggs while the other one was chasing intruders.

It may safely be concluded that the western area of the Luena flats sector is disturbed by human activities during the drier part of the year. Although cattle are an important asset for the people of Barotseland, cattle ranching has had a clear impact on the plains ecosystem. Overgrazing, burning and, to a lesser extent, subsistence farming have all added to the degradation of wet and dry habitats. The Zambezi River edge seems to be the most valuable and vulnerable part in this sector. Therefore, conservation and education activities should concentrate on the islands and sandbanks in the Zambezi (which are breeding and feeding grounds for several species of waterfowl, including Avocet) and on lagoons along the Zambezi. From a conservation point of view, it would seem advantageous to concentrate cattle in certain areas and limit access to certain lagoons or specific access points. Although it is difficult to see how one would implement any measures taken, the matter needs to be looked at carefully if conservation of the river and lagoon habitats and ecological communities is to be achieved.

The eastern parts of the Luena Flats sector (the Luena Flats properly speaking) should be a priority for future exploration. This sector could well be the most exceptional in terms of birds, dragonflies and plants. Observations to date along the edges are promising. Furthermore, the physico-chemical conditions should warrant rare combinations of plants and animals. The area is difficult or impossible to access by boat or car during the greater part of the year – mid-September until November should be the best time. It is advisable to take a local guide along from the villages north of the Luena Flats.

Appendix 5.2 Table 4 Bird survey results from the West Bank, Barotseland, August 1999 (Paul Van Daele).

C Common F Frequent O Occasional R Rare
Mk Lake Makapaella Mg Mongu-Lealui Li Lake Liangandu
LNg Lake Ngame Lp West Luena - dry plains Ll West Luena - lagoons/oxbows
WL West Luena Z Zambezi islands/sandbanks SB S. Barotse plain

English Name	Species	Date (August 1999)								
		25	25	27	27	27	27	28	28	29
		Mk	Mg	Li	LNg	Lp	Ll	WL	Z	SB
Little Grebe	*Tachybaptus ruficollis*			F						
Reed Cormorant	*Phalacrocorax africanus*						C		A	C
Black-crowned Night Heron	*Nycticorax nycticorax*		R				F			
Common Squacco Heron	*Ardeola ralloides*		C				C		F	
Rufous-bellied Heron	*Ardeola rufiventris*		C						C	
Cattle Egret	*Bubulcus ibis*						C			
Black Egret	*Egretta ardesiaca*		C							
Little Egret	*Egretta garzetta*	F	A						O	O
Great White Egret	*Egretta alba*	F	C	F	F				F	
Purple Heron	*Ardea purpurea*			F						R
Grey Heron	*Ardea cinerea*		O						O	
Black-headed Heron	*Ardea melanocephala*		O	F					F	
Yellow-billed Stork	*Mycteria ibis*								O	
Openbill Stork	*Anastomus lamelligerus*		A							C
Marabou Stork	*Leptoptilos crumeniferus*					O				
Glossy Ibis	*Plegadis falcinellus*		F							

English Name	**Species**	**Date (August 1999)**								
		25	25	27	27	27	27	28	28	29
		Mk	Mg	Li	LNg	Lp	Ll	WL	Z	SB
Fulvous Whistling Duck	*Dendrocygna bicolor*	C	F	C			F			
White-faced Whistling Duck	*Dendrocygna viduata*			A						
Spur-winged Goose	*Plectropterus gambensis*			C						
Knob-billed Duck	*Sarkidiornis melanotos*			O						
Red-billed Teal	*Anas erythrorhyncha*	O							F	
Hottentot Teal	*Anas hottentota*			F					O	
Southern Pochard	*Netta erythrophthalma*			C						
Black-shouldered Kite	*Elanus caeruleus*			O						
Black/Yellow-billed Kite	*Milvus migrans*	F								F
African Fish Eagle	*Haliaeetus vocifer*			O					O	O
White-backed Vulture	*Gyps africanus*									R
Bateleur	*Terathopius ecaudatus*			O						F
African Marsh Harrier	*Circus ranivorus*		F	F						
Martial Eagle	*Polemaetus bellicosus*						R			
Lanner Falcon	*Falco biarmicus*					R				
Blue Quail	*Coturnix chinensis*							O		
Kurrichane Buttonquail	*Turnix sylvatica*								R	
Black-rumped Buttonquail	*Turnix hottentotta*			R						
Wattled Crane	*Grus carunculatus*		C							
African Jacana	*Actophilornis africanus*			C			F			
Black-winged Stilt	*Himantopus himantopus*								F	
Avocet	*Recurvirostra avosetta*								F	
Temminck's Courser	*Cursorius temminckii*					O		O		
Common Pratincole	*Glareola pratincola*							F	F	C
White-fronted Sand Plover	*Charadrius marginatus*								F	
Senegal Wattled Plover	*Vanellus senegallus*							O	F	
White-crowned Plover	*Vanellus albiceps*								C	
Blacksmith Plover	*Vanellus armatus*	R			O		C		C	
Crowned Plover	*Vanellus coronatus*							O		
Marsh Sandpiper	*Tringa stagnatilis*								R	
Greenshank	*Tringa nebularia*		O						A	
Wood Sandpiper	*Tringa glareola*	R							O	
Common Sandpiper	*Actitis hypoleucos*								O	
Sanderling	*Calidris alba*								O	
Little Stint	*Calidris minuta*								O	
Curlew Sandpiper	*Calidris ferruginea*								O	
Ruff	*Philomachus pugnax*								O	
Grey-headed Gull	*Larus cirrocephalus*								C	F
African Skimmer	*Rynchops flavirostris*								A	

English Name	**Species**	**Date (August 1999)**								
		25	25	27	27	27	27	28	28	29
		Mk	Mg	Li	LNg	Lp	Ll	WL	Z	SB
Laughing Dove	*Streptopelia senegalensis*							F		
Cape Turtle Dove	*Streptopelia capicola*							F		
Grey Lourie	*Corythaixoides concolor*							F		
Coppery-tailed Coucal	*Centropus cupreicaudus*			F			C			
Marsh Owl	*Asio capensis*						R		R	
Gaboon Nightjar	*Caprimulgus fossii*								C	
Pied Kingfisher	*Ceryle rudis*	F	F				F			
Little Bee-eater	*Merops pusillus*			C				F		
Swallow-tailed Bee-eater	*Merops hirundineus*							F		
Southern Carmine Bee-eater	*Merops nubicoides*									C
Rufous-naped Lark	*Mirafra africana*							O		
Red-capped Lark	*Calandrella cinerea*		O					O		F
African Sand Martin	*Riparia paludicola*								R	F
Grey-rumped Swallow	*Pseudhirundo griseopyga*									C
Lesser Striped Swallow	*Hirundo abyssinica*									C
White-throated Swallow	*Hirundo albigularis*									F
Richard's Pipit	*Anthus richardi*	F	C	C						F
Plain-backed Pipit	*Anthus leucophrys*					O				O
Rosy-breasted Longclaw	*Macronyx ameliae*			R						
Common Bulbul	*Pycnonotus barbatus*							F		
Stonechat	*Saxicola torquata*				C					F
Capped Wheatear	*Oenanthe pileata*									F
Little Rush Warbler	*Bradypterus baboecala*							F	F	
Lesser Swamp Warbler	*Acrocephalus gracilirostris*								F	
Long-billed Crombec	*Sylvietta rufescens*							F		
Fan-tailed Cisticola	*Cisticola juncidis*		O	R					C	F
Desert Cisticola	*Cisticola aridulus*									F
Greater Black-backed	*Cisticola galactotes*			R				F		O
Chirping Cisticola	*Cisticola pipiens*									O
Tawny-flanked Prinia	*Prinia subflava*									F
White-rumped Babbler	*Turdoides leucopygius*					F		F		
Marico Sunbird	*Nectarinia mariquensis*							R		
Swamp Boubou	*Laniarius bicolor*							F	F	O
Orange-breasted Bush Shrike	*Malaconotus sulphureopectus*							O		
Grey-headed Sparrow	*Passer griseus*							O		
Red-billed Quelea	*Quelea quelea*							F		
Red-shouldered Whydah	*Euplectes axillaris*							F		O
Red-billed Firefinch	*Lagonosticta senegala*							F		
Common Waxbill	*Estrilda astrild*									F

English Name	**Species**	**Date (August 1999)**								
		25	25	27	27	27	27	28	28	29
		Mk	Mg	Li	LNg	Lp	Ll	WL	Z	SB
Blue Waxbill	*Uraeginthus angolensis*							F		
Locust Finch	*Ortygospiza locustella*							O		
Quail Finch	*Ortygospiza atricollis*			A						
Pin-tailed Widow	*Vidua macroura*							F		

Note: Sequence and nomenclature follows Dowsett & Forbes-Watson (1993), Checklist of the Birds of the Afrotropical and Malagasy Regions.

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CHAPTER 5 : APPENDIX 3
WETLAND BIRD SURVEY OF THE ZAMBEZI DELTA

Carlos Bento

1. INTRODUCTION

The delta of the Zambezi River where it spreads out before reaching the sea is internationally renowned for its species richness and productivity, and provides breeding, feeding and wintering grounds for many species of national and international concern. It supports at least 14 distinct vegetation communities ranging from papyrus swamps to *Borassus* palm savanna to dry forest. The delta is also vital to the Mozambican economy, providing a lucrative shrimp fishery, sugar production, transportation and many natural resources. Both the ecology and the economy of the delta are intricately linked to the flooding cycles of the Zambezi River.

Unfortunately, historical information on the diversity and abundance of waterbirds in the Zambezi Delta prior to 1990 is limited to a few observations recorded during aerial wildlife surveys, and anecdotal accounts from ecologists working in the study area. Maugham (1910) compiled a list of bird species observed during his travels up the Zambezi from Chinde. His observations include a large number of waterbirds, including the Grey Crowned Crane (*Balearica regulorum*), Saddlebilled Stork (*Ephipiorhynchus senegalensis)*, White Pelican *(Pelicanus onocrotalus*) and a variety of egrets and herons. There is only cursory information on waterbird abundance from riverside observations, however, and several questionable species records (e.g. the Blue Crane, endemic to South Africa and Namibia, is listed, perhaps mistakenly for the Wattled Crane) (Bento & Beilfuss 1999).

Early aerial surveys of the Marromeu Buffalo Reserve and surrounding coutadas or hunting areas (Tinley 1969, Tinley & Sousa Dias 1973) carefully recorded the distribution and abundance of mammal species but did not record waterbird observations, with the exception of large flocks of cattle egrets in association with buffalo herds. According to ecologist Paul Dutton (pers. comm. 1999), waterbird populations were so abundant in the 1960s and 1970s that even cursory counts could not be conducted in conjunction with mammal surveys. The Marromeu floodplains were abundant in waterfowl and fish-eating birds such as White Pelicans and Pink-backed Pelicans (*Pelecanus rufescens)* and several species of storks. Dutton participated in the final surveys of the delta following the large flooding event of March 1978 and prior to the advent of civil war, but no observations of bird species were reported (Tello & Dutton 1979).

During the height of civil war in Mozambique from 1980-1990, there were no wildlife surveys in the Zambezi Delta with the exception of a limited and inconclusive survey by Chambal (1989). There is thus no information on waterbird diversity or abundance for the first fifteen years after closure of Cabora Bassa Dam in 1975. The incredible decimation of wildlife populations during this period (Anderson *et al.* 1990), however, suggests that large edible waterbird species were likely to have been heavily persecuted during this period (Bento & Beilfuss 1999).

The present study provides information which could be used as support for the wise use of the natural resources of the delta, while maintaining its biological diversity.

1.2 **Objectives**

The principal objectives of the study were to: (a) compile annotated checklists of waterbirds from various representative sites in the Zambezi Delta; (b) present a report giving techniques used and evaluating the findings; and (c) indicating particular species or sites of interest.

As we were involved in a similar study looking at potential impacts of dam construction (described in Bento & Beilfuss 1999), many of the findings and sections are common to both reports.

2. STUDY AREA

The Zambezi Delta covers an area of about 18,000 km^2 from its apex at Chupanga to its 120 km front with the Indian Ocean coast from Quelimane southwest to Machesse. There are two distinct climatic seasons, a summer rainy season (approximately November to April), during which the climate is subhumid and hot, and a dry winter period (May to October), during which the climate is subarid and warm. The mean annual rainfall increases from 1000 mm near Chupanga to about 1200 mm at the coast, but there is considerable variation in its inter-annual and seasonal distribution. Evaporation is high, and for only a few months of the rainy season does rainfall approach or equal potential evapotranspiration. The most important influence on the hydrology of the delta is the seasonal floodwaters of the Zambezi River and its distributor channels, and perennial runoff from streams draining the Cheringoma plateau from the west.

3. METHODOLOGY

The species list has been compiled from observations made over 1995, 1996, 1997 (Beilfuss & Allan 1996) and from observations made in 1998 and 1999. Three methods have been used: (a) aerial surveys, (b) ground surveys (in coutadas 11, 10), and (c) boat surveys from Marromeu to Chinde along the Zambezi River in 1998 and 1999. We also include a checklist from observations made over 10 days in the Marromeu coastal area.

The aerial survey covered the entire Marromeu Buffalo Reserve and surrounding coutada floodplains (the Marromeu Complex) with 4 km-width transects running parallel to the coastline in an attempt to generate a complete count of large birds species in the area. During the survey, the team also noted large breeding colonies of White Pelicans, egrets and several species of storks. All species noted during the ground and boat surveys were noted.

For the terrestrial survey, more then four hours were spent each day for five days recording waterfowl on the Coutada 10 and 11 floodplains. Various species were not possible to identify owing to difficulties such as grass height and accessibility. Such species as Crake's Rail's and Flufftails were not recorded due to difficulties in walking over the floodplain to flush them.

Four boat surveys along the Zambezi (from Marromeu to Chinde) were carried out in October 1998 and July 1999, with recording from mid-morning to mid-afternoon. During these surveys several expected species were not noted, possibly owing to the extent of the area surveyed and limited vision with binoculars. At Pambane on Chinde island in July 1999 we surveyed several small channels among the mangroves for 3.5 hours using a small canoe. Possibly many waterbird species were missing from our observations owing to the difficulties of walking in this habitat.

For questionable bird calls, a recorded tape cassette (Common Birds Calls of Southern Africa) was used for confirmation.

4. SPECIES ACCOUNTS

Each species account provides follows the Robert’s number, the English and scientific names, and details on status and numbers. South Africa Red Data Book status is also mentioned. A list of species seen at each locality is given in Table 1.

Appendix 5.3 Table 1 Lists of waterbird species seen at various localities in the Zambezi Delta.

Locality 1: Nhamagote Lake (Coutada 11), 18 25.08' S / 35 33.70' E, 20 June 1999
Locality 2: Nhamagote Lake (Coutada 11), 18 15.30' S / 35 42.49' E, 21 June 1999
Locality 3: Inhagoia, Nhapacue River (Coutada 11), floodplain, 18 33.87' S / 35 39.21' E, 26 & 28 June 1999
Locality 4: Missocossa River (Coutada 10), floodplain, 18 43.43' S / 35 42.45' E, 26 & 30 June 1999.

Species	**Locality**			
	1	2	3	4
Dabchick (*Tachybaptus ruficollis*)		X		
White Pelican (*Pelecanus rufescens*)				X
Reed Cormorant (*Phalacrocorax africanus*)			X	
Darter (*Anhinga melanogaster*)				X
Blackheaded Heron (*Ardea melanocephala*)			X	X
Goliath Heron (*Ardea goliath*)			X	X
Purple Heron (*Ardea purpurea*)	X			X
Great White Egret (*Casmerodius albus*)			X	X
Yellowbilled Egret (*Egretta intermedia*)	X		X	X
Cattle Egret (*Bubulcus ibis*)			X	
Squacco Heron (*Ardeola ralloides*)			X	X
Rufousbellied Heron (*Butorides rufiventris*)			X	
Little Bittern (*Ixobrychus sturmii*)				X
Hamerkop (*Scopus umbretta*)			X	X
Woolynecked Stork (*Ciconia episcopus*)	X		X	
Openbilled Stork (*Anastomus lamelligerus*)			X	
Saddlebilled Stork (*Ephippiorhychus senegalensis*)			X	X
Marabou Stork (*Leptoptilos crumeniferus*)				X
Yellowbilled Stork (*Mycteria ibis*)			X	
Sacred Ibis (*Threskiornis aethiopicus*)			X	
Hadeda Ibis (*Bostrychia hagedash*)			X	X
African Spoonbill (*Platalea alba*)				X
Whitefaced Duck (*Dendrocygna viduata*)				X
Hottentot Teal (*Anas hottentota*)	X			
Pygmy Goose (*Nettapus auritus*)	X			
Spurwinged Goose (*Plectropterus gambensis*)			X	X
Bateleur (*Terathopius ecaudatus*)			X	
Palmnut Vulture (*Gypophierax angolensis*)			X	
African Fish Eagle (*Haliaeetus vocifer*)			X	X
Wattled Crane (*Bugeranus carunculatus*)				X
Crowned Crane (*Balearica regulorum*)				X

Species	**Locality**			
	1	2	3	4
Lesser Gallinule (*Porphyrula alleni*)	X			
Lesser Moorhen (*Gallinula angulata*)		X		
African Jacana (*Actophilornis africanus*)	X	X		X
Lesser Jacana (*Microparra capensis*)	X			X
Blacksmith Plover (*Vanellus armatus*)			X	
Whitecrowned Plover (*Vanellus albiceps*)			X	X
Longtoed Plover (*Vanellus crassirostris*)			X	
Great Snipe (*Gallinago media*)				X
Blackwinged Stilt (*Himantopus himantopus*)				X
Pied Kingfisher (*Ceryle rudis*)			X	X
Malachite Kingfisher (*Alcedo cristata*)	X			X

49. White Pelican *Pelecanus onocrotalus*
Common resident and breeds in the delta. Nests in large, conspicuous colonies in the coastal mangrove and are very sensitive to disturbance (Dennis & Tarboton 1993). Dutton observed large numbers of this species feeding in the Zambezi Delta floodplains during the 1960s and 1970s. In recent years they have abandoned the dry floodplains of the Zambezi Delta and now feed on Lake Urema of Gorongosa National Park, but they continue to roost and breed in the coastal parts of the delta. The aerial surveys of March 1995, July 1996 and May 1997 show local movements into the delta (Beilfuss & Allan 1996). The White Pelican is listed in the South African Red Data Book as Rare (Brook 1984).

50. Pinkbacked Pelican *Pelecanus rufescens*
Uncommon resident and breeds in the delta. Dutton observed large numbers of this species feeding on the Zambezi floodplains during the 1960s and 1970s. In the recent years they have abandoned the dry floodplains of the Zambezi Delta and now feed in Lake Urema of Gorongosa National Park, but they continue to roost and breed in the coastal delta. A flock of up to 55 birds was recorded on sandbanks in the Zambezi close to Luabo during the boat survey in July 1999. The aerial surveys of March 1995, July 1996 and May 1997 show local movements into the delta (Beilfuss & Allan 1996). The Pinkbacked Pelican is listed in the South African Red Data Book as Rare (Brook 1984).

55. Whitebreasted Cormorant *Phalacrocorax carbo*
This species is common and resident in the delta, and has been seen flying along the Zambezi and at the coast in Chinde. Normally, single birds were seen, but flocks ranging from 20 to 30 individuals were recorded roosting on tidal sandbanks along the main channel of the Zambezi.

58. Reed Cormorant *Phalacrocorax africanus*
At least three large breeding colonies of this species were recorded on the Marromeu floodplain in reedbeds along small rivers. It is a common and resident bird and feeds in ponds and calm rivers in the delta.

60. Darter *Anhinga melanogaster*
During the boat survey from Marromeu to Chinde (October 1998) this species was very common in areas along the Zambezi influenced by the tide. Up to 700 birds were counted. Few individuals were recorded during the July 1999 boat survey, suggesting migratory movements to elsewhere in southern Africa (probably to the breeding grounds).

62. Grey Heron *Ardea cinerea*
Normally, solitary birds were recorded on coastal and inland shallow waters, also on floodplain pans and lagoons. In coastal areas during high tide they roost on mangroves.

63. Blackheaded Heron *Ardea melanocephala*
Few birds were recorded on open grassland floodplains feeding on fish and frogs.

64. Goliath Heron *Ardea goliath*
Common resident and breeds on the Zambezi floodplain. It often occurs singly, even in the breeding season. It is widespread in river reedbeds on the floodplain.

65. Purple Heron *Ardea purpurea*
Occurs solitary and is a common resident. Breeds in areas with dense reedbeds and other aquatic vegetation on the floodplain and along the Zambezi.

66. Great White Egret *Egretta alba*
A common and resident species in the Zambezi Delta. Breeds in dense reedbeds and papyrus vegetation. Several colonies (up to 80 pairs) were recorded along floodplain streams covered by vegetation. For most records they were associated with other egret species feeding on fish or frogs in ponds and large lagoons (some in woodlands).

67. Little Egret *Egretta garzetta*
Common resident species of the delta breeding in reedbeds. Feeds along small streams, perching in mangrove branches, and on shores of inland and marine waters. Large colonies (up to 100 individuals) of roosting birds were recorded at Pambane (Chinde) in mangroves during high tide.

68. Yellowbilled Egret *Egretta intermedia*
Common resident usually associated with other egrets in the breeding and feeding grounds on the floodplain, ponds and lagoons of the delta. In the mixed flocks of Little Egret, Great Egret and Cattle Egret (flock size 257 birds) in Coutada 11 (Inhagoia), 65 Yellowbilled Egrets were counted.

69. Black Egret *Egretta ardesiaca*
Although this species is considered common in the tropics (Maclean 1993), only two birds were observed during the May 1997 aerial survey.

71. Cattle Egret *Bubulcus ibis*
Common and resident in the delta. During the 1995, 1996 and 1997 aerial surveys, thousands of Cattle Egrets were recorded associated with buffalo and elephant herds (Beilfuss & Allan 1996).

72. Squacco Heron *Ardeola ralloides*
Very common resident in the delta. Is usually associated with reed or papyrus vegetation. They are easily mistaken for Little Egrets during the aerial surveys.

74. Greenbacked Heron *Butorides striatus*
Usually solitary at the Zambezi estuary, along mangroves and in the intertidal mud flats at Pambane and Chinde. Feeds on crustaceans.

76. Blackcrowned Night Heron *Nycticorax nycticorax*
Few birds were recorded on the Zambezi floodplain and large lagoons in the woodland area. A bird ringed in Romania was recovered in Mozambique (Maclean 1993), which suggests that some non-breeding Palaearctic migrants reach Mozambique and the delta.

81. Hamerkop *Scopus umbretta*

Usually solitary along the Zambezi and on the floodplains. During the March 1995 aerial survey, two birds were recorded (Beilfuss & Allan 1996). During the boat survey (Marromeu-Chinde) in 1998, eight birds were counted.

84. Black Stork *Ciconia nigra*

Uncommon on the Zambezi floodplain. Six birds were recorded during the March 1995 aerial survey (Beilfuss & Allan 1996). This species is listed in the South African Red Data Book as Rare (Brook 1984). Breeds in mountainous regions (Maclean 1993).

85. Abdim's Stork *Ciconia abdimii*

Uncommon non-breeding intra-African migrant. A flock of 30 birds were recorded on the Zambezi floodplain during the March 1995 aerial survey (Beilfuss & Allan 1996).

86. Woollynecked Stork *Ciconia episcopus*

Uncommon resident bird on the Zambezi floodplain and inter-tidal area. A flock of 12 birds were recorded during the boat survey. On the floodplain the they are usually seen following fires to feed on insects. Only 6 and 3 birds were recorded during the 1995 and 1996 aerial surveys, respectively, and 69 birds in 1997 (Beilfuss & Allan 1996). This species is listed in the South African Red Data Book as Rare (Brook 1984).

87. Openbilled Stork *Anastomus lamelligerus*

Common and resident in the Zambezi Delta. Large numbers concentrate in sandbars feeding on freshwater snails and mussels in the Lower Zambezi during the dry season (Beilfuss & Bento 1997). They feed in the shallow freshwater lakes in the coastal mangrove zone during the wet season (Bento 1999). During the 1995, 1996 and 1997 aerial surveys, 1896, 1500 and 534 birds, respectively, were recorded on the floodplain. During the boat surveys from Marromeu to Chinde along the Zambezi thousands of birds were counted. This species is listed in the South African Red Data Book as Rare (Brook 1984).

88. Saddlebilled Stork *Ephippiorhynchus senegalensis*

Common resident and breeds on the Zambezi floodplain and large lagoons in the woodlands. Usually they were observed in pairs, or a pair with chick. Sometimes flocks ranging from 4 to 7 birds were observed on the floodplain. During the 1995, 1996 and 1997 aerial surveys, 36, 7 and 31 birds, respectively, were recorded (Beilfuss & Allan 1996). This suggests local movement of the species in the delta. This species is listed in the South African Red Data Book as Rare (Brook 1984).

89. Marabou Stork *Leptoptilos crumeniferus*

Locally common and resident in the delta. Mostly in pairs on the floodplain, but were also seen gregarious in coutadas 11 and 14 around carcasses of mammals during the hunting season. During the aerial surveys of the Marromeu Complex, 52 birds were recorded in 1995 and 56 in 1997. Local people often confuse this species with the Wattled Crane. This species is listed in the South African Red Data Book and is considered a rare and vagrant species in South Africa (Brook 1984).

90. Yellowbilled Stork *Mycteria ibis*

Common resident and breeds in the delta. Approximately 500-1000 pairs were observed in a large breeding colony (Beilfuss & Bento 1997). Out of the breeding season, the species is widespread all over the floodplain and perched on trees in small flocks ranging from 2 to 5 birds. It is also common to see solitary birds feeding in the lagoons. In the 1995, 1996 and 1997 aerial surveys, 41, 14 and 96 individuals, respectively, were recorded. This species is listed in the South African Red Data Book as Rare (Brook 1984).

91. Sacred Ibis *Threskionis aethiopicus*

Common resident and usually seen in association with flocks of egrets in the southwest part of the floodplain during the ground survey. Hundreds of breeding pairs have been recorded in the Marromeu Complex (Beilfuss & Bento 1997). After the breeding season, the species is widespread within the delta and other areas. During the 1995, 1996 and 1997 aerial surveys, 35, 40 and 14 birds were observed.

93. Glossy Ibis *Plegadis falcinellus*
This species is common in the delta, usually observed in the wet grassland. Feeding flocks were associated with Spurwinged Goose in the Marromeu Complex. During the aerial surveys 73 birds were recorded in 1995, and 244 in 1997.

94. Hadeda Ibis *Bostrychia hagedash*
Very common and resident in the delta, often gregarious in groups of 2 to 7 birds. During the ground survey in Coutada 10, up to 900 birds were seen early in the morning travelling from roosting trees in woodland to the feeding grounds in the grassland area.

95. African Spoonbill *Platalea alba*
Common resident and breeds in the delta. Hundreds of breeding pairs have been recorded in the Marromeu Complex. During the aerial survey only 10 birds were recorded in 1997. This species might be underestimated because it can be easily mistaken with egrets from the air. A flock of up to 25 birds was observed during the boat survey from Marromeu to Chinde in July 1999. A few feeding birds were recorded on the floodplain in Coutada 10 in July 1999.

96. Greater Flamingo *Phoenicopterus ruber*
Common in the coastal areas of the delta. A flock of up to 900 flamingos was recorded during the inter-tidal survey at Chinde in October 1998 and in July 1999. More than 300 birds were recorded during the ground survey in Pambane near Chinde. 100 birds were counted during the boat survey (October 1998) from Marromeu to Chinde in a big lagoon along the main Zambezi River around 6 km from Chinde. During the aerial survey flamingos were not recorded because the flights did not cover the inter-tidal area. Fortunately, in 1999 we flew the inter-tidal area and a flock of around 1000 birds were observed.

97. Lesser Flamingo *Phoeniconaias minor*
Common in the coastal areas of the delta, normally associated with Greater Flamingos. More than 150 birds were counted in Chinde District. The population of Lesser Flamingos might be underestimated because of the difficulty in distinguishing the Greater from Lesser Flamingo when they are far away.

99. Whitefaced Duck *Dendrocygna viduata*
Common resident of the Zambezi floodplain. During the 1995, 1996 and 1997 aerial surveys, 57, 400 and 58 birds, respectively, were counted on the floodplain (Beilfuss & Bento 1997). Usually they are associated with small floodplain lagoons together with Fulvous Duck and Spurwinged Goose. Hundreds of Whiteface Duck were counted during the boat survey along the Zambezi River from Marromeu to Chinde in July 1999. The flocks range from 20 to 60 birds. More birds were recorded on the floodplain behind the mangroves (Bento 1999).

100. Fulvous Duck *Dendrocygna bicolor*
Common resident in the delta. During the 1995, 1996 and 1997 aerial surveys, 4, 15 and 230 birds, respectively, were counted on the floodplain (Beilfuss & Bento 1997). These numbers might be underestimated owing to difficulties in differentiating this species from Whitefaced Duck.

101. Whitebacked Duck *Thalassornis leuconotus*
Uncommon resident in the small lagoons protected by mangroves on the way to Pambane (Chinde). Six dispersed pairs were recorded feeding during the ground survey.

102. Egyptian Goose *Alopochen aegyptiacus*
Common and resident in the small lagoons on the Zambezi floodplains. During the aerial surveys only one individual was recorded due to difficulties in identifying the bird from the air. During the Marromeu-Chinde boat survey a group of 11 birds were recorded crossing the main river channel from the south to north banks.

108. Redbilled Teal *Anas erythrorhyncha*
Two birds were recorded during the November 1997 aerial survey. It is probable that the population was underestimated owing to difficulties in distinguishing the bird from the air. Three pairs were counted in Pembane (Chinde) along the small lagoons behind the mangroves.

113. Southern Pochard *Netta erythrophthalma*
Two pairs of this birds were observed diving in small lagoon on the Coutada 11 floodplain during the 1999 ground survey.

114. Pygmy Goose *Nettapus auritus*
It is a common and resident bird in the Zambezi Delta. Was only recorded from the ground survey in small floodplains lagoons and lagoons behind the Mangroves in Chinde. A total of 30 birds were recorded, usually in small flocks ranges from 2 to 4 birds (always in pairs). This species belongs to South African Red Data Book and is considered a Rare species (Brook 1984).

115. Knobbilled Duck *Sarkidiornis melanotos*
A common waterbird in the delta, nevertherless it disappears in certain seasons. During the aerial surveys 7 birds were counted in March 1995, and 3 in May 1997 (Beilfuss & Allan 1996).

116. Spurwinged Goose *Plectropterus gambensis*
A common and resident on the Zambezi floodplains including the riverine areas along the Zambezi River. During the aerial surveys made over the Marromeu Complex in 1995, 1996 and 1997, 101, 14 and 172 birds, respectively, were observed. Along the Zambezi sandbanks flocks ranging from 10-50 were observed.

146. Bateleur *Terathopius ecaudatus*
Common and resident on the Zambezi floodplain. Feeds on catfish in almost dry small lagoons. During the ground survey 15 birds were counted in Coutada 10. This species is listed in the South African Red Data Book as Vulnerable (Brook 1984).

147. Palmnut Vulture *Gypohierax angolensis*
Common on the floodplain boundary. A flock of 11 birds were recorded on palm trees in Coutada 10 during the ground survey. This species is listed in the South African Red Data Book as Rare (Brook 1984).

148. African Fish Eagle *Haliaeetus vocifer*
Common in the delta, particularly on the floodplain and by large lagoons where trees are available to perch on. In the coastal areas (Chinde) they are also common and perch on the mangroves. On large highly productive lakes in coutadas 11 and 10, more then two pairs of African Fish Eagle were counted.

165. African Marsh Harrier *Circus ranivorus*
Common resident usually observed on the floodplain. During the ground survey 17 birds were counted within a range of 4 km on the Coutada 11 floodplain.

207. Wattled Crane *Bugeranus carunculatus*
Common and resident on the Zambezi floodplain. During the 1995, 1996 and 1997 aerial surveys, 156, 60 and 179 birds, respectively, were recorded (Beilfuss & Allan 1998). Usually they are seen in pairs, or pair with a chick during the breeding season. This species is sensitive to human disturbance and its presence is used by the Maputo Museum and International Crane Foundation as an indicator for habitat changes in the delta. This species is listed in South African Red Data Book as Endangered (Brook 1984).

209. Crowned Crane *Balearica regulorum*
Common and resident on the Zambezi floodplain, normally on dry grassland. Usually they occur in pairs and are very territorial. During aerial surveys 25, 44 and 50 birds were counted in 1995, 1996 and 1997, respectively.

210. African Rail *Rallus caerulescens*
Common resident on medium and large lagoons in the woodland area and floodplains of the delta. During the ground survey 13 birds were counted, but the population is underestimated because the species is often hidden. They were more often heard than seen.

213. Black Crake *Amaurornis flavirostris*
Common resident on medium and large lagoons in the woodland area and on floodplains. The best time to count them was early in the morning before sunrise. During the ground survey 105 birds were counted in two lagoons in Coutada 11.

240. African Jacana *Actophilornis africanus*
Common resident in the lagoons and pans of the Zambezi floodplain. None of these birds were counted from the air during the aerial survey owing to their small size. From the ground a total of 1000 birds were counted in Coutadas 10 and 11.

241. Lesser Jacana *Microparra capensis*
The Lesser Jacana is common in areas where there is a less human disturbance, including fishing. On the floodplain 35 birds were counted, although this number might be an underestimate owing to its small size This species is listed in the South African Red Data Book as Rare (Brook 1984).

246. Whitefronted Plover *Charadrius marginatus*
Common resident in the coastal area on sand along the inter-tidal zones. In Chinde we counted 175 birds in 1998, and 670 birds in 1999. Usually they are in flocks of up to 7 but less than 30 individuals. They are gregarious at high tide and the flock size ranges from 100-250.

249. Threebanded Plover *Charadrius tricollaris*
Common resident in the coastal areas, with a few records on ponds on the floodplain. During the ground survey at Chinde, 23 birds were counted at low tide. The numbers are probably an underestimate.

254. Grey Plover *Pluvialis squatarola*
Common non-breeding Palaearctic migrant species. More then 350 birds were counted at Chinde from Pembane to Villa do Chinde. They are widespread in the inter-tidal area during low tide.

258. Blacksmith Plover *Vanellus armatus*
Common resident on small ponds in the floodplain. Usually in pairs or small flocks ranging from 3 to 5 birds. Also seen in burned grassland.

259. Whitecrowned Plover *Vanellus albiceps*
This species is associated with the larger river floodplains. On the road along the Zambezi towards Malingapanse 12 birds were recorded, and 25 on the Coutada 11 floodplain. This species is listed in the South African Red Data Book as Rare (Brook 1984).

260. Wattled Plover *Vanellus senegallus*
Common resident on the Zambezi floodplain. More then 70 birds were recorded during the ground survey on the coutada 10 and 11 floodplain. During the 1997 aerial survey 13 birds were counted.

261. Longtoed Plover *Vanellus crassirostris*
Common resident of the Zambezi floodplain. During the ground survey 6 pairs were counted and one pair in the lake near the Mungari Camp. During the 1995, 1996 and 1997 aerial surveys, 21, 3 and 4 birds were counted.

264. Common Sandpiper *Actitis hypoleucos*
Common non-breeding Palaearctic migrant. Solitary individuals were recorded along the Zambezi and streams in the floodplain and pans. Total count during the ground survey was 75 birds.

270. Greenshank *Tringa nebularia*
Common non-breeding Palaearctic migrant. Usually seen in the inter-tidal area in Chinde and sometimes in the estuary along branches of the Zambezi. In Chinde 560 birds were counted.

272. Curlew Sandpiper *Calidris ferruginea*
Common non-breeding Palaearctic migrant. Mainly occurs on mudflats. In Chinde 1050 birds were counted. Usually they feed in flocks ranging from 15 to 50 mixed with Sanderlings.

281. Sanderling *Calidris alba*
Common non-breeding Palaearctic migrant, observed in the inter-tidal area. A flock of 750 birds were counted in Chinde during high tide.

290. Whimbrel *Numenius phaeopus*
Common non-breeding Palaearctic migrant. The numbers are very high during the summer in the inter-tidal area and on muddy flats in mangroves. More then 900 birds were recorded in the coastal area of Chinde. Few birds overwinter in the delta in flocks ranging from 5 to 7 birds.

295. Blackwinged Stilt *Himantopus himantopus*
Common resident and breeds on the Zambezi floodplains. Flocks range from 2 to 6 birds. During the aerial survey in 1997 four birds were recorded from the air.

298. Water Dikkop *Burhinus vermiculatus*
Common resident in the delta, particularly along the small meanders in the mangrove. During the night we heard calling from the pans. Up to 25 birds were recorded by walking along the river edge to the mangroves in Pambane. A few birds were noted doing the short flight to the grassland close nearby.

304. Redwinged Pratincole *Glareola praticola*
A migrant species common at certain times of the year in the delta. During the 1998 boat survey 25 birds were counted roosting on the sandbanks along the Zambezi, while during the 1999 boat survey more then 2000 birds were observed feeding in the air along the river from the area called Bento to Luabo. This species is sensitive to water regime changes. It is listed in the South African Red Data Book as Rare (Brook 1984).

315. Greyheaded Gull *Larus cirrocephalus*
A common species especially in the coastal and estuarine area. Three birds were recorded during the aerial surveys in 1995, and 23 in 1997 (Beilfuss & Bento 1997). During the boat survey from Marromeu to Chinde up to 70 birds were counted. Usually this species is associated with fishery activities and follows fishermen's boats.

322. Caspian Tern *Hydroprogne caspia*
A flock of 13 birds was recorded in the Zambezi estuary during the inter-tidal waterbird survey along the Chinde coastline. This species is listed in the South African Red Data Book as Rare (Brook 1984).

324. Swift Tern *Sterna bergii*
Few individuals (around 10) were observed fishing along the Chinde coastline. It is considered common and resident.

332. Sooty Tern *Sterna fuscata*
Common resident in the delta coastal area. More then 10,000 birds were counted in Puga-Paga Island (Nampula-Angoche), where this species breeds. The presence of the Sooty Tern in the Zambezi Delta suggests that the species moves south after the breeding season.

338. Whiskered Tern *Chlidonias hybridus*
Common along the coastline of the Zambezi Delta. This species is nomadic and moves according to rainfall (Maclean 1993). A few flocks ranging from 5 to 7 birds were recorded on the floodplain along the Zambezi.

343. African Skimmer *Rynchops flavirostris*
Common intra-African migrant bird along the Zambezi and Pungue rivers. During aerial surveys 10 birds were counted in 1997, but none were seen during the boat surveys from Marromeu to Chinde. In South Africa this bird is considered Threatened.

428. Pied Kingfisher *Ceryle rudis*
Common resident all over the Zambezi Delta. During the boat survey from Marromeu to Chinde 55 birds were recorded. From the ground survey in coutadas 10 and 11, 17 birds were recorded. Two birds were counted from the air in 1997. They usually breed along the Zambezi.

429. Giant Kingfisher *Megaceryle maxima*
During the whole trip by boat (October 1998) from Marromeu to Chinde only 3 birds were counted. In following year, on the similar boat survey (July 1999), none were recorded.

431. Malachite Kingfisher *Alcedo cristata*
A total of 12 birds were recorded during the ground survey in coutadas 10 and 11 on floodplain ponds and small streams.

434. Mangrove Kingfisher *Halcyon senegaloides*
Common resident and breeds in the delta mangroves. During the ground survey (October 1998) 100 birds were counted at Chinde. This species is listed in the South African Red Data Book as Vulnerable (Brook 1984).

5. STATUS OF WATERBIRDS IN THE ZAMBEZI DELTA

A total of 73 species of waterbirds were observed during the aerial and ground surveys (Table 2). The aerial survey counts in March 1995 gave 33 waterbird species totalling approximately 5905 individuals. Counts of July 1996 gave 4399 individuals of 25 waterbird species, and 14,960 individuals of 42 waterbird species in May 1997. Aerial counts in 1998 and 1999 focused on accurate counts of the species of international concern and did not record total counts for the more abundant species such as egrets and herons.

The combined surveys reveal that the Zambezi Delta supports numerous Vulnerable and Threatened species of Global Concern, including the Wattled Crane, Grey Crowned Crane, African Skimmer (*Rynchops flavirostris*), White Pelican, Pinkbacked Pelican, Woolynecked Stork (*Ciconia episcopus)*, Openbilled Stork (*Anastomus lamelligerus)*, Saddlebilled Stork, Yellowbellied Stork (*Mycteria ibis)*, Black Stork (*Ciconia nigra)*, Redwinged Pratincole (*Glareola pratincola)* and Caspian Tern (*Sterna caspia).* The delta supports colonies of thousands of pairs of White Pelicans among the coastal mangroves in the southeastern Marromeu Complex, one of the largest breeding colonies recorded in Southern Africa (Goodman 1992a, Beilfuss & Allan 1996). Three immense breeding colonies of storks and herons were also observed during the wet season surveys on the central Marromeu floodplains. The largest colony supports hundreds of pairs of Openbilled Stork, Yellowbellied Stork, Sacred Ibis (*Threskiornis aethiopicus*), African Spoonbill (*Platalea alba*) and three species of egrets (*Egretta* spp). Large breeding colonies of Reed Cormorant (*Phalacrocorax africanus)*, Squacco Heron (*Ardeola ralloides)*, Grey Heron (*Ardea cinerea)* and Blackheaded Heron (*Ardea melanocephala)* were also recorded (Beilfuss & Bento 1997). Large groups of migrant Abdim's Storks (*Ciconia abdimii*) utilize the delta grasslands in the wet season.

During the boat surveys from Marromeu to Chinde, thousands of Openbilled Stork (in groups ranging from 200-1000 individuals) were recorded in association with Glossy Ibis (*Plegadis falcinellus*) and Sacred Ibis on small sandbank islands along the main channel of the Zambezi. Large numbers of Reed Cormorants, African Darters (*Anhinga melanogaster*), Lesser Flamingoes (*Phoenicopterus minor*), Goliath Herons (*Ardea goliath*), Purple Herons (*Ardea purpurea*), African Spoonbills, White Pelicans, Pinkbacked Pelicans, Spur Winged Geese (*Plectropterus gambensis*), Sandwich Terns (*Sterna sandvicensis*) and Redwinged Pratincoles were observed. Many of these species were under-represented in the aerial surveys because of their small size or similarity to other species (for example, the comparison of aerial and boat surveys of Lake Urema, Gorongosa National Park in Beilfuss *et al.* 1998). This is especially true for several duck species, including Whitefaced Ducks (*Dendrocygna viduata*) and Fulvous Ducks (*D. bicolor*), that typically did not flush during aerial surveys and could not be accurately counted.

Whimbrels (*Numenius phaeopus*), Greenshank (*Tringa nebularia*), Grey Plovers (*Pluvialis squatarola*), Curlew Sandpipers (*Calidris ferruginea*), Sanderlings (*C. alba*) and other migratory shorebirds were common on the coast near Chinde. A large flock of Lesser Flamingos was also observed. Whitebreasted Cormorants (*Phalacrocorax carbo*), Mangrove Kingfishers (*Halcyon senegaloides*) and Pygmy Kingfishers (*Ispidina picta*) were widespread in the coastal mangroves.

6. IMPACT OF WATER RESOURCES DEVELOPMENT ON THE ZAMBEZI DELTA

Over the past half-century, water resources development projects have greatly altered the hydrology of the Zambezi Delta. Prior to the construction of Kariba Dam on the Middle Zambezi River, peak floods inundated a mosaic of habitats in the 18,000 km^2 Zambezi Delta – flooding an area at times comparable in size to the Okavango Delta in Botswana (White 1993, Coppinger & Williams 1994). Maximum flow in the Lower Zambezi occurred in March-April, several months after maximum precipitation in the Upper and Middle Zambezi Basin. Low-lying floodplains were inundated with floodwaters for up to nine months of the year, and many areas were saturated throughout the dry season (SWECO 1983). With the closing of Kariba, the third largest dam in Africa, in 1959, approximately 54% of the total Zambezi runoff became regulated. The vast Lake Kariba reservoir now captures the transient minor flood (known locally as "gumbura") generated by local rainfall in the Middle Zambezi catchment, and effectively reduces and regularizes the major annual inundation ("murorwe") from the Upper Zambezi catchment area (Davies 1986). These hydrological impacts are further exacerbated by the damming of the Kafue River, the most important Zambezi tributary below Kariba Dam. More than 90% of the total Zambezi catchment runoff is now controlled by Kariba and Itezhi Tezhi Dams (RPT 1979, SWECO 1983).

Appendix 5.3 Table 2 Waterbird species numbers observed in the Zambezi Delta (categories Common and Uncommon follow Maclean 1993).

	no. species
Total waterbird species observed	73
Common species	45
Uncommon species	8
Rare species	20
Breeding species (confirmed)	28
South Africa Red Data Book species	17
Endangered species, breeding (confirmed)	11
Non-breeding palaearctic species	7

Despite these changes in the Zambezi's hydrological regime, the sheer volume of floodwaters reaching the Lower Zambezi continued to seasonally inundate the floodplains of the delta until the construction of the massive Cabora Bassa dam in 1975. With the closing of Cabora Bassa, the last vestiges of the ancient floodcycles of the Zambezi River have been nearly eliminated. Only four significant tributaries enter the Zambezi below Cabora Bassa dam, and of those, only the Shire River is perennial. Flooding events in the Zambezi Delta, when they occur, are now dependent upon local rainfall within the Lower Zambezi sub-catchment, or unplanned (possibly catastrophic) water releases from Kariba Dam (RPT 1979). The timing, magnitude, duration and sediment deposition of these floods now differ greatly from natural flooding conditions (Suschka & Napika 1990, Beilfuss & Davies 1999).

These hydrological changes are further exacerbated by the construction of dykes along the Lower Zambezi to protect the Sena Sugar plantations at Marromeu and Luabo. Dykes were set at the elevation of the 1924 flood peak and prevent floods of less than 12,000 m^3/s from inundating the Marromeu floodplains (Bolton

1983). Prior to that time, floods of 5000 m^3/s or more inundated the Marromeu Complex on an annual basis (RPT 1979). The railway line constructed between Marromeu to Inhaminga, and the road between Marromeu and Chupanga further impede drainage through several important distributor channels in the northwestern portion of the delta or Solane depression. The cumulative impact of these developments is a dramatic reduction in flooding on the south bank of the Zambezi during moderate flood years. The north bank sector of the delta has also undergone considerable drying since the 1960s, and is much drier than the south bank sector (Tinley 1994).

Over the past 23 years, overbank flooding of the Zambezi Delta has occurred only a few times, and the western portion of the Marromeu Complex is now fed primarily by silt-free runoff from local rainfall on the Cheringoma Plateau. Anderson *et al.* (1990) observed that the complex is much drier at the end of the dry season than under natural conditions, with a reduction in wetland and open water areas, infestation of stagnant waterways with exotic vegetation, and intrusion of saltwater. Beilfuss & Allan (1996) observed the Lower Zambezi River more than 2 m below bankful discharge in the delta during the period when peak floods historically occurred. The desiccation of the floodplain opened the area to aggressive poaching of wildlife species with a more than 90% reduction in buffalo, zebra, waterbuck, reedbuck, hippo and other important grazing species (Anderson *et al.* 1990). Grassland fires now consume more than 90% of the Zambezi Delta grasslands during the dry season.

Prior to the closing of Cabora Bassa dam, Tinley (1975) and Davies *et al.* (1975) predicted that the hydrological changes imposed by the dam would result in reduced fisheries productivity, reduced silt deposition and nutrient availability, salt water intrusion, replacement of wetland vegetation by dryland species, failure of vegetation to recover from grazing, and disrupted or mis-timed reproductive patterns for wildlife species. A few years later, Bernacsek and Lopez (1984) lamented:

> “It is clear that in the case of Cahora Bassa there was no serious attempt to ecologically optimize the dam prior to construction... furthermore, after dam closure, proposals put forward by the ecological assessment team were not implemented and there has been no regular monitoring of the dam’s downstream effects during its lifespan. As a result, Cahora Bassa has the dubious distinction of being the least studied and possibly least environmentally acceptable major dam project in Africa.”

In recent years, several studies have been initiated to assess aspects of these potential changes on the ecology of the Zambezi Delta (e.g. GERFFA's Gorongosa-Marromeu Mountain to Mangrove Project, GEMA's Mangrove Assessment Project and the International Crane Foundation–Museu de Historia Natural Zambezi Delta restoration project). Among the most significant and obvious changes observed over the past 40 years are the mass invasion of young *Borassus* palms into the open grassy floodplain, and the invasion of *Acacia* woodland into the older palm savanna associations. These changes are quantified elsewhere (Beilfuss, Vol 3 Chapter 13 of this report), and clearly have important implications for the waterbirds of the Zambezi Delta.

7. IMPACT OF HYDROLOGICAL AND ECOLOGICAL CHANGES ON WATERBIRDS

Although we lack historical data on the abundance and distribution of most waterbirds in the Zambezi Delta, it is clear that water resources development on the Zambezi River is resulting in widespread changes in the quantity and quality of many key waterbird habitats. These changes are especially significant for the many species that either depend on natural flooding cycles to meet their reproductive requirements (e.g. Wattled Cranes), depend on natural low flow periods in the Zambezi River for breeding (e.g. African Skimmer) or feeding (e.g. Openbilled Stork), or depend on the annual recruitment of fish prey in the delta floodplains (e.g. pelicans, many storks). Case studies of these species are presented below.

If present trends continue, species requiring vast expanses of open floodplain, seasonally flooded marshland or brackish mangrove are also vulnerable to the further dessication of the delta. At present, very few waterbird species occur in the northwestern portion of the south bank of the delta where the combined effects of dams and dykes are most marked. There are also very few waterbirds in the drier north bank portion of the

Zambezi Delta. The great majority of waterbirds are clumped in the southeast corner of the Delta where seasonal runoff from the Cheringoma escarpment still inundates the floodplains on an annual basis. There is very limited waterbird utilization of the active and abandoned agricultural and livestock grazing fields around Marromeu and Luabo villages. This may be due, in part, to local hunting pressures.

These changes to important waterbird habitats are exacerbated by other ecological changes in the delta, particularly the decrease in grazing species (e.g. buffalo, waterbuck, zebra) and wallowing species (e.g. hippo), and the increased frequency of grassland fires. Further expansion of the Sena Sugar Estates into reclaimed wetland areas also threatens disturbance-sensitive waterbird species.

8. SPECIES OF SPECIAL CONCERN

8.1 Wattled Crane

The Wattled Crane (*Bugeranus carunculatus*) is a Globally Endangered resident of sub-Saharan Africa, with a total population estimated at no more than 13,000-15,000 birds (Urban 1996). The vast majority (more than 95%) of the population occurs in south-central Africa in the floodplains and dambos of the Zambezi, Lower Zaire and Okavango River basins.

Goodman (1992b) estimated there were 2570 Wattled Cranes in the Marromeu floodplain during September 1990, one of the largest populations of Wattled Cranes ever reported. The birds were observed in pairs across the floodplain, although family groups were not reported. Repeating these survey routes during March 1995, we observed 156 Wattled Cranes in the Marromeu floodplain, including 58 pairs (74%) on territories. Only two observations were made of Wattled Cranes on nests, and no juveniles were observed in the population. Surveys during the normal time of peak Wattled Crane breeding yielded similar results. We observed 20 pairs and no juveniles in July 1996 and (with an expanded survey) 60 pairs and no juveniles in May 1997. Winter surveys in 1998 and 1999 revealed numerous pairs of Wattled Cranes with chicks in the southwest corner of the delta near the Cheringoma Plateau, and very few Wattled Cranes and no chicks in the core Marromeu floodplains affected by Zambezi flooding. Large non-breeding flocks were also observed in the southwestern coastal floodplains of the Marromeu Complex. Later in 1999 20 pairs of Wattled Cranes with nearly full-grown chicks were seen in this area. Although cranes are present in large numbers, repeated surveys have yielded no evidence of breeding success in the Wattled Crane population of the Zambezi floodplains. Only where natural hydrological conditions are maintained by Cheringoma runoff are the cranes successfully breeding.

In undisturbed floodplain systems elsewhere in Africa, the breeding cycle of Wattled Cranes is intimately linked to the natural flood cycles of rivers. Wattled Crane pairs are “triggered” to nest as floodwaters begin receding after peak flooding. Nesting in deep, open water after the major flood peaks ensures that nests will be protected from predators and wildfires but will not be drowned by further rising floodwaters. As floodwaters slowly recede, Wattled Cranes raise their single chick on the pulse of exposed plant and insect life (Konrad 1981).

With the present erratic and mis-timed flooding of the Lower Zambezi system, Wattled Crane pairs may not be induced to initiate nesting. Where nesting is attempted, unanticipated water level rises can drown nests and food sources. Rapid water level drawdown in the floodplains may expose nests to wildfires and predators and limit food availability. Observations from other disturbed systems support this explanation. On the Kafue Flats, Douthwaite (1974) observed that whereas 40% of Wattled Crane pairs attempt to breed in a year of normal flooding conditions, only 3% of all pairs breed in a year of negligible flooding conditions due to drought. When the hydrological regime of the Kafue Flats was altered by the Itezhi Tezhi Dam, Konrad (1981) predicted a dramatic reduction in Wattled Crane nesting sites and feeding area. Dodman (1996) observed limited breeding activity on the Kafue Flats in 1992 (a drought year) and 1993 (normal precipitation year). Based on these and other observations, and on our findings in the Lower Zambezi system, we anticipate a significant decline in the ageing Wattled Crane population of the Marromeu Complex unless hydrological conditions in the Lower Zambezi system are improved.

8.2 **African Skimmer**

The African Skimmer (*Rhynchops flavirostris*), now extinct in South Africa and restricted to a few river basins in southern Africa, occurs in small numbers in the Lower Zambezi. Two small flocks totalling 10 Skimmers were observed over Marromeu during aerial surveys in 1997, but no individuals were seen during boat surveys of the Lower Zambezi during 1998 and 1999. A census of the Upper and Middle Zambezi River yielded only 1428 birds. The global population is estimated at less than 10,000 birds (Zusi 1996).

The survival of the African Skimmer depends in large part on the rise and fall of water levels in large rivers such as the Zambezi (Coppinger *et al.* 1988). In large, unregulated rivers, water levels rise many metres during floodstage, conveying heavy loads of suspended silt from upstream. As floodwaters recede, the silt is deposited and sandbars are formed. African Skimmers nest and roost on these exposed, open sandbars. At present the sediment load of the Zambezi is trapped by Kariba and Cabora Bassa dams, and floodwaters in the delta are primarily derived from the silt-free rainfall runoff from the Cheringoma Plateau (Davies 1986). The sandbars used as nest sites for Skimmers and other species are no longer deposited downstream. Over time, older sandbars may become vegetated and abandoned by nesting waterbirds (Dennis & Tarboton 1993).

In the Middle Zambezi, this loss of sandbar habitat is exacerbated by unseasonable water releases from Lake Kariba. When water is released during the dry season, a metre high wave surges downstream, sweeping away nests of any birds using the low islands (Coppinger *et al*. 1988). In the Lower Zambezi, erratic water releases from Cabora Bassa are probably affecting populations in the Marromeu Complex as well. There were no observations of Skimmer nesting activity during dry season surveys. In addition, proposed dam development on the Pungwe River threatens the only other population of African Skimmers in Mozambique.

The African Skimmer, with its strong dependence on the ebb and flow of the Zambezi and its sediments, is an excellent indicator for the myriad of species that depend on the natural hydrological fluctuations of the Zambezi. The Redwinged Pratincole, with similar habitat requirements, is probably also threatened by river management.

8.3 **Openbilled Stork**

Openbilled Storks (*Anastomus lamelligerus*) concentrate in large numbers to feed on freshwater snails and mussels on the exposed sandbars of the Lower Zambezi during the dry season (Beilfuss & Bento 1997), and feed in shallow freshwater lakes in the coastal mangrove zone during the wet season. Regulation of the river has reduced flood peaks and increased dry season flows, resulting in fewer seasonally exposed sandbars and more permanently vegetated sandbar islands. At present, Openbilled Storks appear to be thriving in the Lower Zambezi system relative to other wetland areas in Africa (Dodman *et al.* 1998). However, further attempts to stabilize the Zambezi flow regime will greatly diminish the availability of sandbar habitats and threaten one of the largest populations of Openbilled Storks reported in Africa.

8.4 **White and Pink-backed Pelicans**

White Pelicans (*Pelecanus onocrotalus*) nest in large, conspicuous colonies in coastal mangroves and are very sensitive to disturbance (Dennis & Tarboton 1993). Floodwaters discharged from Cabora Bassa dam do not carry or deposit sufficient alluvial sediments to maintain the coastal delta in balance with the forces of coastal erosion, resulting in extensive seaward die-off of mangroves (Hughes & Hughes 1992). The shrinking density of coastal mangroves increases the susceptibility of pelicans to disturbance and will eventually force abandonment of the nesting colonies.

Dutton (pers. comm. 1999) observed large numbers of White and Pink-backed Pelicans feeding in the Zambezi Delta floodplains during the 1960s and 1970s. In recent years, pelicans have abandoned the dry floodplains of the Zambezi Delta and now feed in Lake Urema of Gorongosa National Park, although they continue to roost and breed in the coastal delta.

8.5 **Other waterbird species**

The fates of other waterbird species in the Marromeu Complex are also linked to hydrological changes in the Lower Zambezi. These impacts of these changes include the degradation of breeding habitats for some species and the impoverishment of feeding grounds for others. As with pelicans, Saddlebilled Storks (*Ephippiorhynchus senegalensis*), Goliath Herons (*Ardea goliath*) and many other piscivorus waterbird species depend on concentrations of laterally migrating fish that are trapped in shallow floodplain depressions as floodwaters recede. Saddlebilled Storks nest at the end of the wet season, and fledge their chicks during the dry season when food is concentrated and easy to obtain (Hancock *et al.* 1992). Goliath Herons feed on large fish in lake edges and shallow waterbodies of the floodplain (Hancock & Kushlan 1984). Such species are now unable to utilize the vast areas of the Marromeu Complex that no longer receive overbank flooding sufficient for fish to migrate to floodplain spawning grounds from the main channel.

9. INDIRECT IMPACTS ON WATERBIRD SPECIES

In addition to changes in the quality and quantity of waterbird habitat, hydrological changes in the Zambezi system have also contributed to the decrease in grazing and wallowing mammals, and the increase in hot dry season fires across the delta. The dramatic decrease in the previously widespread buffalo, zebra, waterbuck and other grazing species has led to greatly reduced grazing pressure on the grassy floodplains (Tinley 1969, Anderson *et al.* 1990). Many species of waterbirds feed preferentially in recently grazed floodplains, and are unable to utilize the rank grasslands of large portions of the delta that remain ungrazed during the dry season. Wattled Cranes, for example, are closely associated with areas grazed heavily by lechwe in the Kafue Flats and Bangweulu Basin in Zambia (Konrad 1981, Kamweneshe 1996). Similarly, several species of ducks feed on waste seed and rhizomes in heavily grazed areas. The near elimination of hippo from the Zambezi Delta has also resulted in a loss of open water habitat maintained by wallowing activity. In the 1960s and 1970s, hippo were vital in maintaining open water conditions in many of the small distributor channels of the delta (Tinley 1977). These channels have been subsequently choked with floating and emergent vegetation, and no longer provide open water habitat for piscivorus birds. The desiccation of the delta has also resulted in increased fire frequency during the dry season. The traditional mosaic pattern of burned dry areas and unburned wet areas has given way to extensive fires across the grasslands (Anderson *et al.* 1990) which threaten grassland birds that nest in the standing vegetation (e.g. egrets, reed cormorants). The reduction in above-ground biomass resulting from widespread fires, however, may perhaps offset some of the waterbird habitat losses caused by low grazing pressure. There is no data available to quantify the impact of these indirect effects on waterbird diversity and abundance in the Zambezi Delta.

10. THE RAMSAR CONVENTION

The Convention on Wetlands of International Importance Especially as Waterfowl Habitat, known as the Ramsar Convention, was adopted in 1971. This convention provides a framework for international cooperation in the conservation of wetlands and the communities that serve, in part, as waterbird habitat. Nations that ratify the Convention agree to designate at least one wetland for inclusion in the List of Wetlands of International Importance, to promote the wise use of all wetlands and their resources, to stem the loss of wetlands where possible, and to promote the training of personnel in wetland management. The Ramsar Convention defines the wise use of wetlands as "sustainable utilization for the benefit of mankind in a way compatible with the maintenance of the natural properties of the ecosystem" (David 1993).

Wetlands are selected as Wetlands of International Importance on the basis of sound ecological, botanical, zoological, limnological and hydrological criteria. There are currently 893 wetlands in 104 nations worldwide on the list, with a total area of over 66.8 million ha (Dwight Peck, pers. comm. 1998). In Africa, 25 nations have ratified the Convention, including Zambia, Botswana, Tanzania, Malawi and South Africa. Within the Zambezi catchment, only the Okavango Delta and the Kafue Flats are designated Wetlands of International Importance.

The Zambezi Delta easily meets the criteria as a Wetland of International Importance under the Ramsar Convention. It supports at least 17 species of global concern, including the endangered Wattled Crane, endangered African Skimmer, White Pelican, Pinkbacked Pelican, Woolynecked Stork, Openbilled Stork, Sanddlebilled Stork, Yellowbellied Stork, Black Stork, Redwinged Pratincole and Caspian Tern. Eleven of the endangered species breed in the delta (Table 1). The delta also supports Globally Important breeding colonies of resident pelicans, storks, herons and egrets, and provides summer feeding grounds for palaearctic migrant shorebirds and the inter-African migrant Abdim's Stork. At least seven palaearctic species and 28 breeding species have been recorded (Table 1), while other breeding species are still to be confirmed.

From among the many coastal wetlands of Mozambique, the Zambezi Delta is of the highest ecological value. The Inkomati, Limpopo, Sabie and Pungwe coastal floodplains are all vitally important for ducks and other waterbirds in Mozambique, but the size and diversity of the Zambezi Delta is unparalleled. It is an excellent example of the wetlands characteristic of the coastal zone of Mozambique, and it is part of a complex of high quality wetland habitats ranging from floodplain grasslands and papyrus swamps to mangrove estuaries. The Zambezi Delta has a substantial hydrological, biological and ecological role in the functioning of the Zambezi Basin and coastal system, and is a wetland of great socio-economic and cultural value. It is also part of the extensive Sofala Bank system, the most important prawn fishery in Mozambique. The fisheries sector contributes significantly to Mozambique's economy, accounting for 40% of GNP and US$55.4 million in revenue from the prawn fishery alone in 1996 (MICOA 1998).

The nomination of Marromeu as a Wetland of International Importance creates new opportunities for international awareness and ecotourism development, particularly in conjunction with ongoing efforts to link management and sustainable utilization of the Marromeu area with Gorongosa National Park to create an immense protected area system (DNFFB 1994). It creates a conservation network linking the Zambezi Delta with other major wetlands of the Middle and Upper Zambezi system, including the Okavango Delta and Kafue Flats and enables Mozambican resource managers to gain better access to training in wetland management and monitoring and funding for research.

11. CONCLUSIONS

The Zambezi Delta supports 73 species of waterbird, including numerous Vulnerable and Threatened species of Global Concern, large breeding colonies of several waterbird species, and numerous palaearctic and intra-African migrant species. There are 17 species that are considered Endangered in South Africa and 11 of them breed in the delta.

Total waterbird numbers in the Zambezi Delta have probably undergone a significant decrease over the past 30 years due to changes in the hydrological regime of the Zambezi River. Widespread changes in the quality and quality of waterbird habitat have been observed. The breeding success of endangered Wattled Cranes, an indicator species for natural flooding conditions, is very low in the Zambezi Delta relative to other floodplain wetlands in Africa. Piscivorus waterbirds such as pelicans and storks occur in very low numbers in the floodplains most affected by water resources development.

The Zambezi Delta qualifies as a Wetland of International Importance under the Ramsar Convention, and is of great socio-economic and cultural value to Mozambique.

12. SURVEY CONSTRAINTS

Because of the inaccessibility of the core swamp grassland areas of the Marromeu Buffalo Reserve, ground surveys were limited to the surrounding coutadas (10, 11 and 14), the riverine corridor from Marromeu to Malingapansi, and the coastline at Chinde. We were unable to gain access on foot to shallow marsh areas in the Delta to flush and expose species such as bitterns, small herons, rails, crakes and flufftails, many of which are of critical conservation concern. However, observations in wetland pans of the miombo woodland adjacent to the Zambezi Delta revealed Africa Rail (*Rallus caerulescens*), Lesser Jacana (*Micropara capensis*) and Black Crake (*Amaurornis flavirostris*), suggesting that these species are likely to be present in the shallow depression wetlands of the delta as well.

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Appendix 6.3, Table 2 : Reptiles that have or may yet be discovered in the Zambezi Delta region, but which were not confirmed during the field survey.

Species	Scientific Name	Locality
Terrapins (4 species)		
Marsh terrapin	*Pelomedusa subrufa*	Quelimane
Pan hinged terrapin	*Pelusios subniger*	
Serrated hinged terrapin	*Pelusios sinuatus*	
Zambezi soft-shelled terrapin	*Cycloderma frenatum*	
Snakes (19 species)		
Pungwe thread snake	*Leptotyphlops pungweensis*	Pungwe Flats
Eyebrow viper	*Proatheris superciliaris*	Beira
Snouted night adder	*Causus defilippii*	
Black mamba	*Dendroaspis polylepis*	Mossuril
Boulenger's garter snake	*Elapsoidea boulengeri*	
Cape centipede eater	*Aparallactus capensis*	Angoche
Floodplain water snake	*Lycodonomorphus obscuriventris*	Charre
Dwarf wolf snake	*Lycophidion nanum*	Chitengo, Gorongoza Nat. Park
Snouted wolf snake	*Lycophidion acutirostris*	Lumbo
Cape file snake	*Mehelya capensis*	
Semiornate snake	*Meizodon semiornatus*	
Angola green snake	*Philothamnus angolensis*	Moebase, Shire Valley
Natal green snake	*Philothamnus natalensis*	Beira
Dwarf sand snake	*Psammophis angolensis*	
Eastern stripe-bellied sand snake	*Psammophis orientalis*	
Marbled tree snake	*Dipsadoboa aulica*	Chinde
Eastern tiger snake	*Telecopus semmiannulatus*	
Common eggeater	*Dasypeltis scabra*	
Eastern eggeater	*Dasypeltis medici*	Ribaue
Olive marsh snake	*Natriciteres olivacea*	Angoche
Amphisbaenids (2 species)		
Swynnerton's worm lizard	*Chirindia swynnertoni*	Pungwe Flats
Pestle-tailed worm lizard	*Dalophia pistillum*	Beira
Lizards (7 species)		
Wahlberg's Snake-eyed skink	*Panaspis wahlbergi*	
Mozambique writhing skink	*Lygosoma afrum*	
Eastern Coastal skink	*Mabuya depressa*	Beira
Grass-top skink	*Mabuya megalura*	Chiniziua Dist.
Common rough-scaled lizard	*Ichnotropis squamulosa*	Charre
Tropical girdled lizard	*Cordylus tropidosternum*	
Rough-scaled plated lizard	*Gerrhosaurus major*	Pungwe Flats