

1. INTRODUCTION

1.1 Objectives and study focus

This report summarises activities to date of studies to determine the biodiversity status and value of designated parts of the Usangu catchment. While terms of reference varied somewhat between the different studies, the general objectives were:

- definition of current status
- evaluation of variation from expected status with an assessment of probable causes and implications for change in the wetland
- identification of rare or endangered species
- discussion of potential current and future economic values
- a prioritised evaluation of management requirements for maintaining and/or improving the current wildlife status.

Specific studies within the biodiversity assignment consisted of:

- small mammals, amphibians, and reptiles
- avian fauna
- flora

Also included here are results from other project studies on:

- large wild animals (aerial survey)
- fish

The original focus of the small mammal, amphibian, reptile, and avian fauna studies in 1999 was the eastern wetland of the study area.; in 2000 this was extended to the western wetland.. The flora and large wild animal work was more extensive, but still focused on the Usangu plain. Fish studies were obviously focused on areas with water – the rivers, perennial swamp, and seasonal swamp in the eastern wetland.

1.2 Biodiversity

Biodiversity is a term which has recently gained common usage. It describes the entire variety of living organisms--from microbes and fungi to plants and animals. It is essentially a shortened form of "biological diversity".

In the past, such a term might have been thought of interest only to biologists, but it has been realised that the entire world as we know it depends, in one way or another, on the continued existence of many species of plants and animals and their complex inter-relationships. In addition, because many plants and animals are used in the pharmaceutical and other industries, the potential for profiting from their exploitation is high, and issues such as biotechnology and intellectual property rights are also biodiversity issues.

Furthermore, in much of the world, especially the tropics, people depend directly on these organisms for their daily existence. Thus, conserving biodiversity, seeing to it that species are used in a sustainable manner, has become an important global focus. The sense of urgency and importance of conserving biodiversity is most evident by the participation of many countries, including Tanzania, in ratifying the Convention on Biological Diversity (CBD) of 1992.

Because biodiversity is such a wide topic, it is often convenient to consider it under three different subsections (Stuart et al., 1988):

- **Genetic diversity** refers to the variety of units of hereditary information, or genes. It is thus a measure of variability among and within species.
- **Species diversity** is concerned with the number of species in a particular area. Also of interest under this category is the number of endemic species, those that are found only in a particular habitat or at a particular site. Issues relating to the introduction, either purposeful or accidental, of alien species, are relevant here.
- **Ecosystem diversity** refers to the variety of habitats in which species occur. Ecosystems are defined as complex, interdependent groups of species as well as the non-biological components. Examples include forest ecosystems, grassland ecosystems and wetland ecosystems, as well as many others. Ecosystems help maintain natural cycles of water, oxygen, carbon, nitrogen and sulfur. They also contribute to the flow of energy on which all life depends.

1.3 Threats to biodiversity: the IUCN classification

As part of a general increased awareness of environmental issues on a global basis, it has long been recognised that biodiversity generally is under threat. Most threats stem directly or indirectly from human activity. A major cause of loss of biodiversity is alteration or destruction of habitat; another is the fragmentation of habitat.

Unsustainable utilisation is a further cause, especially of species of plants used for fuel and building.

In Tanzania, there exists a live-export trade for many species of birds, amphibians and reptiles, and to a smaller extent, mammals. The United Republic of Tanzania is a member of CITES, the Convention on the International Trade in Endangered Species of Fauna and Flora. Species which are regarded as threatened with extinction by such trade are placed on Appendix I of CITES, which essentially means no trade is permitted. For species on Appendix II, trade is permitted, but it must be reported and controlled.

A variety of terminologies has been used to assess the levels of threat and conservation status of species. Most recently, IUCN (1996) has developed a system which attempts to bring a more objective approach to the terms used to describe the conservation status of a species. It also tries to more clearly define the types of threats, and to provide an estimate of the time involved before severe reduction and/or extinction for a species would be expected occur. The basic system is as follows:

- *extinct* means that the last individual has died, either absolutely (*extinct*) or in the wild although the species may be preserved in captivity (*extinct in the wild*)
- *threatened* indicates that there are serious conservation concerns. The degree of threat is divided according to quantitative criteria. These include the degree of population decline in the last ten years or three generations; the area extent, fragmentation, and fluctuation in occurrence; existing population size; and probability of extinction. These provide for three sub-categories – critically endangered, endangered, and vulnerable. Details are shown in table 1.1.

- *lower risk*, meaning that they are not immediately threatened. Again there are three sub-categories:
 - *conservation dependent* – species that would be fall within the vulnerable category but for on-going conservation activities
 - *near-threatened* – other species that almost qualify for the vulnerable status but are not conservation dependent
 - *least concern* – taxa that are not in any immediate dander of extinction.

Two final categories (data deficient and not evaluated) do not reflect conservation status but the current state of knowledge and/or evaluation such that conservation status cannot be determined.

Table 1.1 Summary of new IUCN categories and criteria

Criteria	Critically endangered	Endangered	Vulnerable
A. Declining population Decline rate at least:	80% in 10 years or 3 generations	50% in 10 years or 3 generations	20% in 10 years or 3 generations
B. Small distribution and decline or fluctuation Either: extent of occurrence <i>or</i> area of occupancy <i>and</i> 2 of the following: 1. Either severely fragmented or known to exist at a number of locations 2. Continuing decline in any of the following: a) extent of occurrence b) area of occurrence c) area, extent and/or quality of habitat d) number of locations or sub-populations e) number of mature individuals 3. Fluctuating in any of the following: a) extent of occurrence b) area of occurrence c) number of locations or sub-populations d) number of mature individuals	<100 km ² < 10 km ² = 1 any rate > 1 order/mag	<5 000 km ² < 500 km ² ≤ 5 any rate > 1 order/mag	<20 000 km ² < 2 000 km ² ≤ 10 any rate > 1 order/mag
C. Small population size and decline Number of mature individuals and 1 of the following: 1. rapid rate of decline 2. continuing decline and either a) fragmented b) all individuals in a single sub-population	<250 25% in 3 years or 1 generation any rate all sub-ops of ≤ 50	< 2 500 20% in 5 years or 2 generations any rate all sub-pops ≤250	< 10 000 10% in 10 years or 3 generations any rate all sub-pops ≤1000
D. Very small or restricted Either 1. number of mature individuals, <i>or</i> 2. population is susceptible	< 50 (not applicable)	<250 (not applicable)	<1 000 area of occupancy <100 km ² or number of locations < 5
E. Quantitative analysis Indicating the probability of extinction in the wild to be at least:	50% in 10 years or 3 generations	20% in 20 years or 5 generations	10% in 100 years

1.4 Background to natural resource and biodiversity policy and management in Tanzania

1.4.1 Past approaches to conservation and management of biodiversity

Tanzania has made considerable political and financial investment in protecting and managing its natural resources, including biodiversity. About 25% of its land is under one form or another of protected category, although these vary greatly in purpose and levels of management and protection. In addition to participating in a number of continental meetings on conservation, more recently it has become a signatory to the Convention on Biological Diversity and a member of CITES, the Convention on the International Trade in Endangered Species of Fauna and Flora. In 1999 it also acceded to the 1971 RAMSAR convention for the protection of wetlands. Translating the principles of these conventions into practice on the ground has been found to be difficult, and not only in Tanzania.

As is the case for many countries, Tanzania has in the past had a highly sectoral approach to managing its natural resources, including biodiversity. This is reflected in the complexity of its legislation relating to managing and conserving natural resources. For example, fish were managed almost entirely from the point of view of the resources as food. Yet Tanzania has some of the highest levels of endemism in the world (in the great lakes) as well as very high species diversity. As a further complexity, Tanzania may be the only country in the world in which officially, sea turtles and a marine mammal, the dugong, are officially regarded as fish!

Similarly, with few exceptions, "wildlife" had historically meant large, "big game" mammals and a few birds which were hunted for sport. First efforts at "protecting" these were mainly the creation of Parks and Game Reserves which specifically excluded indigenous people who in some cases had lived there for hundreds of years. The conservation of the forest resources had a somewhat similar approach. Since its inception, the Forestry Division has been in a policy dilemma between production and protection, but priority has been on utilisation. Only relatively recently (with funding from NORAD) was a Catchment Forestry Reserve system developed and formalised..

The strongly sectoral approach may have difficulties in addressing complex biodiversity issues. For example, much of Tanzania's high species diversity and endemism among smaller vertebrates (birds, small mammals, amphibians and reptiles) and invertebrates is found within forest reserves. However, the foresters in charge have little detailed knowledge of these species or of the non-timber plants they are also charged with managing.

The Division or Department responsible for water issues may have few if any employees familiar with the ecology of natural catchment forests. Foresters may not have detailed, specific training in hydrology. Most officers in the Wildlife Division will be familiar with larger mammals, but not with the smaller forms of life, especially fish and insects, for which they are also responsible.

Issues relating to mining and mineral exploitation are especially complex; for example, in the past it was possible to obtain permission to mine within a forest reserve not from the Director of Forests, but from either a Regional government, or the Division of Mines. Yet it is the forester who is charged with maintaining the soil and vegetation cover within the reserve.

Until very recently, there has been relatively little formal stakeholder involvement or even consultation in the management of natural resources.

With regard to the conservation of the Usangu Plains, as well as other wetlands in Tanzania, there is unfortunately no Wetland Policy which would guide sustainable use and ensure protection of biodiversity values. Given this background, it is not therefore surprising that there are often gaps in basic information about the physical parameters of the Usangu area, as well as about biodiversity. It is not clear which branches of government and at what level (national, regional or local) are charged

with collecting such information -- and if they are so charged, whether such activities are specifically included in the budget.

1.4.2 Recent biodiversity policy developments

Over the past three years, the government of Tanzania has concluded a long process of reviewing and re-writing its natural resource policies (URT 1997a,b; 1998a,b,c; in draft). While in many ways these still are rather sectoral, in each there are significant major changes in approach and outlook. Overall, there is a trend towards the recognition of gender issues, and awareness of the importance of utilisation in a sustainable and economically manner, and the involvement of local communities in benefit sharing. Private sector and NGO involvement are specifically mentioned. A major change is the recognition for stakeholder involvement in the decision making process *vis a vis* resource conservation and utilisation.

With specific regard to Game Reserves for example, the Ugalla Game Reserve (Tabora and Rukwa Regions) has been selected as a pilot project and is Tanzania's only multi-use Game Reserve in which fishing and bee keeping as well as more trophy hunting, are permitted.

While it is beyond the scope of this report to review each individually, some of the major changes and trends are briefly described in box 1.1, to provide the reader with an impression of these policies.

Box 1.1: Natural resource policy changes and trends

National Environmental Policy

Lists Cross Sectoral Policies as addressing poverty, demographic dynamics, land tenure, technology, biodiversity, public participation and education, private sector and NGOs; enhanced role of women. Sectoral policies are then listed. Specifically mentions EIA policy

Wildlife policy:

Strategies: protecting biological diversity:

- continuing to maintain Protected Area (PA) network; identifying, creating and upgrading series of protected area network and important wetlands;
- establishing a new category of protected area Wildlife Management Areas for effecting community based conservation, etc.
- incorporating important wetlands into the wildlife protected area network
- surveying and acquiring land title deeds for all PAs.

Conserving and managing biodiversity:

- ensuring that wildlife conservation competes with other forms of land use
- addressing women and children issues
- solving human-wildlife conflicts

Box 1.1 (continued): Natural resource policy changes and trends**Forestry:**

Policy statement 5 includes the following objectives:

To enable sustainable management of forests on public lands, clear ownership for all forests and trees on those lands will be defined. The allocation of forests and their management responsibility to villages, private individuals or government will be promoted. Central, local and village governments may demarcate and establish new forest reserves.

and

To reduce uncontrolled use of forests, allocation of forests on public lands to villages, private individuals and government will be promoted so as to have a defined owner.

It also notes that beekeeping resource assessment will be intensified and included in management plans of forest reserves in the context of joint forest management.

“.....special provisions will be included for protection of water sources such as rivers, streams, wells and wetlands. Local community and other stakeholder involvement will be encouraged ...in the establishment and management of buffer zones as well as overall catchment forest protection through joint management agreements”.

It specifically mentions the need for biodiversity conservation.

Fisheries**Main areas of concern are:**

Improved resource management and control
 Integration of environmental protection and development
 Community Participation
 Gender and development
 Cross-sectoral collaboration
 Regional and international cooperation
 Stakeholder Participation (Private Sector, ngos)

Specific objectives include:

Protect productivity and biological diversity of aquatic ecosystems through prevention of habitat destruction, pollution and over exploitation

Promote sound utilisation of the ecological capacity of water-based areas as a means of generating income and diet..

Improve involvement of the fisher communities in the planning development and management of fishery resources;

Incorporate gender perspective in the sector

Strengthen collaboration on cross-sectoral issues between fisheries and other sectors

To strengthen regional and international collaboration in the sustainable exploitation, management and conservation of resources in shared water bodies.

2. VEGETATION

2.1 Introduction

The vegetation of the Usangu plains is among the southernmost portions of the Somali-Maasai floristic region in Tanzania and forms the northern portion of the Zambezian floristic region (see figure 2.1). It is characterised by Acacia-Commiphora bushland and thicket mosaic, secondary Acacia wooded grassland, and semi-desert grassland.

The following main vegetative groups were recognised:

2.1.1 Swamp vegetation

The 'swamp' consists of the perennial swamp (*ihefu*). The swamp vegetation may be subdivided into:

- perennial open water dominated by water lilies
- swamps dominated by floating grasses

2.1.2 Vegetation of the lowland flood plain

Four distinct communities were recognised on the plains:

- surrounding grasslands susceptible to both seasonal flooding and rapid drying as floodwaters recede. The dominant vegetation at the margins is the grass *Echinochloa scabra* and a variety of sedges. (Referred to as black *mbuga* in the Main Report)
- wooded grassland and woodland which is seasonally inundated for much longer than the surrounding area, where *Acacia seyal* intermingles with *Acacia tortilis* on black cotton soils. The herb *Hygrophylla auriculata* is indicative of such vegetation types.
- *Acacia kirkii* bushland found in isolated areas which are not permanently inundated overlying hard pans.
- open grassland with scattered clumps of *Lannea humilis* scrub only 1-2 m tall and short tufts of *Microchloa* and *Blepharis*. Hardpan soils impede drainage and root penetration. Although trees are generally absent, the herbaceous shrub *Senna obtusifolia* is present. (Referred to as grey *mbuga* in the Main Report).

2.1.3 Woodland

Two types of woodland were recognised:

- Commiphora/Terminalia woodland with *Commiphora africana*, *Commiphora ugogensis*, *Acacia tortilis*, *Lannea humilis*, and *Terminalia* spp.
- Miombo woodland with *Brachystegia spiciformis*, *Julbernardia globiflora*, and *Pterocarpus angolensis*.

2.2 Floral affinities

As noted above, the Usangu area includes elements of both the southern Somali-Maasai and Zambesian floristic zones. A list of the plants based on the transects sampled in May and December is presented in Appendix 1, with other conspicuous species also indicated.

2.3 Endemism

No floral species encountered is known to be endemic to the Usangu plains.

2.4 Conservation status

No species meeting the IUCN categories of Rare or Endangered were identified in the Usangu area along the transects surveyed.

2.5 Threats to floral diversity

This section discusses current status of the vegetation, usage made of the vegetation, and implications for future trends in vegetation status.

2.5.1 Timber extraction

In most areas examined, the large, high-value timber trees had already been felled and the plants extracted, especially *Pterocarpus angolensis* and *Azelia quanzensis*. This removal has reportedly gone on for years, and there are very few trees of these species remaining. These hardwoods are very marketable in the nearby urban centres. Evidently no controls were in place when this extraction took place and it was done in an unsustainable manner.

2.5.2 Clearing of woodland and bushland for agriculture

Acacia/Commiphora/Lannea woodland and bushland is found on alluvial soils of low slope and is often cleared to open up new land for cultivation. Because few or no inputs are made in the form of fertilisers to increase and/or maintain soil fertility, the plots are abandoned after a few years. Colonisation by *Acacia tortilis* is frequent. While colonisation by this species is better than no vegetation at all, there is a need to assess the rate of natural regeneration under different systems of clearing and to determine what if any long-term effect this has on the fauna and flora.

Coppicing was evident in some places where stumps remained, but further studies are required to establish the long-term regeneration of key tree species such as Acacia, Commiphora, Combretum, Terminalia, Brachystegia, Julbernardia and Lannea. Seed bank studies in combination with these regeneration studies could give an indication of species loss.

In December 1999 it was learned that villagers clearing allocated plots of land under supervision (committee comprised of agricultural extension officer, forest officer and village government) are advised to leave any *Pterocarpus angolensis* and *Azelia quanzensis* standing as these are important timber species. It is also suggested that because *Acacia albida* is a useful timber tree and conserves water, it and other large shade trees should not be felled. These are useful and positive approaches, and with further knowledge of which species are used by villagers for other purposes, for example, fodder, it might be possible to suggest other species suitable for retaining on the homestead and farms.

2.5.3 The use of *Dichrostachys cinerea* (*mpangala*) as fuel wood for fish smoking

The leguminous tree known to the Wasangu and Wahehe as *mpangala* is preferred over all others by fishermen for smoking fish. Estimates indicate that each fish-smoking site uses about 2-3 m³ of wood /day for smoking. This fuel wood is said to be cut at distant sites and then carried into the *ihefu* to the fish smoking sites by bicycle, on foot, or by donkey drawn carts.

An estimated 200 fish smoking sites are found on the edge of the *ihefu* and the consumption of wood is thus considerable. There is a need to assess the stocking rates for this species, and to examine the possibility of alternative fuels if this is deemed necessary.

2.5.4 The use of *Acacia spp* as fencing material around kraals and homesteads

Acacia species are cleared when opening up new farms and homesteads and in addition, large numbers are cut to make fencing material (*boma*). If the clearing of *Commiphora* and the use of certain *Acacia* species are greater than the regeneration, aggressive pioneer species such as *Acacia tortilis* may come to dominate these areas.

2.5.5 Overgrazing

Probably no topic regarding utilisation of vegetation is more controversial in the Usangu area than overgrazing and its effects not only on vegetation, but also on ecosystem functions and stability. In terms of habitat fragility, the grasslands are the best suited for grazing. Once grazed, what remains is largely bare ground and small amounts of stubble and broken stems. Herds of livestock are then moved towards the remaining greener vegetation near the permanent waters of the swamps. In the woodlands, signs of overgrazing appear most evident, and are compounded by the clearing and cultivation of land in this same habitat.

The trampling of the soil by livestock may compact the soil and thus affect the seed bank, possibly having a negative effect on the genetic resources of some species of plants in the area.

The dry season impression of some observers of heavy grazing in the woodlands at the edges of the virtually bare plains, and the movement of several hundreds of thousand of cattle to and from the permanent water in the *ihefu* may be misleading. It has been suggested that these large numbers of cattle have been responsible (through increasing erosion, trampling of soil and removing vegetative cover) for altering the natural water retaining characteristics of the Usangu wetlands (see discussion in Kikula et al, 1996). However, data sufficient to support or reject the hypothesis that the combined effects of the cattle have reduced the water holding and regulatory capacity of the wetland are lacking.

Woodlands and even arid and semi-arid lands are capable of considerable recovery when grazing and other pressures on vegetation are reduced, either naturally, seasonally or as part of management regime. Two examples from Tanzania are the rapid regeneration of cultivated land into *miombo* when people were moved by government into "sleeping sickness havens" (see Kjekshus, 1977 for details) and, more recently, the attempts to control extensive soil erosion in Kondo, central Tanzania, by excluding cattle (see references in Christiansson & Kikula, 1996). In both examples, the natural vegetation was able to regenerate.

While the situation at Usangu is not directly comparable, there is a need to evaluate the natural potential for regeneration, especially of the surrounding woodlands, under different land uses and pressures. Close co-operation and communication between the vegetation specialist and the range ecologist will be needed when considering how this best might be done.

With regard to the current grazing pressure of cattle, it is well to consider what pressures might have been like on the plains and surroundings 100 years ago, when larger forms of wildlife were present. There has probably always been some form of relatively heavy grazing pressure on so rich a pasture resource. Even with Game Reserve status of the Usangu, it is unlikely that the wildlife would be able to return to such high numbers, and the controlled seasonal grazing of cattle on the plains would appear to be a sustainable use of this resource. However, other issues, such as the number of grazing animals permitted in certain areas or zone at any one time need to be closely examined, as do the mechanisms for controlling people and cattle.

With the many population and administrative changes taking place in the Usangu area, and the longer- run introduction of greater control over who uses which resources and when, it may be useful to examine other alternative types of traditional farming systems used in woodland elsewhere in Africa (Biodiversity Support Program, 1993).

2.5.6 Use of medicinal plants

As is true for most parts of Tanzania, local villagers rely heavily on medicinal plants to cure various ills. Using local informants, nine such species were identified during a dry season visit, there are doubtless many others. Of concern was that one of these, *Securidaca longipedicellata*, used to cure asthma and snake bite (but among tribes in southern Africa, also known as the plant of choice to commit suicide among females), was being harvested in a completely unsustainable manner; the entire plant was being uprooted. This is probably indicative of commercial exploitation of the resource for markets outside those within the local communities in the immediate area.

2.5.7 Household use of woody plants: spoons, utensils, mortars, pestles, axe and hoe handles

No detailed study was made of this aspect of utilisation, but it is known that certain species are preferred and sought after for some of these purposes.

2.5.8 Use of fuel wood by households

The short time available for fieldwork precluded a detailed study of this aspect. It is probably that certain species are recognised for particular values (calorific values, taste, ease of cutting, etc) and sought after, if there is sufficient wood to allow a choice. No attempt was made to estimate volume of wood consumed for household.

2.5.9 Use of wild fruit

Fruits from *Tamarindus indica*, *Adansonia digitata*, *Vangueria infausta*, *Azanza garckeana* and *Zanha capensis* are often overexploited and if this is done over a long period of time, such use may limit the regeneration of these species.

2.5.10 Use of wood for canoes

It was noticeable that the canoes used by local fishermen were generally small and extremely narrow and it was explained to us that reflected the lack of availability of larger trees. Although little data appear are available on tree size and canoe use in Tanzania, on the Kilombero valley this became a social and political issue during colonial times when attempts were made by

government to limit the size of trees felled, despite the need of the local communities for large canoes (Monson, 1996).

2.5.11 General comment on the removal of trees, both live and dead for fuelwood, etc.

Studies in southern Africa have shown that even the removal of dead wood, much less the felling of live trees for fuel, can have severe effects on animal biodiversity by reducing the number of feeding and nesting trees available to cavity nesting birds, such as hornbills, woodpeckers, kingfishers and barbets. Such trees may also provide shelter and breeding sites for a variety of invertebrates, amphibians, reptiles and small mammals (Newton, 1994; Du Plessis, 1995).

3. AMPHIBIANS: FROGS AND TOADS

3.1 Introduction

As a group of organisms, which within the study area largely depend on water or at least moist conditions for reproduction, the amphibia also exemplify the extremes of wet and dry in the Usangu area. Detailed studies were conducted during four intensive sampling periods of usually ten nights each. In the first, May 1999, a period originally planned as wet season sampling, most amphibian breeding activity had ceased, and the waters in the temporary pools on the plains were rapidly receding. Even though the airboat was used to successfully sample the waters of the *ihefu* and its floating and emergent vegetation, relatively few species were encountered.

In December 1999, sampling was repeated at some of the precise sites used in May. During the first few days of the field session, conditions were extremely dry. However, the rains arrived and after only a few days, it was no longer possible to drive across the plains to reach the boat-mooring site in the permanent water. When the rains appeared, heralded by a few males calling and large numbers of flying insects attracted to lamps, thousands of frogs seemed to simply appear on the plains and at its edges; these had been in aestivation; one was seen still covered by its cocoon.

Thus, in a very short period, amphibian biodiversity and biomass on the plain went from almost zero to many species and high biomass. Tens of thousands of frogs began feeding on the abundant insects brought by the rains and made their way to temporary pools to breed. Numerous birds, especially storks and egrets, arrived to feed on this newly appeared supply of food. The temporary water and associated vegetation was filled with frog spawn, and then tadpoles.

Similarly, amphibian activity in the surrounding woodlands also peaked during this time; areas, which previously appeared devoid of frogs and toads suddenly, became alive with active animals.

The western wetlands were sampled during two similar periods in June 2000 and December 2000. Similar striking differences were observed between the dry sampling period in June and the wet season sampling in December.

Species present in the four sampling periods are shown in Table 3.1

3.2 Faunal affinities

Most species of the Usangu amphibian fauna (see appendix 2) are widely distributed in the seasonally wet and dry woodlands and savannas of sub-Saharan or eastern and southern Africa. Some of the species sampled appear to be the first records of dry country species from the area. These include the Western shovel-nosed frog *Hemissus guinnensi*, Parker's Toad, *Bufo parkeri* and the Tremelo Sand frog, *Tomopterna cryptotis*.

As was expected, no legless amphibians, known as Caecilians or Gymnophionans, were found; these are known in East Africa only from moist forest or the areas immediately surrounding larger rivers such as the Wami and Rufiji.

Anuran species typical of the few well-studied moister highland areas nearby, such as Mufindi, were absent at Usangu.

Table 3.1 Seasonal captures of Usangu amphibians

Classification	Eastern Wetland	Eastern Wetland	Western Wetland	Western Wetland
Amphibians	Dry Season (May 1999)	Wet Season (Dec 1999)	Dry Season (June 2000)	Wet Season (Dec 2000)
Order Anura:				
Anurans, Frogs and Toads				
Bufonidae:				
Toads				
<i>Bufo gutturalis</i> Guttural Toad	X	X	X	X
<i>Bufo parkeri</i> Parker's Toad	-	X	-	X
<i>Schismaderma carens</i> Red Toad	-	X	-	-
Hemisotidae:				
Shovel-snouted Frogs				
<i>Hemisis guineensis</i> Western Sharp-snouted Frog	-	X	-	X
<i>Hemisis marmoratus</i> Eastern Sharp-snouted Frog	-	X	X	X
Hyperoliidae:				
Tree, Reed and Sedge Frogs				
<i>Hyperolius nasutus</i> Gunther's Sharp-nosed Reed Frog	X	X	-	-
<i>Hyperolius pictus</i>	X	X	-	-
<i>Kassina senegalensis</i> Bubbling Kassina	X	X	X	X
<i>Leptopelis bocagii</i> Bocage's Leptopelis	-	X	-	X
Arthroleptidae: Bush Squeakers				
<i>Arthroleptis stenodactylus</i> Bush Squeaker	-	X	-	-
Ranidae: "Typical" Frogs				
<i>Hildebrandtia ornata</i> Hildebrandt's Burrowing Frog	-	X	-	X
<i>Hylarana galamensis</i> Golden-backed Frog	-	X	-	
<i>Phrynobatrachus spp.</i> Puddle Frogs (includes at least two species, <i>P. acridoides</i> and <i>P. natalensis</i>)	X	X	X	X
<i>Ptychadena spp.</i> Ridged Grass Frogs (includes at least 2 species)	X	X	X	X

Table 3.1 (continued) Seasonal captures of Usangu amphibians

Classification	Eastern Wetland	Eastern Wetland	Western Wetland	Western Wetland
	Dry Season (May 1999)	Wet Season (Dec 1999)	Dry Season (June 2000)	Wet Season (Dec 2000)
<i>Pyxicephalus adspersus</i> African Bull Frog	-	X	X	X
<i>Tomopterna cryptotis</i> Tremelo Sand Frog	-	X	X	X
Microhylidae: Microhylid Frogs				
<i>Phrynomantis bifasciatus</i> Red-banded Frog	-	X	-	X
Pipidae: Pipid Frogs				
<i>Xenopus sp.</i> African Clawed Frog	X	X	X	X
Rhacophoridae: Foam Nest Tree Frogs				
<i>Chiromantis petersii</i> Peters' Foam Nest Tree Frog	X	X	X	X

3.3 Endemism

No amphibian species encountered is known to be endemic to the Usangu Plains. Parker's Toad, *Bufo parkeri*, is a Tanzanian endemic originally described from the dry portion country of central Tanzania but which is now known from Usangu as well as northern Tanzania.

3.4 Conservation status

None of the species present is regarded as threatened, nor is any on a CITES Appendix.

3.5 Threats to amphibian diversity

Evidence from elsewhere in eastern (Msuya, in prep.) and southern Africa suggests that the role of the thickets and other vegetation at the edge of the grassland plains may be critical for the survival of some species of amphibians during the dry season. Such vegetated areas at distances of even a kilometre or more from the breeding pools serve as dry season refugia for amphibians. After breeding, it is towards these areas of thicket and woodland that the juveniles as well as adults migrate. The termitaria and associated vegetation may be especially important as refugia for anurans in the sparsely vegetated areas of the western wetland, which lacks the miombo woodland found near the eastern wetland.

In the permanent swamp, breeding also takes place, but species diversity appears to be lower, and involves species which either live in close association with or permanently in water (*Ptychadena* and *Xenopus*) or on emergent vegetation (*Hyperolius* spp).

Most of the species encountered are widely distributed in eastern and southern Africa, or indeed, sub-Saharan Africa. The presence of a number of amphibians typical of seasonally arid areas such as the

Tremelo Sand Frog, *Tomopterna cryptotis*, the African Bullfrog, *Pyxicephalus adspersus*, and Peters' Foam-nest Frog, *Chiromantis petersi* is indicative of the great seasonal differences found in the Usangu area. In strong contrast are those species such as *Xenopus* and small *Hyperolius* spp., which are much more dependent on permanent water.

Possible threats to amphibian biodiversity include:

- natural threats such as long term climatic changes, which might cause droughts longer than those to which the species are adapted
- changes to vegetation at the edge of the plains, especially the woodlands and thicket (these include over-utilisation of the woody vegetation for fuel wood, charcoal, building poles, fencing, etc)
- uncontrolled burning of the vegetation at the edge of the wetland, which also might destroy dry-season refugia
- overgrazing in the woodland, which would negatively affect vegetation cover and possibly excessively compact the soil
- changes to the water flow regime in the permanent swamp which might reduce the populations of those species most dependent on permanent water, and changes in water quality (excess siltation, pollution from agro-chemicals, etc.).

Some of the species of anurans listed above are exported from Tanzania in large numbers for the live animal trade but it is not known how many, if any of these, are taken from the Usangu area. Given the huge albeit seasonal abundance, it is not likely to be a significant number. Although African Clawed Frogs and African Bullfrogs are eaten in some parts of Africa, this does not appear to be the case in the Usangu area.

4. The reptiles: crocodiles, chelonians, snakes and lizards

4.1 Introduction

The reptiles of Usangu and environs were typical of either of the two major habitats: permanent swamps and swamp edges (terrapins, Nile Monitors, pythons), and drier woodlands and associated habitats (most other species). Terrapins and monitors also made use of temporary water bodies. In addition to the role of reptiles as both prey and predators in the food chain, the larger species, especially crocodiles, may, in conjunction with hippopotamus and other large mammals, prevent the formation of anoxic conditions in drying pools by creating channels in the vegetation and substrate (Gereta & Wolanski, 1998).

Reptiles, especially the larger and more active diurnal snakes, are difficult to sample systematically. For example, we did not find Pythons in the wetlands, although one was seen on the road between Makambako and Igawa, and they are reported as regularly seen by local wetland residents. Reptile species diversity did not appear especially high, but little detailed sampling was conducted in the woodlands. In general, the BPFLs yielded few reptiles with modest species diversity, which on the plains probably reflected the inability of animals to survive in large numbers (or at least to remain active) during the harsh dry conditions. Intensive night time sampling in the wet season might well reveal a wider variety of snakes feeding on the concentrations of breeding amphibians.

The sampling in the western wetlands revealed two species of lizards the distributions of which are poorly known in Tanzania. The first, the Blue-tailed Snake-eyed Skink, *Panaspis megalurus*, is a Tanzanian endemic previously known only from central Tanzania and the Usangu record represents a considerable range extension. The second, a lacertid, Johnston's Long-tailed Lizard, *Latastia johnstoni*, is known from central Tanzania south to Mozambique, Malawi, Zimbabwe and Zambia and west to the eastern Belgian Congo.

Species presence of reptiles in the two sampling seasons is shown in table 4.1.

4.2 Faunal affinities

The species present are of relatively wide distribution in sub-Saharan Africa woodlands and savanna. The Sand Lizards *Heliobolus spekei*, the Long-tailed Lizard *Latastia johnstoni*, the skink *Panaspis megalurus*, the Velvet Gecko *Homopholis fasciata* and the Thick-toed Gecko *Pachydactylus turneri* are indicative of a strong dry habitat component to the reptile fauna.

Although another typical dry country species, the Sand boa *Eryx colubrinus* has been found in nearby Ruaha National Park, this species was not detected in Usangu, despite the presence of the strong dry country faunal element noted above. Also, no Worm Lizards (Amphisbaenids) were captured during the field work. These cryptic reptiles prefer loose sandy or loamy soils and several species are endemic to the Dodoma area and it is possible they might be expected to occur under suitable soil regimes.

4.3 Endemism

No reptile species is known to be endemic to the Usangu area.

4.4 Conservation status

Several species (see appendix 3) are placed on CITES Appendix 2 because they are regarded as under threat from the live animal export trade (tortoises, chameleons, python, Nile Monitor) or the leather trade (Nile Crocodile). None is regarded as endangered under the current IUCN classification of conservation status.

4.5 Threats to reptile diversity

Human conflict with crocodiles has already apparently reduced their number, although they are found within Ruaha National Park, and indeed, reported in small numbers from the larger areas of permanent water. Pythons are also feared and killed, as they are seen as a threat to smaller livestock. Most snakes are regarded as dangerous and killed when encountered. This is the usual situation in much of East Africa and certainly is not unique to Usangu. In the very long term, expansion of the human population and related clearing of woodland for agriculture and grazing, as well as alteration of vegetation through burning and cutting probably will reduce numbers and possibly the presence of some species.

Another possible threat is an increase in the removal of reptiles for the live animal trade. However, unless this targets species the populations of which are already low, this would seem unlikely under the current levels of offtake. With adequate controls put in place by Wildlife Division, it should be possible to permit a regulated number of animals on a sustainable basis.

There is a small trade in reptile skins such as those of the Python in Tanzania and possibly with neighbouring countries, but unless this were to suddenly expand it is not seen as a real threat to the species.

Table 4.1. Seasonal records of reptiles

Classification	Eastern Wetland Dry Season (May 1999)	Eastern Wetland Wet Season (Dec 1999)	Western Wetland Dry Season (June 2000)	Western Wetland Wet Season (Dec 2000)
Reptiles				
Order Chelonii: Terrapins and Tortoises				
Pelomedusidae: Fresh Water Chelonians (Terrapins)				
<i>Pelusios</i> sp.	X	X	X	X
Testudinidae: Tortoises				
<i>Geochelone pardalis</i> Leopard Tortoise	X	X	-	-
<i>Kinixys spekei</i> Speke's Hinged Tortoise	-	X	X	-
Order Sauria: Lizards				
Chamaeleonidae: Chameleons				
<i>Chamaeleo dilepis</i> Flap-necked Chameleon	-	X	-	-
Cordylidae: Plated Lizards				
<i>Gerrhosaurus major</i> Southern Tawny Plated Lizard	X	-	-	-
Gekkonidae: Geckos				
<i>Hemidactylus</i> sp.	-	X	-	-
<i>Homophilus fasciata</i> Banded Gecko	-	X	X	-
<i>Pachydactylus turneri</i> Turner's Thick-toed Gecko	-	-	X	-
Scincidae: Skinks				
<i>Mabuya planifrons</i> Tree Skink	X	-	X	X
<i>Lygosoma sundevallii</i> Suindevall's Writhing Skink	X	-	-	-
<i>Panaspis megalurus</i> Blue-tailed Snake- eyed Skink	-	-	X	-

Table 4.1: Seasonal records of reptiles, continued.

Classification	Eastern Wetland	Eastern Wetland	Western Wetland	Western Wetland
	Dry Season (May 1999)	Wet Season (Dec 1999)	Dry Season (June 2000)	Wet Season (Dec 2000)
Scincidae: Skinks				
<i>Panaspis wahlbergi</i> Wahlberg's Snake Eyed Skink	-	X	-	-
Lacertidae: Lacertid Lizards				
<i>Heliobolus spekei</i> Speke's Sand Lizard	-	X	-	-
<i>Latastia johnstoni</i> Johnston's Long-tailed Lizard	-	-	X	X
Order Serpentes: Snakes				
Viperidae: Vipers				
<i>Bitis arietans</i> Puffadder	X	-	-	-
Elapidae: Cobras and Mambas				
<i>Dendroaspis polylepis</i> Black Mamba	X	-	-	-
<i>Naja nigricollis</i> Black-necked Spitting Cobra	-	-	X	-
Colubridae: Colubrid Snakes				
<i>Dasyveltis scabra</i> African Egg-eating Snake	X	X	-	-
<i>Lycophidion sp.</i> Wolf Snake	-	-	-	X
<i>Meizodon semiornata</i> Semi-ornate Snake	-	-	-	X

5. Avian fauna

5.1 Introduction

The first documented ornithological work in the Usangu plains of southern Tanzania was begun in the 1960s by Mr. E. Balson, the Principal Game Warden of Mbeya. His work was expanded upon and compiled by J. Procter who published a list of Usangu birds containing records of 268 species (Procter 1968). For the next 15 years there was little work done on the birds of this area aside from a few published breeding records (Elliott 1985). Then, in the mid 1980s, Fr. Etienne Sion started making regular visits to the north-western parts of the Usangu and contributed many valuable records to the Tanzania Bird Atlas project (Baker & Baker in prep.).

Further visits, sponsored by Birdlife International and the Wildlife Conservation Society of Tanzania, have been made by various survey teams to the wetlands. These were conducted as part of the national water bird count and to collect further records for the Tanzania Bird Atlas project. The current species total for the quarter degree atlas square encompassing the *ihefu* swamp now stands at 418 and can be expected to level off at around 450 when survey work is complete (N. Baker pers. comm.).

The Usangu has been identified by Birdlife International as one of Tanzania's Important Bird Areas, IBA 38 (Baker & Baker in press). This is because of the number and variety of species present and because it is an important site for a number of endangered or threatened species (see section 5.4).

The current ornithological survey was carried out from 23-26 May and 20-23 September 1999, in and around the *ihefu* perennial swamp. Thus this report contains a summary of the initial dry season survey focused on the permanent wetland of *ihefu*. Following further fieldwork at the height of the rainy season, it should be possible to make a more thorough assessment of the avian biodiversity and economic values of the central wetlands. A total of 190 species were recorded from the wetland, grassland and surrounding arid and deciduous woodlands (Appendix 4A). A majority of time was spent on the permanent wetland within the eastern wetland, including one night spent in a tent on a floating island to listen for birds that typically call only after dark. Observations in the fringing woodlands were made while travelling to and from the wetlands and in the evenings and early mornings prior to beginning survey work in *ihefu*. The species list from an independent bird survey recently undertaken by the Max Planck Institute, in the western wetland and surrounding areas focussed on the Kapunga rice scheme, will shortly be forthcoming. A native Kisangu speaker was engaged for several days in an attempt to document the local names of bird species. This resulted in a fairly short list of names for some of the waterfowl species (Appendix 4B). This has not been corroborated by other independent informants.

5.2 Faunal affinities

The vegetational complexity of the area is reflected in the avifauna affinities. The avifauna is a complex mixture of wetland species, species widely distributed in woodland and mosaic vegetation, and of dry country specialists of the Somali-Maasai affinities. Tanzania has about 77 species regarded as typical of the Somali-Maasai zone, 26% of these are found in the Usangu area.

Not all species are permanent residents of the area. Even breeding birds may undergo local or longer movements, and in addition, both intra-African and African-Palaeartic migrants (those which move between Africa and Europe and Asia) are at times present (see appendix 4A).

5.3 Endemism

None of the species seen or recorded in Usangu is known to be endemic to the area.

5.4 Conservation status

Of the avian fauna found in Usangu, several are near-threatened or vulnerable:

- *Near-threatened*: Pallid Harrier, Black-winged Pratincole, Great Snipe, Basra Reed Warbler
- *Vulnerable*: Lesser Kestrel, Wattled Crane

The Usangu is also thought to contain 1% or more of the biogeographical population of the following species:

Common Pratincole
Black-winged Pratincole
Little Egret
Squacco Heron
Rufous-bellied Heron
Yellow-billed Stork
Open-billed Stork
Glossy Ibis
Fulvous Duck
Spur-winged Goose
Black-winged Stilt
Caspian Plover
White-crowned Plover

A number of other species have extremely localised occurrence within Tanzania.

Species of particular conservation interest include:

White-throated Swallow: One of the most important records of this fieldwork was made on 22 September when a number of White-throated Swallows were found. This represents the third record of this southern African migrant from Tanzania. The first record was of a vagrant found at Lake Jipe in July 1957 (Britton *et al.* 1980). It was not recorded again until July 1995 when several were seen at *ihetu* (N. Baker pers. comm.). The September 1999 record confirms that Usangu is probably a regular wintering site for this species. The *ihetu* then represents the only known locality in Tanzania where White-throated Swallow is a regular visitor and may be the northernmost wintering area for this species.

Yellow-crowned Bishop: Aside from Rukwa, Usangu represents the only other locality in Tanzania where the southern subspecies, *taha*, is known to occur (Britton *et al.* 1980, Procter 1968, Vesey-Fitzgerald 1960). This species was seen frequently in the *ihetu* but was not very abundant relative to other weaver species found there. Throughout East Africa this is a scarce and localised species (Britton *et al.* 1980).

Crowned Crane: Relatively few individuals were seen in the *ihetu* and the low numbers could be cause for serious alarm. Procter (1968) lists this species as abundant and Baker (in press) reports thousands. It may be that the bulk of the Usangu population was elsewhere during this period, such as the rice paddies in the southern Usangu or that reduced numbers represent a genuine decline. This species will eat grain and can become a pest in some areas (Urban *et al.* 1986). Because of this, it is vulnerable to poisoning in the Usangu.

Wattled Crane: This species was not recorded during this survey. The Usangu is one of the few localities in Tanzania where it has been recorded (Britton 1980, Procter 1968, Baker 1997). Other areas are Rukwa, Ufipa, Mufindi and Ugalla / Moyowosi swamp. Throughout its African range this species is vulnerable and declining and the last remaining strongholds are in Zambia and Botswana and Tanzania (Urban *et al.* 1986).

The current status of Wattled Crane in Tanzania is not well known but the population trend is not encouraging. This species has one of the lowest recruitment rates among African cranes (Urban *et al.* 1986). In the past 15 years it has disappeared from the Ufipa Plateau due to hunting pressure and disturbance of nesting sites by cattle and humans. It was formerly frequent on the short grass plains of Rukwa but there are no recent records from there (Vesey-Fitzgerald and Beesley 1960). Rising lake levels have flooded virtually the entire suitable habitat in the Rukwa Valley and Wattled Cranes may no longer be present there. Formerly this species was found on the permanent wetlands and montane grasslands around the headwaters of the Little Ruaha River and the Ndembera wetland. The only reported and published breeding record in Tanzania was of a juvenile bird spotted from a helicopter somewhere in the Ndembera wetland (Elliot 1983). Tree planting on the grasslands of the Mufindi Plateau (Strömquist 1976) may have decreased the amount of flooded grassland, an important breeding and feeding habitat for this species, and it is no longer regularly encountered around Mufindi. The Ugalla / Moyowosi Swamp in western Tanzania may be the last remaining stronghold for Wattled Cranes in East Africa.

Denham's Bustard: This species has been recorded from the Usangu in the past but was not encountered during fieldwork. Throughout southern Tanzania this species is suffering a fate similar to that of the Wattled Crane. It has been heavily hunted on its breeding grounds on the Kitulo and Ufipa plateaux and the numbers are greatly reduced. Other causes of the population decline have been increasing amounts of cultivation and tree planting on the montane grasslands further reducing breeding habitat. This also has the effect of concentrating cattle populations on the reduced areas of breeding habitat and increasing disturbance of nest sites by stock and herd boys.

Other: This is the only locality in Tanzania where four species of Coucals are found together, these are the Black, Senegal, White-browed, and Coppery-tailed (Baker & Baker in press). It is also the only known wintering site for White-throated Swallow and Black-winged Pratincole in East Africa and one of two known localities for Saker Falcon, *Falco cherrug* in Tanzania (Procter 1960, Baker in press).

The *ihifu* is probably the most important breeding site for Allen's Gallinule, Lesser Moorhen and Rufous-bellied Heron in southern Tanzania and, perhaps, in all of Tanzania. It also contains one of the highest breeding densities of Long-toed Plovers in East Africa. In addition to being an important breeding site for these species, *ihifu* and the entire Usangu wetland areas are very important feeding, resting and breeding grounds for a vast number of waterfowl. Seasonally, the Usangu contains some of the highest concentrations of waterfowl in Tanzania and a number of species are likely to exceed the Ramsar minimum 1% levels ((Baker & Baker in press, Rose & Scott 1994). This wetland is also very important for many species of Palearctic migrants that stop to rest, feed or winter there.

Two species of dry woodland affinities found at Usangu are endemic to Tanzania, but are much more widely distributed. The Yellow-collared Loverbird *Agapornis personata* ranges widely in well-timbered bushlands north of Mount Meru to Morogoro, Njombe and Mbeya and Rukwa areas. It is especially partial to Baobab trees. The Ashy Starling *Cosmopsarus unicolor* is found in bushed and wooded grassland and open woodland at 1100 – 1850 m asl. It ranges over much of interior Tanzania except miombo woodland and highlands.

5.5 Threats to avian diversity

A number of activities pose threats to the avian diversity. The major issues are presented here.

5.5.1 Disturbance from human activities

There are many direct and indirect adverse affects on birds in Usangu resulting from the use of the floodplain and permanent marsh by fishermen and stock keepers. The most serious effect is disturbance and destruction of habitat caused by stock and fires. As the waters recede on the flood plain the stock advance. Their impact is from both eating and trampling, which remove breeding and foraging habitat from a majority of the flood plain. For many species of passerines that have bred during the wet months this may not be a major problem. However, for species with very long breeding seasons, such as the Wattled and Crested cranes, the result may be the failure of breeding attempts. Such an effect may not be noticed in long-lived species, such as cranes, until many years after the problem has reached serious proportions. The population of adults may remain fairly stable for a long period then suddenly crash due to a lack of recruitment. This problem is especially serious for Wattled Cranes as this species has the lowest recruitment rate of all the 15 crane species of the world (Urban et al. 1986).

For species that have already finished breeding when the cattle and fires advance, the major problem is a resource crunch. Much of their feeding habitat and food is no longer available, and the entire population of the wetland is crammed together at artificially high densities in the little remaining habitat. This causes a huge increase in the amount of fighting and territorial squabbles in the Rallids and probably results in a serious increase of stress for the entire population.

The burning and grazing of *Echinochloa-Cyperus-Cynodon* associations on the flood plain is not detrimental to the welfare of the grasses (Vesey-Fitzgerald 1955, 1970, Backlund 1956). In fact, *Cynodon* stands may be invigorated after burning. However, burning removes habitat needed by birds, mammals and amphibians for survival in the dry months.

As noted in the vegetation section, in southern Africa it has been shown that one of the indirect effects of removal of trees, even dead wood, for fuel for a period of less than a decade can affect the diversity of cavity-using vertebrates (Du Plessis, 1995). It is possible that this has occurred, or will occur, in the woodland if pressure for wood resources continues uncontrolled.

This resource bottleneck, coupled with the continual presence of fishermen on the permanent wetland, could result in population declines of many species. On the permanent wetland, most open water contains fishing nets and lines. Many of the diving and dabbling species of waterfowl suffer greatly from this. The incidental (bycatch) of birds, such as Little Grebe, Hottentot Teal, Red-billed Teal, Reed Cormorant, African Darter, and Pygmy Goose is considerable. A number of individuals of these species were observed entangled in nets during the survey, and a good number of the fishing canoes usually have one or more water birds among the daily catch.

In the western wetland, the conversion of areas to rice farming also has an impact. Such impacts are not well studied. However, Arnaitwe (1993) writes:

Species richness of Afrotropical water birds was lower on the rice fields than on unreclaimed parts of the flood plain but numbers of some species, mainly large wading birds and ducks, were higher. Some of the conservation implications of rice growing are discussed in view of the fact that some species benefit while others, principally wetland specialists and some threatened species, do not when wetlands are converted to agricultural use.

5.5.2 Effects of hunting, fishing and the bird trade

Direct hunting of birds is not thought to be a serious problem in the *ihifu*. Although fishermen set snares for waterfowl, the actual numbers caught are probably not significant relative to total population numbers. However, species targeted are the large ones, such as cranes and geese. This type of low-level snaring has led to the extirpation of Wattled Cranes and a population crash of Denham's Bustard on the Ufipa Plateau.

There is some evidence that considerable trapping for the bird trade is going on in Usangu. This is mostly targeted at woodland and savannah species and no quantitative data has been collected on the extent and levels of this trapping. Collection of data on the bird trade should form part of any socio-economic surveys conducted in Usangu. It would be very useful to determine from this what economic benefit, if any, accrues to Usangu residents.

5.5.3 Poisoning and direct persecution

Poisoning of birds at rice schemes is a problem generally and especially for some of the species of conservation interest. This practice is indiscriminate and can result in a very high incidental kill. Where there is a genuine problem with pest species, such as Red-billed Quelea, there exist very specific guidelines, methodologies and pesticides to deal with the problem. When carried out according to these guidelines, aerial spraying of quelea results in very little incidental kill. However, indiscriminate aerial spraying and baiting with a broad spectrum pesticide at rice schemes is a very questionable practice. In addition to being very destructive, it is also illegal under Tanzania Law unless proper procedures are followed and significant crop damage and loss can be unequivocally demonstrated (GoT 1987).

Wattled Cranes are very vulnerable to this practice. This species congregates in the non-breeding season and may forage in flocks of up to 15 or more birds. If just one of these flocks takes poisoned bait that could result in a 25–50% population reduction in the Usangu.

Local informants reported some poisoning of birds using pesticides on small-scale rice cultivation. They also described poisoning of ducks and geese with agrochemicals for a local meat market. The birds were sold to patrons of establishments at which locally brewed alcohol is sold and drunk (*vilabu*). People were aware that the poison might affect human health in the long run, but stated that since the effects would not become evident until “much later”, the risk was regarded as acceptable to consumers of the bird flesh.

The poisoning of birds not only has a direct effect on bird mortality, but may have others which are long term. Social and other behaviour may be altered, and this in turn could effect both breeding and migration.

5.6 Comparisons between May and September

There was a great contrast in relative abundance and species composition between the two survey periods. These were both in the dry season. However, in late May there was still quite a bit of water in the wetland and many of the species were breeding or accompanied by young.

In May there were large numbers of Rallids at *ihifu* including African and Black Crakes, Lesser and Common Moorhens, Allen's and Purple Gallinules. Virtually all species had dependant young or were setting on eggs. Numbers of birds with young were particularly high on *Nyan'gulage* bwawa. In September both Allen's Gallinule and Lesser Moorhen were absent from the *ihifu* but numbers of Purple Gallinule appeared to have gone up.

The large numbers in May of **Allen's Gallinules**, including many in immature plumage, indicate a preference for breeding after the peak of the rains. This supports the few East African breeding records given by Brown & Britton (1980). This species is an uncommon nomadic wanderer in East Africa but may suddenly appear in huge numbers to breed at optimal sites. Small numbers are resident in some permanent wetlands in south-western Tanzania (Britton 1980, Verheyen 1939, Vesey-Fitzgerald & Beesley 1960). However, Allen's Gallinule was not recorded from the Usangu by Procter (1968). This is probably because it is found in the permanent swamp and very difficult to see without venturing out in a boat. During September no Allen's Gallinules were found at the *ihetu*. It is not known whether they wander around within the Usangu Catchment system or go farther afield to areas such as the Rukwa, Moyowosi and Kilombero wetlands. In drier years, permanent swamps in south-west Tanzania, including Usangu and Rukwa probably represent the most important breeding sites for this species in Tanzania.

In May there were also large numbers of **Lesser Moorhens** breeding at the *ihetu* and many pairs were seen with downy young. These records represent a new breeding locality in Tanzania for this secretive species. Previous records were from Monduli, Dar es Salaam and Tabora (Britton 1980, Brown & Britton 1980). Similar to Allen's Gallinule, this species was not recorded during fieldwork in September. Lesser Moorhen is known to be an intra-African migrant so a major post breeding dispersal is not surprising.

In contrast to Allen's Gallinule and Lesser Moorhen, **Purple Gallinule** appeared to have increased in numbers on *ihetu* between May and September. Whether this was a true increase or, more likely, a result of a decrease in suitable habitat and concentration of the resident population is not known. The high density of Purple Gallinules, Moorhens, and Jacanas on the permanent wetland at the peak of the dry season may present a serious resource limitation for some species. It may be this reason that causes species prone to local movements to move on during this time and return during the rains when there is a peak in resource abundance and available breeding habitat. Further detailed ecological investigations of the resource base, foraging and breeding behaviour of the Rallids in *ihetu* would help to answer some of these questions.

Other species that were breeding or accompanied by young in May were African Jacana, Long-toed Plover, Golden-backed and Black-headed weavers. Of these the Long-toed Plovers were still breeding in September. It is not known whether this was a second clutch or repeated breeding attempts after failure of earlier nests.

Other contrasts between the two periods were rather dramatic. In May there were huge numbers of Glossy Ibis, Open-billed Storks, Fulvous Ducks, Knob-billed Ducks and Common Pratincoles. In September the numbers of Fulvous Ducks and pratincoles had declined dramatically and were replaced by huge numbers of Spur-winged Goose and White-faced Ducks. Numbers of storks and Knob-billed Ducks remained similar between the two periods.

5.7 Possible role of water birds

What does it matter if these birds are displaced? While there is an obvious loss of economic opportunity, it should be remembered that birds form part of the ecosystem and affect other aspects of the environment. Howard (1993) makes the point:

The role of water birds in the movement of nutrients through the water and soil that support wetland vegetation is implicit. This is especially relevant where there are large accumulations of birds which transfer from wetland to wetland during migration or local movements. Transfer of nutrients from non-wetland areas occurs when birds move from pastures and woodlands to rest, roost or feed in a wetland. Nutrients are also redistributed and mixed in the submerged

substrates of swamps and shallow waters by feeding ducks, spoonbills, ibises and waders

...it is necessary that water birds be seen as essential parts of the wetland system which, if removed, will reduce not only biodiversity but also functional efficiency. ...It is possible to plan and manage a wetland system for multiple use so that it retains its values, products and functions and still provides livelihoods for residents and other users. ...

Any system of conservation of water birds within multiple uses of a wetland assumes that the needs of the birds are understood. The development of a new protected area requires insight of food needs, minimum foraging area, movement or migration and minimum viable population size for birds and the wetland concerned...

Multiple use of wetlands and water bird conservation presupposes that the needs of people and the functions and uses of the ecosystem concerned are known.

6. LARGE MAMMALS

6.1 Introduction

6.1.1 Historical Perspective

Although there are no estimates of the numbers of large mammals either past or present in the Usangu area, much circumstantial evidence indicates that within the 19th and early 20th century the Usangu supported a wide range of savannah species in numbers consistent with its habitats and rainfall. Cotterill and Elton, who passed through Usangu in 1877, recorded impala, zebra, giraffe, elephant, buffalo, eland, hippo, warthog, hyena and silver jackal as numerous (Charnley, 1994).

Adams (1899) describes the area centred on the Ruaha as supporting numerous game species. He describes the following as abundant: waterbuck, mountain and bohor reedbuck; impala; topi; zebra; hippopotamus; rhinoceros, giraffe, lion, hyena, jackals and crocodile. Between Madibira and the Ruaha he occasionally saw kudu, eland, sable, roan and wildebeest. In his account, no mention is made of elephant, buffalo, ostrich or leopard, although all of these still occur in the north today. The mention of wildebeest is of interest. Although other observers did not corroborate the wildebeest records, a subspecies of Wildebeest, the Nyasa blue wildebeest, *Connochaetes taurinus johnstoni* was recorded by Swynnerton and Hayman (1951) from Tunduru and Songea Districts as well as from Ifakara and Mahenge. It is therefore quite possible that it once occurred in Usangu, but if it did, it is now extinct.

Mbeya district government documents reviewed by Charnley (1994) as the writings of Fortie (1938) and Burt (1942) indicate that Usangu continued to support large numbers of large game mammals until the 1960s. The extensive scarring of baobab trees north of the Great Ruaha river indicates the substantial densities of elephant persisted there until at least the 1960s. After this time there were, however, reports of dwindling large mammals in the area.

6.1.2 SMUWC Aerial Surveys

This description of the large mammals of the Usangu plain is drawn from two aerial surveys undertaken by the SMUWC project, in May and October 1999. These surveys are also reported separately, including a discussion of methodology and results.

The aerial surveys undertaken focussed on the northern miombo areas. The grassland plains and fringing miombo woodlands to the west and the south were not specifically surveyed for large mammals, but were covered during the livestock aerial surveys undertaken at the same time. Any wild large mammals were noted at this time. Sightings of crocodiles and ostrich were also recorded.

Species present during the two surveys are shown in table 6.1. Mammals known or thought to occur in Usangu are listed in tables 6.2 (large mammals known), 6.3 (large mammals possible), and 6.4 (small mammals known).

6.2 Faunal affinities

The large mammal fauna of the Usangu is that of woodlands found over much of the drier eastern and some parts of southern Africa.

Large mammals are primarily found in the miombo woodlands to the north. The miombo woodlands of the southern (Chimala) and western (Chunya) escarpments were not found to contain wild large mammals. These miombo habitats are similar to those in the north; the absence

of wild large mammals is attributed to a combination of the proximity of human settlement and dry season water shortages. A few large mammals may be seen in the margins of both the eastern and western wetlands, but they retreat with the recession of the waters.

Table 6.1 Population estimates for large wild animals

Species	Savannah plains				Miombo woodlands			
	Wet season		Dry season		Wet season		Dry season	
	Number seen	Density per km ²	Number seen	Density per km ²	Number seen	Density per km ²	Number seen	Density per km ²
Topi	386	.230	91	.020				
Impala	379	.226	56	.013	106	.028	360	.095
Ostrich	223	.133	26	.006				
Zebra	169	.101	0	0	63	.017	166	.044
Reedbuck	81	.048	7	.002				
Warthog	74	.044	35	.008	190	.051	332	.088
Sable					328	.087	249	.066
Hartebeest					159	.042	221	.059
Giraffe					122	.050	0	0
Wild dog	x							
Cheetah								
Hippo	x							
Eland	x							
Crocodile	x							
Kudu	x				x			
Roan					x			
Waterbuck					x			
Duiker					x			
Oribi					x			
Bushbuck					x			

6.3 Endemism

As far as is known no species of large mammal is endemic to the Usangu area. An isolated subspecies of Topi, the so-called Usangu Topi, *Damaliscus korrigum* eurus has been described, but no assessment of its status in light of current understanding of the normal variation of the species has been undertaken.

6.4 Conservation status

The following large mammals found in Usangu (or which are known to have occurred there within historic times) are regarded by the IUCN (1996) as Threatened:

- the Black rhinoceros, *Diceros bicornis*, is classified as Critically Endangered and has been extinct within the Usangu area for some time due to poaching for its horn.
- the African Elephant is classified as Endangered. It was extensively poached for ivory.
- of the big cats found in Usangu, the lion and cheetah are both regarded as Vulnerable.

Species in the lower risk category include:

Waterbuck
Oryx
Topi
Nyasa Wildebeest

The single group of six Hippopotamus detected during the surveys may well be the only individuals remaining in the swamp.

The Wildebeest *Connochaetes taurinus* has also been extirpated in recent times.

CITES status

Because of international concern about the trade in several species and their products, the following larger mammals found in Usangu are placed within the CITES appendices.

Appendix I: African Elephant (with recent proviso permitting some trade of elephant products originating in some African states); Black Rhinoceros; Cheetah; Leopard

Appendix II: Hippopotamus

Whether or not there is international conservation concern over a particular species, there is obviously serious pressure on almost all of the larger mammals of the Usangu area. It is known that formerly the Usangu plains supported large wild mammal populations, which have almost completely disappeared. Today the whole Usangu plain except for the northern end is virtually devoid of large mammals and is used throughout for cultivation and livestock. A few large mammals occur during the wet season but are almost completely absent during the dry season, presumably due to competition from livestock. Animal populations in the northern miombo are also low, well below the habitat potential. This can be attributed directly to human activities, especially poaching.

Clearly, the large mammals in this area are maintained by the populations present in the adjacent Ruaha National Park in a source-sink relationship.

Table 6.5 provides an estimate of numbers of large mammals in the Usangu Game Reserve that would be expected to occur under natural conditions in both the northern miombo and most of the eastern wetland (see East, 1981, 1984 for methods used in obtaining these estimates).

6.5 Threats to large mammal diversity

Given that large wild animals have almost been eliminated from the seasonal wetlands and numbers are severely reduced in the miombo, talk of 'threats' may seem redundant. However, now that the Usangu Game Reserve has been created, there is a need to re-consider the threats in light of the management and conservation strategies and actions which may be implemented, to ensure the continued survival of larger mammals in the area, even if their numbers are currently greatly reduced from what they were in the past.

The major threats to larger mammals stem from human activities. One is poaching, especially in the northern miombo woodland. The other is from competition from livestock in the grasslands. The woodlands have been identified as important for the survival of larger mammals. Any significant loss of woodland habitat, or competition with cattle in the woodland if livestock grazing were to increase there, would be detrimental to the wild large mammal fauna.

6.6 The role of large mammals in the ecology of the wetland

While the focus of the large mammals studies has been on the status of the wildlife population, and possible threats to that population, it is interesting to reverse the question and consider the impact of large mammals on the overall ecology of the wetland. Eltringham (1974) documents a case from East Africa of the removal of hippopotomi.

There has been little recognition of the ... importance of large animals in shaping the character of riverine corridors. This ... is especially surprising considering their influence on the habitat mosaic of rivers is second only to the primary factors of matter, energy and water. By eating plants, moving soil and dispersing seeds, larger animals (mammals, reptiles and birds) alter vegetative structure, modify channel morphology and assist in developing microtopography. The ecosystem-level consequences of these physical and trophic activities go far beyond supplying individuals with food and habitat in the process of making nightly feeding forays hippo create a maze of trails and canals that serve as corridors for the movements of many other species ... Warthog are important in structuring riparian vegetation in southern Africa

Similarly, hippo have been shown to be an integral part of the dynamic Okavango Delata system in Botswana. Depending on local conditions, their use of regular trails creates more favourable routes for water dispersal as well as maintaining mior channels (McCarthy, T.S., Ellery, W.N. & Bloem, A. 1998).

To provide ecosystem-level integrity for river systems, it is necessary:

to maintain nutrient fluxes across boundaries between the river channel, riparian forest and uplands, it is necessary to allow ... hippo and various ungulates freedom of movement; to ensure roosting sites for bats and birds; to encourage colonisation of riparian zones, and to maintain viable populations of large animals that consume aquatic animals and plants but defecate in terrestrial environments or the converse. (Eltringham, 1974)

Maintenance of a larger mammal species may be necessary to ensure the health of smaller species, both of fauna and of flora. By extension, the role of hippopotomi and other aquatic animals in maintaining channels open to water flow, cannot be dismissed. The loss of such species in the Usangu may have broad implications.

Table 6.2 Large mammals known to occur in Usangu (* = extinct within recent times)

Order, Family	English name	Scientific name	Swahili name
Order Primates			
Family Cercopithecidae	Monkeys		
	Monkey, Vervet	<i>Cercopithecus aethiops</i>	Tumbili
	Baboon, yellow	<i>Papio cynocephalus</i>	Nyani
Order Carnivora			
Family Canidae	Jackals, Foxes		
	Jackal, Black-backed	<i>Canis mesomelas</i>	Mbweha
Mustelidae	Mustelids		
	Zorilla	<i>Ictonyx striatus</i>	
Herpestidae	Mongoose		
	Slender Mongoose	<i>Herpestes sanguinea</i>	Nguchiro
Hyaenidae	Hyaena		
	Hyaena, Spotted	<i>Crocota crocuta</i>	Fisi
Felidae	Cats		
	Cheetah	<i>Acinonyx jubatus</i>	Duma
	Lion	<i>Panthera leo</i>	Simba
	Leopard	<i>Panthera pardus</i>	Chui
Order Proboscidea	Elephants		
Elephantidae	African Elephant	<i>Loxodonta africana</i>	Tembo or Ndovu
Order Perissodactyla	Odd-toed Ungulates		
Equidae	Plains Zebra	<i>Equus burchelli</i>	Pudamilia
Rhinocerotidae	Black Rhinoceros	<i>Diceros bicornis</i>	Kifaru
Order Tubulidentata	Aardvark		
Orycteropodidae	Aardvark	<i>Orycteropus afer</i>	Muhanga
Order Artiodactyla	Even-toed Ungulates		
Suidae	Pigs		
	Warthog	<i>Phacochoerus africanus</i>	Ngiri
	Bush pig	<i>Potamochoerus larvatus</i>	Nguruwe
Hippopotamidae	Hippopotamus	<i>Hippopotamus amphibius</i>	Kiboko
Giraffidae	Giraffe	<i>Girafa camelopardalis</i>	Twiga
Bovidae	Horned Ungulates		
Alcelaphinae			
	Hartebeest	<i>Alcelaphus buselaphus</i>	Kongoni
	Wildebeest	<i>Connochaetes taurinus</i>	
	Topi	<i>Damaliscus lunatus</i>	Nyamera
Antelopinae			
	Impala	<i>Aepyceros melampus</i>	Swalapala
Bovinae			
	Buffalo	<i>Syncerus caffer</i>	Nyati
	Eland	<i>Tragelaphus oryx</i>	Pofu
	Bushbuck	<i>Tragelaphus scriptus</i>	Bongo
	Kudu, Greater	<i>Tragelaphus strepsiceros</i>	Tandala mkubwa
Cephalophinae			
	Duiker, bush	<i>Sylvicapra grimmia</i>	Nsya
Hippotraginae			
	Roan Antelope	<i>Hippotragus equinus</i>	Korongo

	Sable Antelope	<i>Hippotragus niger</i>	Palahala
Neotraginae			
	Dikdik, Kirk's	<i>Rhynchotragus kirkii</i>	Dikidiki
Reduncinae			
	Waterbuck	<i>Kobus ellipsiprymnus</i>	Kuru
	Reedbuck, Bohor	<i>Redunca redunca</i>	Tohe

Table 6.3 Larger mammals that may occur in Usangu

Swahili name	English name	Scientific name	Status
	Bat-eared fox	<i>Otocyon megalotis</i>	
	Southern reedbuck		
Simbamangu	Caracal	Felis caracal Schreber 1776	
Mbuzimawe	Klipspringer	<i>Oreotragus oreotragus (Zimmermann 1783)</i>	
Taya	Oribi	<i>Ourebia ourebi (Zimmermann 1783)</i>	
Mondo	Serval	<i>Felis serval</i>	
	Steinbuck	<i>Raphicerus campestris</i>	
Mbwa mwitu	Wild dog	<i>Lycaon pictus (Temminck 1820)</i>	

Table 6.4 Small mammals known from or which may occur in Usangu

Swahili name	English name	Scientific name	Status
	Bush squirrel	<i>Paraxerus sp.</i>	Known
Sungura	Cape hare	<i>Lepus capensis</i>	Known
Fungo	Civet cat	<i>Civetticus civetta</i>	Known
Nunguri	Crested porcupine	<i>Hystrix cristata</i>	Known
Komba	Galago	<i>Galago senegalensis</i>	Possible
Kanu	Genet	<i>Genetta genetta</i>	Known
Komba	Greater galago	<i>Otolemur crassicaudatus</i>	Possible
Nguchiro	Mongoose, banded	<i>Mungos mungo</i>	Known
Nguchiro	Mongoose, dwarf	<i>Helogale parvula</i>	Known
Nguchiro	Mongoose, Egyptian	<i>Herpestes ichneumon</i>	Known
Nguchiro	Mongoose, Marsh	<i>Atilax paludinosus</i>	Possible
Nguchiro	Mongoose, slender	<i>Herpestes sanguinea</i>	Known
Nguchiro	Mongoose, white-tailed	<i>Ichneumia albicauda</i>	Known
Kakakuona	Pangolin	<i>Smutsia temmincki</i>	Known
Nunguri	Porcupine, crested	<i>Hystrix cristata</i>	Known
Nyegere	Ratel	<i>Mellivora capensis</i>	Known
	Rock hyrax	<i>Procavia johnstoni</i>	Known
Mondo	Serval	<i>Felis serval</i>	Possible
	Spring hare	<i>Pedetes capensis</i>	Known
Kimbiru	Wildcat	<i>Felis silvestris</i>	Possible
Kicheche	Zorilla	<i>Ictonyx striatus</i>	Known

Table 6.5 **Expected numbers of animals in Usangu Game Reserve under good management**

Species	Population
Buffalo	6 236
Bushbuck	461
Elephant	3 566
Giraffe	1 723
Hartebeest	2 383
Hippo	1 630
Impala	4 936
Kudu	1 213
Reedbuck	423
Rhino	928
Roan	720
Sable	830
Topi	5 641
Warthog	3 868
Waterbuck	1 433
Zebra	6 870

7. SMALL MAMMALS: THE SHREWS AND RODENTS

7.1 Introduction

The small mammals trapped at Usangu were as far as is known, species which have wide distributions in woodlands and associated habitat such as thicket in eastern Africa. Shrews and climbing mice were as would be expected, taken in the relatively moister conditions, with other species found in several of the habitat types. At least three species in the genera *Arvicanthis*, *Mastomys* and *Tatera*, are regarded as agricultural pests, and can also be involved in plague outbreaks.

Little is known about shrew distribution and taxonomy, and at least two species of shrews were trapped. As is the case for all of the mammals, identifications can only be made after a detailed examination of teeth and skulls, a time-consuming process.

Although there were differences in numbers trapped in the May and December sessions, the same species were taken during both periods. The two trapping sessions conducted in the dry and wet seasons of 2000 in the Western Wetland yielded slight differences, a typical dry-country species, *Saccostomus campestris*, was found only in the western wetland. In 1999, trapping in the eastern wetland detected two species, *Dendromus* and *Steatomys* which were not taken in the western wetland.

The species trapped are listed in Table 5.

Bats were not studied in detail. The Yellow-winged Bat, *Lavia frons*, a widespread species, was found in thickets in both wetlands.

7.2 Faunal affinities

The faunal affinities are those of the wide sub-Saharan African region, and the rodents or closely related species have also been reported by Sheppe & Osborne () to occur in the Luangwa Valley floodplain. element.

7.3 Endemism

No endemic small mammals are known from the study area.

7.4 Conservation status

None of the small mammals is known to be of conservation concern.

7.5 Threats to small mammal diversity

The alteration of the woodlands and thickets surrounding the wetland is probably the major threat to small mammal diversity. The mammals need cover for refuge from the elements and predators; they also require safe nesting sites. These are mostly unavailable on the flat, sparsely vegetated plains during the dry season, although some species may profit from the lush growth of grass after the rains. The amount of disturbance by cattle grazing is difficult to assess; certainly the impression is that the cattle quickly remove much of the flush of green grass which appears as the waters recede. The

falling of large live or dead trees is likely to remove suitable roosting and nesting sites for a variety of small mammals (Du Plessis, 1995). Similarly, hot fires, especially in the woodland, could be damaging for some species.

Although in many parts of southern Tanzania small mammals, especially rodents, are a popular food item, this is seen as a sustainable use rather than a threat to populations, since many rodents are able to reproduce large number of young relatively quickly.

Table 5. Seasonal records for small mammals

Classification	Eastern Wetland Dry Season (May 1999)	Eastern Wetland Wet Season (Dec 1999)	Western Wetland Dry Season (June 2000)	Western Wetland Wet Season (Dec 2000)
Small Mammals				
Insectivora, Soricidae				
<i>Crocidura spp.</i> Musk or White-toothed shrews	X	X	X	X
Rodentia, Muridae				
<i>Arvicanthis niloticus</i> Unstriped Grass Rat	X	X	X	X
<i>Dendromus sp.</i> Climbing mouse	-	X	-	-
<i>Grammomys dolichurus</i> Thicket Rat	X	X	X	X
<i>Mastomys natalensis</i> Multi-mammate Rat	X	X	X	X
<i>Mus minutoides</i> Pigmy Mouse	X	X	X	X
<i>Otomys sp.</i> Groove-toothed Rat	-	X	-	-
<i>Tatera robusta</i> Gerbil	X	X	X	X
<i>Saccostomus campestris</i> Pouched Mouse	-	-	X	X
<i>Steatomys pratensis</i> Fat Mouse	-	X	-	-

8. FISH

8.1 Introduction

The fish of the Usangu Plain reflect the extremes in ecological conditions present. During the dry season they can only be found in the permanent swamps and lakes and residual drainage channels of the watercourses. After rains have inundated the flat grasslands of the "mbuga" and the temporary residual water bodies, *Clarias* catfish move out on to these areas to deposit eggs. These hatch and the young fish make use of the extremely rich but temporary feeding grounds. Here they also form an important item of prey for many water birds as well as presumably for other predators, including invertebrates, other fish, amphibians, birds and mammals. As the waters recede, many of the remaining fish will die unless they can either find a suitable place (possibly by digging deep into mud) in which to aestivate, or can make their way to permanent water.

8.2 Faunal affinities

An examination of the fish fauna, which is commercially harvested, indicated that a single species of catfish *Clarias gariepinus* makes up more than 99% of the fishery (Dunn, 1999). This species is extremely hardy and able to withstand desiccation, and is even able to breathe air using special organs. They thus can survive the conditions of low oxygen found in the temporary and permanent swamp waters.

Other species in the commercial fishery include (see table 6.1):

- "Tilapia" in the genus *Oreochromis* make up only 1-2% of the total catch
- Elephant snout fish
- several other smaller species, smallest of which is about 67 mm in total length.

Few details are available as to which fish species are caught where, in what specific ecological situation, for example. More biological details on each would be needed before it was possible to comment on the ecological role and significance of these species. Which are herbivores? What is their role as grazers? Predators? Prey for other organisms? What is the fish biomass for a particular area, or portion of the wetland? There is great temporal variation in fish biomass from season to season, i.e., zero for vast portions of the plain in the dry season to tens of thousands of kilos in the wet season, when some species move on to the flooded flatlands to deposit eggs (Dunn, 1999). How much dung do they produce, and how important is this (if indeed it is) to the Usangu wetland ecosystem? What are the relationships between fish populations down-river and those of the wetland?

Fisheries studies have understandably focused on species of commercial importance. However, given the vast area of the wetland, it is possible that smaller species of no commercial value but of biodiversity interest have been overlooked. A sampling programme designed to cover certain particular areas and aimed at smaller sized fish would probably reveal small members of the families Cyprinidae and Cyprinodontidae, as has recently been shown to be the case in the Serengeti ecosystem (Farm, 2000).

8.3 Endemism

Currently, no endemic species of fish is known from the Usangu study area.

8.4 Conservation status

None of the species identified is regarded as threatened or endangered.

8.5 Threats to fish diversity

One possible major threat would be reaching unsustainable levels of capture (estimates of what such sustainable levels would be have yet to be determined), especially if the permanent swamp was to shrink and refuge areas thus decline. Another is the introduction of non-native fish species, or species, which are native to Tanzania but not currently, found in the Usangu catchment. Experience elsewhere in East Africa would suggest that whatever fisheries strategies are adopted, the introduction of non-native species should be avoided at all costs. Local residents also need to be made aware of the grave dangers of either introducing non-local fish to the Usangu system.

Similarly, no new species of aquatic vegetation should be introduced; millions of dollars have been spent on attempts to reduce the population of the introduced Water Hyacinth on Lake Victoria. If this or another aggressive weed species were to find its way into the Usangu wetland area, the ecology would very likely be negatively affected.

Table 8.1 Fish species diversity (based on species taken for food in the local fishery)

Name	Importance in Catch
Clariidae: Clarias Catfish <i>Clarias gariepinus</i>	99%
Cichlidae: Mouth Brooders <i>Oreochromis urolepis</i>	1-2%
Mormyridae: Elephant-snout Fish <i>Marcusenius livingstonii</i>	minor
<i>Petrocephalus ?steindachneri</i>	minor
Mochokidae <i>?Synodontis</i>	minor
Schilbidae <i>? Schilbe</i>	minor
Cyprinidae <i>?Labeo</i>	minor
<i>Barbus ?paludinosus</i>	minor

9. KEY BIODIVERSITY ISSUES AND SUGGESTIONS FOR FUTURE WORK

For many people in Tanzania, the key biodiversity issue of the Usangu wetland and environs is their ecosystem function as collectors and regulators of water to the Ruaha River, and eventually to Mtera Dam. On a more local scale, the people who live in and around the wetland are most concerned with sustainable utilisation issues, such as woody plant values for building materials, fuel, medicines, and grazing and irrigation rights.

Biodiversity issues relating to sustainable use are discussed in separate SMUWC project reports such as fisheries, livestock, range, livelihood study and others. These and others are referred to in the following discussion.

As a result of the initial project fieldwork and other studies in the eastern wetland, the focus of work shifted in 2000 towards the western wetlands and the fan areas. Neither of these was included in the initial terms of reference for fieldwork, yet information on their biodiversity is crucial to any description and understanding of the larger Usangu area. Future studies need to address specific areas which have remained unsampled and which it is felt are critical to the understanding of the Usangu ecosystem and/or its relationship with Ruaha National Park.

9.1 Invertebrates, nutrient cycling, etc. in the wetland ecosystem

A topic of critical importance to the understanding of the Usangu wetlands and environs is that of the role of invertebrates and aquatic plants in the cycling of nutrients. At the time of writing (January 2000), no detailed information is available on this topic. Yet these organisms and the manner in which they supply nutrients may very well be the basis for future sustainable or other-use of the resources of the wetlands.

According to historical accounts (see Wildlife Report) early visitors to the Usangu area found large concentrations of game mammals, including grazers. Detailed counts or descriptions of the impacts of these animals on the area, especially the plains, are not available. However, the dung from these wild mammals would have contributed to the energy and nutrient flows in both the terrestrial and aquatic systems. In seasonally dry lands in Tanzania, such as Tarangire National Park, dung beetles have been shown to play a significant role in dung breakdown. Livestock dung has now replaced that of the wild mammals, and contributes to both soil and aquatic fertility. Studies elsewhere in the tropics suggest that termites are important in cycling nutrients from vegetation, and may play a role similar to that of earthworms in more temperate climates. The breakdown of dung and the remaining vegetation plays an important role in providing nutrients for aquatic invertebrates, tadpoles, fish and thus to other organisms in the food chain.

In Tanzania generally there are few studies describing aquatic invertebrates in either riverine, permanent or temporary wetland ecosystems. Petr's work (Petr, 1974) relating to the Ruaha River system discusses mainly invertebrates as dietary items for fish. Freshwater prawns are known to occur and may be of some local importance as food; freshwater crabs are also eaten by the Wahehe people of Iringa region.

In contrast, in southern Africa, where freshwater aquatic ecosystems have received more attention, methods exist for assessing the presence or absence of groups of aquatic invertebrates and associated organisms using a scheme known as SASS 4 to monitor water quality (Thirion, Mocke & Woest, 1995).

It would seem prudent to recommend that:

- a) Specialist studies be conducted on “aquatic” biology, including at least basic descriptions of macrofauna and flora. Depending on these and other findings, it might then be necessary to examine microflora and fauna. Comparisons could be made among temporary wetlands, permanent swamps, the eastern and western wetlands, streams and the Great Ruaha river look at microflora and fauna.
- b) Depending on the results, a monitoring system using these organisms might be developed as one way of monitoring wetland health.

9.2 Sustainable use of natural resources in Usangu

9.2.1 Vegetation

As has been noted earlier, many of the vegetation issues are directly related to grazing and its effects on the edges of the permanent water, the plains, and the woodlands. Also important are levels of use. For example, it was noted that on ridge tops (along the main road from Mafinga to Makambako), miombo woodland was stunted; it appeared to have been cut, and in some places was coppicing. It would be useful to know the regeneration rate for these trees, how long ago they were cut, etc. Also needed are details of how much wood is used as fuel, for poles, etc by villagers. This would allow a rough estimate of how much wood is used by each household. Charcoal making is often uncontrolled in Tanzania. With the high human population in the area, there is a need to study production schemes and methods and to suggest a control mechanism which encourages the charcoal makers to have a stake in the land from which they remove trees. Relatively few detailed studies on charcoal production under such situations are available in Tanzania (Monela, O’Kjting’ati & Kiwele, 1993).

Also needed are details of how much wood is used as fuel, for poles, etc by villagers. This would allow a rough estimate of how much wood is used by each household. Studies such as those by Kikula & Nilsson (1982), Mascarenhas, Kikula & Nilsson (1983) and Kikula (1997) would form useful starting points and would permit some comparisons.

No work at all was done along the Ndembera; since the inception of the project, observations have been shown that this is largely a seasonally drying wetland and is not permanent and so is of a lesser priority at this time.

Recommendations: There are no data as to the level of use of what would seem to be commercially (albeit locally) important species of medicinal plants. General studies on utilisation of vegetation for specific purposes are required.

A sampling of the vegetation of the western wetlands and associated fans for the purposes of comparing the results with those of the earlier study is suggested.

9.2.2 Fish

The main direct biodiversity issues for fish are related to the sustainability of the fishery in the permanent water; the effects of any proposed management and conservation practices on productivity and therefore the fishery; and the possible presence of species of interest because of their conservation value, such as endemics.

The general species diversity from the small-scale commercial fisheries was very low and it was deemed unlikely that further detailed sampling would yield many other species.

If for some reason, such as pollution, disease, or decline in inundation, fish populations were to “crash”, then this obviously would have severe effects on fish predators and on large concentrations of water birds.

Further data may be needed to assess the effects of fishing in the permanent water. Under earlier natural conditions, all fish trapped in pools far from water would either have died from predation or exposure to high temperatures. Thus it is clear that fishing in the temporary pools can have little effect on stocks. However, intensive fishing of the residual waters may have an effect on the breeding stock. At first glance current dry-season fishing levels in the permanent pools appear quite intensive; correlation of activity levels to the effect on breeding stocks is required.

There is a need for a fisheries survey of the western area of the wetlands to ensure that no local endemic small species of fish are present, as well as for the purposes of comparing the findings with those of the eastern wetlands.

Also related to the use of fish biodiversity are questions such as which woody species and what volumes of these are used for smoking fish; does their removal now, or will it in the future, impact on floral and faunal biodiversity in the woodlands.

9.2.3 Amphibians

The key issue related to amphibian biodiversity is the need to manage the woodlands and thickets surrounding the plains to ensure sufficient cover to protect amphibians during the dry season. Studies in Tanzania and South Africa have indicated that seasonally breeding dryland amphibians require woodland, termitaria and forest at the edge of the temporary pools in which they breed and in which the larvae develop and feed. Simply conserving wetlands and pools is insufficient to guarantee the long-term survival of the amphibians.

Areas and habitats which are of interest but which remain unsampled are those of the northern portion of Usangu Game Reserve, on the border with Ruaha National Park.. A list of species from this area would be useful in assessing the efficacy of the Ruaha National Park and the Game Reserve in protecting amphibians and identifying any gaps as regards habitats and species between the two protected areas.

For a project with the wide scope of SMUWC, it is impossible to sample all areas of potential interest to amphibians. However, it is important to sample representative habitat types, even if this is not done with the same amount of sampling intensity as was used in the eastern and western wetlands. The most important gaps in information regarding amphibians are those for the species which breed along the Ndembera, small seasonal wetlands which may be ephemeral in nature but important to certain species or local populations for breeding, and information on amphibians which are able to utilise the habitat provided by large scale or small-scale rice cultivation.

It is therefore recommended that sampling focus on those areas which have not yet been examined. Ideally the work to the north would be conducted using the same techniques as in the two wetlands sampling sessions, but surveys in other areas could be night visual and auditory sampling rather than which would permit sampling larger areas in less time.

9.2.4 Reptiles

As is the case for amphibians, reptiles also depend on the continued existence of suitable habitat at the edge of the wetlands, that is, the woodland and thickets and termitaria. Further surveys of reptiles are also needed in the northern portion of the Usangu Game Reserve, for the same reasons

as stated for amphibians. Given the high probability of continued human pressure in the area, it is unlikely that there will be much serious conflict between humans and crocodiles, since local fishermen stated that these were not usually encountered in the wetland. However, if greater levels of enforcement were to reduce human pressures in the Game Reserve, then crocodiles might return in larger numbers, increasing the chance for conflict with fishermen and others.

Given the large export market for live reptiles, there is a possibility of unsustainable harvesting of various reptile species, but this trade is already controlled to some extent by the Wildlife Division and as far as its known, there is no over-harvesting of animals for the trade in the Usangu area.

Other potential threats to reptiles include pollution or other changes in water quality which might have long as well as short-term effects on the aquatic reptiles, especially terrapins.

If adequate cover is available, many reptiles should be able to withstand seasonal “cold” fires. However, if the soil and vegetation characters are greatly altered, for example, through removal of trees and destruction of termitaria, reptiles which rely on these for use as refugia will become vulnerable to the effects of fires, especially if these are more frequent than under a natural level of occurrence.

9.2.5 Birds

Grazing and water birds: The earlier section on birds outlined a number of issues and threats to bird biodiversity. One is that of the grazing pressure on the grass as the temporary pools on the plains rapidly dry out. No detailed data exist on how fast the livestock deplete the cover, but anecdotal evidence suggests that it is extremely rapid. Disturbance, removal of cover and trampling from the intensive grazing by livestock all have severe negative effects on adults, as well as eggs and nests. Those species of birds whose young require a relatively long time to become independent will suffer most.

Although large numbers of grazing cattle may indeed cause severe damage to birds, limiting the feeding grounds of some, and preventing the successful nesting and raising of young by others, it is not necessarily the grazing itself which is harmful, but its scope and intensity. For example, historically it is known that large numbers of grazing bovids were present on the Usangu. Yet it seems unlikely that the plain was ever as completely denuded by wild mammals as it is now by livestock.

It is recommended that a study be conducted to assess the temporal and spatial effects of the influx of the cattle back on to the plains as regards the nesting and feeding of critical species of wetland dependent birds.

Uniqueness of species assemblages of birds: The Usangu is unique and its species assemblage is not replicated on any of the other wetlands in East Africa. If substantial areas of the floodplain are not maintained, there will be a loss of biodiversity and corresponding ecosystem values. Already, both the Wattled and Crowned Cranes appear to have become drastically reduced in numbers. Precisely which portions of the wetland and environs should be designated remains to be determined (see Management Considerations, below).

Numbers: While difficult to quantify precisely, it is clear that thousands of water birds make use of the Usangu area. They concentrate in the areas of permanent water in the driest of periods, but with the arrival of the rains are able to extend their activities, especially feeding on huge quantities of insects, tadpoles and frogs which appear at this time. Many of these birds are Palearctic migrants, others are Intra-African migrants. Birds found on the Usangu may also be individuals who have left drier local ponds to enjoy the permanent water of the wetlands.

The Usangu have been named as one of Tanzania's Important Bird Areas.

Recommendations for further study include continuation of the survey in progress, and an aerial count of the larger Cranes. The western wetlands and fan areas, as well as associated cultivated areas, have not yet been surveyed for birds; sampling needs to be conducted in both the dry and wet seasons.

In conjunction with the livelihood studies, it is important to gather data on who is involved in the bird trade, how much money does an individual make trapping, etc. Such data are lacking from Tanzania.

9.2.6 Small Mammals

As is the case for the amphibians and reptiles, there are few key issues related to this group alone. Most small mammals such as shrews and rodents have large fluctuations in their numbers, with populations crashing as food supplies dwindle—or alternatively, a possible further litter or more if food (because of more than usual rainfall and/or human cultivation) and cover are available. It seems unlikely that there are endemic species of small mammals.

The sampling of medium-sized mammals, for example, genets and mongooses, which occur in lower densities and numbers than rodents and require much more intensive study, was beyond the scope of this exercise.

9.3 Management Considerations

Under the new natural resource related policies, stakeholder involvement and community conservation—as well as utilisation—play an important role. It would be reasonable to expect that utilisation, especially fishing, bee-keeping, grazing and agriculture will feature prominently in any management plans developed by local communities. There is already a precedent for this in the Ugalla Game Reserve project.

Grazing

While it is clear that on the plains many of the effects of cattle are negative for birds (see Bird report), especially for some of the most threatened species, elsewhere under different circumstances cattle may actually maintain open water and suitable habitat for birds.

In at least two well-studied cases, when cattle were completely removed from a wetland system, the results had severe negative effects for some types of water birds. Neither of these cases were situations directly comparable to Usangu. But an examination of one indicates how complex the relationship between grazing and wetlands can be.

The following summary is paraphrased from McCoy (date not available) and describes a situation in Palo Verde, Costa Rica, where cattle elimination resulted in massive invasions of cattail (*Typha* sp.), which in turn eliminated waterfowl habitat.

The marsh studied was 5 km long and 1 km wide. Since 1923, the marsh and associated natural levee of 1000 ha were grazed by 10 000 to 15 000 cattle from November (end of wet season) until March or April. As the upland areas dried, cattle were brought to the marsh. After many years of grazing by cattle at a density of up to 15 per ha, an open marsh resulted, with virtually no tall emergent vegetation and with a diverse flora of some 60 species. During the wet season,

large expanses of deeper water were covered only by *Nymphaea*; shallower islands of low sedges *Eleocharis mutata* were also present.

In December with the onset of strong northeasterly trade winds and with cattle in the marsh, floating vegetation was broken up and pushed towards shallower areas, creating open water in deeper pools and channels. As water levels dropped, bands of exposed soil formed between open water and shallower sedge beds. It was this shallow, open water that attracted the bird life, which came to the marsh at this time. When the marsh had completely dried in late March or April, the emergent vegetation in shallower areas, except the sedge beds, was grazed to soil level or heavily trampled. This biomass reduction from cattle grazing was so great that there was not enough forage to support cattle until the following November.

In 1977 the marsh was made the First National Wildlife Refuge in Latin America, and cattle were completely eliminated from it in 1980. By 1988, what had been small patches of cattail covering about 40-50 ha had grown to cover 95% of the 500 ha marsh. The shallow, open water and soil interface that previously existed in the dry season was no longer present, and numbers of one species of duck fell from 35 000 in 1979 to 3000 in 1988.

Uncontrolled fires in the marsh in the dry seasons of 1981-85 and 1987 also took their toll. Flames from the dried cattail leaves destroyed almost all of a particular species of tree, the only nesting sites from some birds. Almost no other species of plant was able to grow in the dense cattail stands. The elimination of grazing in upland pastures also allowed highly combustible non-native African bluestem grass to invade forest openings and produce more fuel for hotter and hotter fires, and killed more and more trees. Intensive management (underwater mowing) has permitted some return to natural conditions. It is suggested that some cattle grazing should be reinstated in the dry season.

A second example cited by McCoy is that of Ali & Vijayan, 1986, which refers to a marsh in Keoladeo National Park, south of New Delhi. This reference is not currently available.

At Usangu, there is a need to protect certain areas from the negative effect of clear grazing and trampling to ensure the survival of those birds which require specific features of cover and food which currently are not available under the current grazing regime. The information needed to evaluate the effect of this trampling and grazing would be provided by the study suggested earlier.

10. THE BIODIVERSITY VALUES OF THE USANGU PLAINS AND WETLANDS

10.1 Economic valuation of the environment

The traditional approach to environmental values was to dismiss them as 'intangibles'. There is now much greater understanding and more widespread acceptance that the environment does have real value. However, to enable these values to enter into economic assessments, they need to be quantified. Unfortunately, valuation techniques for the environment are relatively recent and not fully developed. The problem of attaching values to environmental goods and services remains difficult, and subject to much discussion.

In brief, environmental valuation (total economic value) is often divided into use and non-use values. *Use values* derive from:

- Direct use values of the environment, such as for hunting, tourism, and recreation. These are normally directly measurable (e.g. tourism revenues)
- Indirect (ecosystem function) value, that is functions undertaken by the environment which benefit mankind, such as atmospheric condition and climate control, water purification, nutrient recycling, maintenance of soil condition, etc. To the extent that parallels might be identified, such as costs of equivalent water treatment, actual values may be assigned; other function values are more difficult to assess
- Option value, which is the value of retaining options for the future. Our knowledge of the environment is very limited; not all ecological functions and values can currently be identified and assessed. For example, pharmacological developments are frequently based on naturally occurring substances. Further, the requirements and demands of future generations are unknown, and may be significantly different from those of current generations. There is therefore value to retaining options, although this is difficult to assess.

Non-use values include 'existence value' – the satisfaction of knowing that the resource is there and in good condition. Such values are hard to measure and are disputed by some economists. However, there are, for example, many 'wildlife' charities which raise large amounts of money from people most of whom have no possibility of direct benefit. The act of preserving a habitat or species, even if there is no chance of personally visiting/seeing it, is sufficient return. The amount thus donated to such charities is one measure of 'existence values'.

Much work remains to be done in this field. However, the above breakdown offers a basic structure for assessing the types of economic value of the Usangu biodiversity and associated resources.

Quantifying biodiversity and wildlife values in economic terms is a difficult and involved task and, as a discipline, environmental economics is still undeveloped in Tanzania. As of yet, there are no practical examples in the literature where the total economic value of one hectare of East African savannah, wetlands or forests has been determined. However, all of these habitats play a critical yet unrecognised economic role in the everyday lives of Tanzanians. As long as the supply of these "ecosystem services" is adequate they tend to be ignored and, as a consequence, the ecosystems are often damaged irreparably by other forms of economic activity. Once the supply of a particular ecosystem service becomes limiting, such as the flow of water from the Usangu, assigning an economic value to the ecosystem and ensuring its long-term health becomes a local, regional or national priority. It is at this juncture that an analysis of the total economic value of the ecosystem in question should be made to determine what the best use of this will be.

Would the Usangu wetlands be of more national value from the maximised production of fish products? Would Usangu be of more value in terms of water catchment, flood control and hence,

greater financial output if the entire area were converted to paddy fields? Or would a healthy wetland functioning with a full complement of its biodiversity, be of more national value than either of these. These are questions that must be asked and answered to determine the future of the Usangu wetlands.

Although there are no Tanzanian examples, it would be useful to look at two Canadian examples. In Canada the total value assigned to wildlife on a national scale is \$7 billion and the industry surrounding this sustains 126 000 jobs. Also in Canada, the total value of one hectare of healthy wetland has been determined as \$50 000 for the function of water purification and a pollution sink, and an additional \$100 000 in regulating flood peaks (Edwards and Abivardi 1998). Often the value of an ecosystem can be determined by calculating the replacement value for the ecosystem services. For example, how much then will it cost to replace the power shortfall in the national grid resulting from reduced water delivery from Usangu? This is only one example out of many ecosystem services provided by the Usangu wetlands.

The above refer to direct and indirect use values. These are things which it is possible to directly measure or, at least, to conceive and to simulate. However, what of non-use values? One measure of non-use values is the value of contributions to conservation by those who expect no visible return to themselves. For example, in Tanzania, Birdlife International supported by United Nations is investing US\$7 000 000 (?) in enhancing biodiversity conservation in Africa in Important Bird Areas. The Usangu wetland is one of the selected areas. Birdlife International is an international NGO supported by donations from individuals, most of whom have no expectation of visiting Tanzania or of receiving any measurable benefit from their contributions.

Some possible examples of values which could be quantified are given in table 10.1. This requires further development during the coming year.

A detailed discussion on environmental values is presented in the 'note on economic analysis' presented as a Technical Annex to this Interim Report. The remainder of this chapter focuses on more qualitative aspects of environmental valuation.

10.2 Qualitative approaches to valuation: valuing, using and conserving biodiversity

Not surprisingly, there is often disagreement about the values of biodiversity, the scale of biodiversity issues, and how biodiversity should be used. Simplistically, these might be summarised as use by whom? when? and for whose benefit? Are values highest at a local, national, or global level? Table 10.2 attempts to summarise some of these values for the SMUWC project area; this table is still under development, and will be gradually filled in and modified as information becomes available.

Three subsections of biodiversity -- genetic, species and ecosystem -- were discussed in chapter 1. One approach to valuation is through analysis of these different biodiversity aspects.

10.2.1 Genetic Diversity Values

Issues relating to genetic diversity values are among the most complex from a legal point of view. Many of the important points for discussion on genetic biodiversity are financial and are related to values associated with biodiversity and its sustainable use. Others questions focus on intellectual property rights.

How does one address issues of "use and ownership" of genetic material found naturally within plants and animals? Can modified genes be patented? If a major pharmaceutical company spends millions of dollars to screen plants for pharmacologically active compounds and uses these to make medicines, how do citizens of the country in which the plant is found obtain benefits? How does the

government of that nation share profits? Even more complex is where the plant has been actively protected by a government (for example, through the establishment of a protected area such as a park or forest reserve). Does profit sharing still occur when the same or a different drug company synthesises an active plant compound and markets this product instead of harvesting it sustainably from the wild? In other words, if Tanzania invests in protecting its genetic diversity for international benefit, what assurance does it have for sustained returns against the possibility of substitution by synthetic products produced in other countries?

The Convention on Biological Diversity (CBD), signed at the Rio Convention in 1992, begins to address these issues. Proposals were made for the sharing of commercial benefits from biological components between the source countries and the 'developers'. Sharing included both direct payments and 'participation' in development, for example through the establishment of in-country research facilities and associated training. The details will be gradually established through protocols and other agreements. However, the CBD points the way forward; such developments could, potentially, become important revenue sources for developing countries which contain most of the world's genetic resources.

In Usangu, the issue of genetic biodiversity has not been studied in detail. As far as is known, there is no indication of the presence of species unique to Usangu which are of particular value because of their genetic composition, other than in the sense that all species are potentially useful. The plant and animal species so far identified would seem to be relatively widespread, and there is no reason to think that their genetic value is unique or limited to the Usangu area. Probably the greatest potential genetic diversity values lie in the woodland plants, and indeed, many of these are already used locally as medicinal plants.

10.2.2 Species Biodiversity Values

Issues relating to species diversity include those such as who has rights over wildlife and vegetation? How are people compensated when they are displaced by the creation of a protected area? Is it possible to allow some sustainable use of wildlife within Game and Forest Reserves by local people? Perceptions of values may differ greatly; certain species of large mammals might be viewed very differently by policy makers in Central Government and by villagers.

Species biodiversity values may be considered at several levels. A basic distinction is made between values associated with direct and indirect use. A third category might best be described as "non-consumptive" use; often this category is considered among "future option" values. Depending on the level of use and its timing, the three categories of use and value may not be mutually compatible. However, in some cases all three sets of values may be maintained at sustainable levels, if the use is sustainable and users are properly managed.

Also associated with biodiversity values is the issue of value for whom. In Usangu, it is often possible to distinguish local, national and international values. Many of the direct use values are those of the local level, while others may be at the national or international level.

Values attached to species biodiversity: the ihefu

In the *ihefu* permanent wetland, certain species of reeds are used for thatch and for making traditional "grass" mats and thus have high **local** value. Indirectly, this vegetation also provides habitat for feeding and breeding fish, and fishermen may on occasion destroy these species of plants in their fishing activities. Herders make use of the new flush of green vegetation on the plains as the waters recede to graze their cattle. A non-consumptive value of the vegetation is that it provides breeding and feeding habitat for birds, small mammals, amphibians, reptiles, and many species of invertebrates.

Some of the water birds of the Usangu are regarded at a local level as pests to rice farmers and hunted and killed, or killed with poisons. Such a “consumptive” use, however, might greatly reduce the uniqueness value of the area for birds. This in turn would reduce the value of the area as an ecotourism (in this case, with a focus on birds) destination. This tourism could be local in value (providing employment and markets to local residents) but would also have **national values**. Although often seen as “non-consumptive” or at least “non-invasive”, if not carefully planned and managed, tourism can have negative effects on local natural resource use and therefore on biodiversity.

It is not clear from the information so far available how important Usangu is at the local level as regards the capture of birds and reptiles for the international export trade. There is no evidence to suggest that the crocodiles found in the area are being harvested for the trade in their skin. If managed well and tightly controlled, these local use values are not necessarily incompatible with protecting with what is the most important species biodiversity value of the Usangu -- that is, as a **local, national and global** feeding and breeding ground for wetland birds.

The *ihifu* and surrounding area is one of high species diversity and would appear to be of probable critical importance to a number of water birds for both breeding and feeding. Two species of special importance are the Wattled and Crowned Cranes. Many of the waterbirds, but others as well, are Intra-African or Palearctic migrants. The Usangu has already been identified as an Important Bird Area in Tanzania.

As of April 1999, the Tanzanian government has officially approved the Ramsar Convention. The signed instruments have been deposited with the appropriate international authorities and await the formal registration process. The first Ramsar site chosen is the Malagarasi complex; other suggested sites include Lake Manyara and Lake Natron. The Usangu wetlands meet the criteria for qualifying as a Ramsar site; that is, the site must be used on a regular basis by more than 20 000 water birds, or by a minimum of 1% of the known biogeographical population of a particular water bird (Baker, 1996).

In terms of a non-consumptive species biodiversity value, birds rank high on a national and global value.

Values attached to species biodiversity: the woodlands

In the woodlands, the major **local** consumptive use, and therefore local value of biodiversity, is the cutting of vegetation for timber, fuel, fencing, house construction, charcoal production, etc. Depending on human and cattle population pressures in the area, such use is expected to increase. At low levels of human population such a use might be sustainable, but at least in places, the use appears unsustainable. If a significant number of large trees, especially older individuals with holes and snags are removed, this will result in loss of species diversity values for species of birds and smaller vertebrates as well as invertebrates that depend on these trees for nest sites and shelters.

The long-term effects of the alteration of the vegetation of the woodland by grazing and by clearing for agriculture are yet to be determined; certainly as noted above there would be a **local** loss in species diversity of both plants and animals. For many species dependent upon the woodlands for shelter and cover, the loss of dry season refuge sites would be important.

10.2.3 Values attached to ecosystem biodiversity

Ecosystem diversity issues are usually of a large scale and are related to the complex, long term processes and interactions, often termed ecosystem functions. Common examples include

maintenance of climate, purification of water, waste management and recycling, flood control, groundwater recharge, etc.

As far as is known, no attempt has ever been made in Tanzania to place a direct value on an ecosystem in Tanzania. However, it is frequently pointed out that, for example, if the catchment forest ecosystem functions in the Uluguru and other related mountain forests were greatly altered, the economic cost of the resulting loss of water to Dar es Salaam would be huge.

Recently, two outstanding examples of how ecosystem function values may be valued at different levels have come under scrutiny. The first was the proposed construction of large-scale prawn farm ponds in the Rufiji delta. This is an area occupied by many people who value the biodiversity of the mangrove and associated ecosystems for a variety of purposes. The proposal resulted in a public outcry when it became clear that the local residents placed a high value on the mangrove ecosystem for their livelihoods. A second example is the failure by developers to appreciate the scope of reduced catchment quality on water flow reaching the Pangani river hydropower station. Questions such as ‘will activities sometimes hundreds of kilometres away on a catchment, such as clear felling of trees, burning of grasslands, or abstraction of water, affect the quality and quantity of water flow downstream?’ are often ecosystem function issues.

Ecosystem values of the ihefu and wetlands

In contrast to many of the direct uses mentioned above which are largely important at a local level, the ecosystem values of the *ihetu* and wetlands are important at a **national** scale. Certainly it was these national values and concern over the ecosystem functions of the Usangu in regulating water flow to the Great Ruaha river and eventually to Mtera Dam which caused much of the interest, and indeed, development, of the SMUWC project.

Maintaining the ecology of the Usangu plains provides indirect value which may be seen as a component of many of the direct use values:

- to the extent that the *ihetu* acts as a reservoir, it may be central to maintaining flows in the Great Ruaha river throughout the year
- the *ihetu* swamp certainly acts as a modulator of flows, smoothing out the flow and generally preventing downstream flooding
- direct uses of hunting, tourism, livestock and fishing are all dependent on the productivity of the area, which in turn depends on the maintenance of the ecosystem. For example, loss of the wetland – woodland interface may lead to severe reductions in birds, small mammals, amphibians and reptiles. As these are the feed source for higher order predators, which might be severely reduced or disappear. Similarly the productivity of the fishery is dependent on the breakdown of dung and other organic debris, releasing nutrients for the fish
- the *ihetu* also certainly serves to ‘clean’ water passing through it, to the benefit of downstream users. Such purification value will increase with increased use of pollutants (e.g. agro-chemicals) in Usangu and/or increased downstream water use (domestic, industrial).

Issues such as the assessment of ecosystem health are not easy to address when there is not even knowledge of the basic composition of the macro and micro invertebrate and microbial faunas which must play an important role in the functioning of the permanent and seasonal wetlands as well as the surrounding habitats. Data on hydrology and water flow were also not readily available prior to the SMUWC project.

Conserving biodiversity will, of necessity, involve strategies policies and legislation that has the participation and support of those who value it the most. When these values are perceived as differing greatly, conflicts are almost certain to arise.

Table 10.1 Possible sources of economic values

L = local; N=national; I = international

Biodiversity Value	Direct Use	Indirect Use	Option	Non-Use
Ihefu				
Genetic values		Possible value for future breeding of fish, etc. (L,N,I)		
		Potential value of pharmaceutical compounds from frog skin, etc. (N,I)		
Species Values				
Grass	Thatch (L)	Habitat for Fish (L)		
Grass etc.	Livestock food (L,?N if cattle sold elsewhere; we met a buyer for the army from Songea...	Habitat for breeding and feeding birds, amphibians, and reptiles; some small mammals (L,N, I)		
Small vertebrates		Role in food web		
Waterbirds general	Some eaten; may be seen as pests by farmers, L			Ihefu is primary breeding habitats for many species
Cranes, Wattled and Crowned	These and other species seen as pests, so negative value for some L			High value for these two species
Palearctic migrants				Ihefu and surrounding rank grass of high value to many of these
Habitat, Ecosystem Values				
	? direct use of water; fishing, drinking, enables fishermen to travel by canoe (L)	Slows down flow of water, traps soil, allows conversion of nutrients		
				Ihefu is a dry-season refuge for birds which are dependent on moist conditions for survival.
				Ihefu and system collects and "controls" water flow to Ruaha NP and so is of high economic importance for tourism and related businesses.. (N, high)
				Potentially, there is possibility of having a bird viewing-ecotourism on the Ihefu (N, high)

Biodiversity Value	Direct Use	Indirect Use	Option	Non-Use
PLAINS				
Genetic		Possible source of useful plant genes?		
Species				
Grass	Grazing of cattle		Grazing for wildlife	
Crocodiles		Possible export of croc skins (N,I)		
Small mammals, frogs, reptiles		Energy flow; food for other animals		Possible value in international trade for live export
Grass		During seasonal flooding, food, habitat for breeding fish and birds		
Grass	Burned by local people for...?hunting, creating flush of new growth for grazing?			
Ecosystem, habitat values	Combination of wet-dry change allows grazing and fishing in same place but separated temporally (L)			
<i>Woodland</i>				
Genetic diversity		Medicinal Plant development of new products		
Species diversity				
Vegetation, Woody				
	Timber			
	Fuel			
	Fencing, including bomas			
	Charcoal production			
	Building poles			
	Hoe, etc. handles			
	String, rope			
	Kitchen utensils			
	Chairs (stools)			
	Drums			
	beehives			
	Browse for goats			
	Wild fruits			
		Shade for humans and cattle		

Biodiversity Value	Direct Use	Indirect Use	Option	Non-Use
		“trees bring rain” according to some local people		
		Soil stabilization		
		“protect water sources, streams, wells, etc.		Sacred groves
	Medicinal plants			
		Most small vertebrates require woodlands to shelter in dry season		
		Birds require old, hollow trees for nesting sites		
Large, older trees with snags				Required habitat for a variety of breeding birds such as hornbills, woodpeckers, barbets; busbbabies, etc.
Non-woody plants				
	Mushrooms			
Western area				
Genetic				
Species diversity				
Ecosystem diversity				
“Fan”				
Genetic diversity				
Species Diversity				
Ecosystem Diversity				

Table 10.2 Biodiversity values

Biodiversity Feature	“Local” value	Southern Highlands, possibly Zambia	National	Africa Regional	Global
<i>Ithefu and wetland ecosystem</i>	+++ grazing, water, resources gained from woodlands		+++ regulating water; allowing large herds to feed; supports many people, etc. Also supports tourism industry because of flow to Ruaha NP		
<i>Aquatic Vegetation</i>					
fishing floats					
bait					
thatch	+++				
food?					
medicinal	+++				
<i>Terrestrial Vegetation</i>					
Woody					
woodland and thicket	+++	possibly ++			
woody species					
Timber	+++	possibly +			
fuelwood	+++				
Charcoal production	++?	possibly +			
Boma construction	+++				
Building poles, etc.	+++	possibly +			
Fence poles	+++	possible trade +			
Hoe and other handles, etc.	+++	? possible trade			
beehives	++ site for beehives				
drums	++				
household utensils, spoons, ladles etc.	+++	? possible trade			
Fruits, etc.	+++ home consumption				

browse for goats, wildlife	+++				
soil stabilization	? data from interviews needed				
“create rain”	++opinion expressed by villagers				
protect water source (streams, wells)	++ opinion expressed by villagers				
sacred sites	Possible, no details available				
shade	++				
leaves	++ natural pesticides				
<i>non-wood</i>					
mushrooms	+++				
medicinals	+++				
grazing	+++				
string, rope	+++				
<i>Aquatic invertebrates</i>					
detritus feeders	+++ since they convert nutrients which results in availability of grass,etc for grazing and food for fish.	Fish are traded, cattle sold	Fish are traded; cattle sold		
role as predators, prey (food for fish, etc)	As above	As above	As above		
<i>Fish</i>	Food, trade	Food, trade	Food, trade		
<i>Terrestrial invertebrates</i>					
break down of organic matter (dung beetles, termites)	? elsewhere in Ea known to be of importance; no	? elsewhere in Ea known to be of importance; no data			

	data				
bees	+++ pollinators/ honey				
role as predators',prey	Important as food for fish, birds	Important as food for fish, birds	Important as food for fish, birds		
role in ecosystem: production of dung; herbivores, carnivores, etc.	+++				
prey for wide variety of animals					
<i>Amphibians</i>					
species values					
endemism					
genetic values			? unknown		
possible medicines, pharmaceutically active compounds			?unknown		
detritus, etc. feeders (mostly tadpoles)	+++ tadples may be important in making energy available to other forms				
prey for inverts (invert food chain)	+++	+++	+++		
prey for vertebrates, especially waterbirds	+++	+++	+++		
as larvae,juveniles and adults					
<i>Reptiles</i>					
genetic:					
species:					

negative:venemous species	+++				
potential trade value (tortoises, some lizards and snakes)	+		+		
negative, crocs	+++				
(crocs may control hippos under natural conditons, but hippos almost all gone)					
<i>Birds</i>					
species: waterfowl high					
Palearctic migrants					
Intra-African migrants			+++		
Dry season refuge?			+++		
possible pollinators, etc?	No details				
negative: quelea, other pests?	+++				
food source	+				
trade (finches)	+				

<i>Small mammals</i>					
rats/mice pests	+++				
diversity					
normal ecosystem role as herbivores and prey for others	+++				
seed dispersal/ fungus spreading?	Unknown				
food	++				
<i>Larger mammals</i>					
Cattle dung: role as enriching food chain	+++	+++	+++		
monkeys (pest)	+++				
Wildlife: formerly, dung would have been produced by grazing herds of wildlife					
livestock – food	+++	+++			
livestock – income/ trade	+++	+++			
goat dung (storage agent/preservative for maize)	+				
cattle/goats symbolic/ social e.g. bride price	+++				
Tourism	+++potentially local people could benefit from taking visitors out in boats, etc. for birding, fishing(?)...				
Uniqueness value					

11. SUMMARY AND CONCLUSIONS

The SMUWC project is charged with the responsibility of defining options for water management in Usangu. All options will, inevitably, affect the Usangu wetland and plain. Ultimately, therefore, the SMUWC project will need to estimate, for each option, the ecological impact and the importance of that impact. It is faced with the most difficult decision making: if the swamp disappears, does it matter? For cases in which maintaining the swamp competes with other activities, what are the relevant values associated with each option?

It must be recalled that most of the work undertaken in the biodiversity studies has focused on the eastern wetland. Within this context several conclusions may be drawn:

- the key habitats are the perennial swamp and the wetland – woodland interface. The seasonal wetland is directly important primarily to fish productivity. However, for animal biodiversity, of greater importance is maintenance of the seasonal water – land interface and ensuring that sufficient of the woodland habitat is maintained in conditions sufficiently natural to allow the continued existence of the variety of species that depend on it.
- the woodland component of the wetland – woodland interface is under stress from human activities, such as cultivation, livestock, and wood harvesting. On a local scale, it is the woodlands which are under the most threat, and any further reduction in their size or further fragmentation might impact on other species, especially those requiring old trees for nesting and concealment.
- with the exception of the avifauna, there would appear to be few conservation issues related to endemism or species threatened at the regional or global levels. There is no known endemism and few of the identified species are under threat at regional and/or national and international levels. Habitats are also generally not under threat on a regional or larger scale. The dryland habitats are common with Tanzania and elsewhere in eastern and southern Africa. Larger wetlands are also available both within Tanzania and elsewhere
- that being said, wetlands everywhere are under pressure and there are strong arguments to be made in favouring preservation of wetlands, at least to the degree of demanding that it be shown *why* a wetland loss is justifiable. Too frequently the onus of proof falls on those seeking to preserve the status quo
- the situation with the avian fauna is an exception to the above general comments. The combination of perennial swamp, seasonal wetland, dryland thorn bush, miombo woodland, and the nearby mountains provide a habitat complex replicated in few other areas of Africa. Up to 500 species of birds are thought to exist in Usangu, about 80% as residents. By way of comparison, only about 200 species exist in the whole of Europe. The birdlife also perhaps offers the greatest potential for development of tourism. It can also be preserved, through careful management, without greatly impacting other uses of the area, including livestock grazing. Such a multi-use form of management is that favoured by the Ramsar site approach to conservation.
- threats to the biodiversity of the area come from many sources. However, by far the most important are actual and potential changes to the hydrological regime, due to human activities. The direct impact of human activities on the perennial swamp (fishing) and seasonal wetland (livestock) are not clear, but are likely to be manageable. Of greater concern is degradation in the dryland at the wetland – woodland interface.

The western wetland has received little attention. As the western wetland lacks the perennial swamp, the biodiversity situation there will be somewhat different. Indeed, one of the current hypotheses of the SMUWC project is that the western wetland is much more dynamic than the eastern wetland; essentially it is believed that the length and degree of flooding in the western wetland may show much greater inter-annual variation than in the eastern wetland. Such dynamism will undoubtedly affect the biological diversity of the area, although whether it will increase or decrease it is difficult to say. Another critical parameter in the western wetland is that human activities are concentrated

here. This provides both increased direct and indirect threats to the biological diversity. Direct threats obviously involve direct interference, such as land use conversion. Indirectly, most critical is that reductions in flow due to irrigation appear likely to have greater impact in the western wetland than the eastern wetland. This is likely, over time, to result in reduced seasonal flooding, changes in vegetation (e.g. loss of grassland and increased woody encroachment), and associated changes in the macro- and micro-fauna. There are strong arguments for a serious assessment of the biodiversity of the western wetland and assessment of likely impacts of on-going changes in the controlling ecological parameters.

In summary, there are no known compelling biodiversity reasons to totally protect the entire wetland. However, the high species diversity and uniqueness values, especially for birds, as well as and ecosystem biodiversity values associated with it at the local, national and global levels, need to be given priority in the decision making process when management and conservation strategies and plans are drawn up. All activities should be assessed in terms of their potential impact on the wetland, and a presumption of proof made in favour of wetland conservation.

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Appendix 1: Checklist of the plants of the Usangu plains

ACANTHACEAE

Blephharis affinis.Lindau
B. buchneri. Lindau
Crabbea velutina. S. Moore
Hygrophylla auriculata (Schumach.) Heine
Isoglossa laxa Oliv.
Justicia betonica L.
Monechma debile (Forsk.) Nees
Peristrophe bycalyculata (Vahl) Nees

AZIOACEAE

Glinus lotoides L.

ALISMATACEAE

Limnophyton obtusifolium Miq.

AMARANTHACEAE

Achyranthes aquatica L.
Alternanthera nodiflora (L.) DC.
Amaranthus dubius L.
Celosia argentea L.
Centemopsis kirkii (Hook.f.) Schinz
Cleome monophylla L.
Cyathula canceolata Schinz.
Pandiaka rubro - lutea L.
Psilotrichum schimperii Baker

ANACARDIACEAE

Lanea humilis (Oliv.) Engl.
Sclerocarya birrea (A.Rich.) Hochst

ANTHERICACEAE

Anthericum sp.

APOCYNACEAE

Holarrhena pubescens (Buch-Ham.) Wall

ARACEAE

Pistia stratooides

AZOLLACEAE

Azolla nilotica Decne

BALANATIACEAE

Balanites aegyptiaca (L.) Del.

BIGNONIACEAE

Markhamia obtusifolia A. Rich.

BORAGINACEAE

Cordia sinensis Lam.

BURSERACEAE

Commiphora africana (A.Rich.) Engl.

Commiphora mollis (Oliv.) Engl.

Commiphora ugogensis Engl.

CAESALPINIACEAE

Brachystegia spiciformis Benth.

Cassia abbreviata Oliv.

C. singuena Delik

C. siamea Oliv.

CAMPANULACEAE

Wahlenbergia capitata (Bak.) Thulin

CAPPARIDACEAE

Boscia mossambicensis Klotzsch

Capparis tomentosa Taub.

Maerua edulis DC.

Cadaba farinosa Forssk.

CELASTRACEAE

Maytenus senegalensis DC.

CERATOPHYLLACEAE

Ceratophyllum demersum L.

COMBRETACEAE

Combretum collinum Fresen

C. apiculatum

C. obovatum F.Hoffm.

Terminalia kaiserana L.

T. sericea Burch. Ex DC.

COMMELINACEAE

Commelina africana L.

C. benghalensis L.

COMPOSITAE

Vernonia aemulans Engl.

V. porskeana Vatke

CONVOLVULACEAE

Ipomoea aquatica Forsk.

I. rubens Choisy

CURCUBITACEAE

Cucumis sp.

CYPERACEAE

Cyperus alopecularis L.

C. digitatus Roxbb.

C. distans L.f.

Fuirena umbellata L.

EBENACEAE

Diospyros usambarensis F.White

EUPHORBIACEAE

Euphorbia candelabrum Engl.
Excoecaria bussei (Pax) Pax
Phyllanthus inflata Hutch.
Pseudolachnostylis maprouneifolia Pax
Tragia fuliaris L.

FABACEAE

Aeschynomene cristata Vatke var *pubescens* J.Leon
A. indica L.
A. fundii Taub.
Crotolaria spinosa Benth.
Pterocarpus angolensis DC.
Sesbania greenwayi Gillet
Swartzia madagascariensis Desv.
Tephrosia pumila (Lam.) Pers.
Xeroderis stuhlmannii (Taub.) Mendonca
Zornia glochidiata DC.

GRAMINEAE

Aristida barbicolis Trin. Rupr.
Brachiaria leucacrantha (K.Schum.) Stapf.
Chloris gayana Kunth
C. virgata Sw.
Cynodon nlemfuensis Vanderyst
Dactyloctenium aegyptium (L.) Willd.
Digitaria milanjiana (L.) Willd.
Echinochloa colona (L.) Link
E. pyramidalis (Lam.) Hitch. & Chase
E. scabra (Lam.) Roem. & Schult
Eragrostis caespitosa Chiov
E. castellaneana Chiov.
Leersia hexandra S.W
Oryza longistaminata A.Chiov. & Roehr.
Panicum repens L.
Phragmites mauritianum Kunth.
Setaria incrassata (Hochst.) Hack.
S. homonyma (Steud.) Chiov. (Steud.) Chiov.
S. sphacelata (Schumach.) Moss
Sorghum versicolor Anders.
Sporobolus iocladius (Trin.) Nees
Vossia cuspidata (Roxb.) Griff.

HYDROCHARITACEAE

Lagarosiphon cardafanus Caspary
Ottelia ulvifolia DC.

JUNCACEAE

Juncus sp.

LABIATAE

Endostemon wakefieldii (Bak.) Ashby

LEMNACEAE

Lemna gibba

LENTIBULARIACEAE

Urticularia gibba L.

U. stellaris L.f

LILIACEAE

Asparagus africanus Lam.

MALVACEAE

Azanza garckeana(F.Hoffm.) Exell & Hillcoat

Hibiscus calyphyllus Cav.

Pavonia urens Cav.

Sida alba L.

MIMOSACEAE

Acacia kirkii Oliv.

A. nilotica (L.) Del ssp. *subalata* (Vatke) Brenan

A. sieberana DC.

A. stuhlmanii DC.

A. tortilis (Forsk.) Hayne

Albizia anthelmintica (A.Rich) Brongn.

A. harveyi Fourn.

Dichrostachys cinerea (L.) Wight & Arn.

MORACEAE

Ficus sur Forssk.

NYMPHACEAE

Nymphaea lotus L.

N. nouchali Burn f.

OLEACEAE

Schrebera trichoclada Welw.

ONAGRACEAE

Ludwigia stolonifera (Guill. & Pers) Raven

POLYGONACEAE

Polygonum senegalense Meisn.

P. setulosum A.Rich

RHAMNACEAE

Zizphus mucronata Engl.

RUBIACEAE

Catunaregan spinosa Benth.

C. taylorii Benth.

Canthium burttii Bullock

Gardenia ternifolia Schum. & Thonn.

Kohautia sp.

Pavetta gardenifolia A. Rich var
Spermacoce senensis (Klotzsch) Hiern
Vangueria infausta Burch.

RUTACEAE

Zanthoxylum chalybeum Engl.

SAPINDACEAE

Zanha africana (Radlk.) Exell

SCROPHULARIACEAE

Cynium filicalyx Benth

STERCULIACEAE

Waltheria indica L.

TILIACEAE

Corchorus aestuans L.

C. fascicularis L.

C. olitorius L.

Grewia bicolor Juss

Triumfetta rhomboidea Benth.

TRAPACEAE

Trapa natans L. var *africana* (Not in FTEA for T7, new distributional record)

Appendix 2: Amphibian species found in the Usangu plains

ORDER ANURA

Family Pipidae: African Clawed Frogs

Xenopus sp.

These aquatic frogs are probably *Xenopus laevis*, a widespread and common species. They can survive extreme conditions of drought and temperature by burrowing into mud; they also are able to move over land between bodies of water during moist conditions.

Adult African Clawed Frogs are carnivorous and are significant predators in freshwater aquatic systems. Populations of African Clawed Frogs may reach large numbers and be significant in terms of biomass. Larvae may be captured by predatory aquatic invertebrates such as Giant Water bugs, and both larvae and adults are important prey items for a variety of vertebrates, especially birds and reptiles.

Distribution: Taken in all habitats except the rank grass at edge of permanent water.

Family Bufonidae: Toads

Bufo gutturalis: The Guttural Toad

A common and widespread species over much of Africa, which is basically terrestrial, but congregates in large breeding groups in temporary pools. This species is able to survive drought by hiding in burrows on land and was found to be active even in the dry season in the western wetland.

Distribution in the study area: Found in most habitats in both wetlands.

Bufo parkeri. Parker's Toad

A Tanzanian endemic species that until the Usangu fieldwork was known only from Central Tanzania; it has since also been recorded from northern Tanzania.

Distribution in the study area: A small toad taken in both wetlands only during wet season sampling along the edge of the plains.

Schismaderma carens Red Toad

This species is widely distributed in the drier parts of East and southern Africa. A single animal was trapped.

Distribution in the study area: Only a single animal taken in mixed miombo woodland in the wet season sampling.

Hemisotidae

Hemissus guineensis Western Shovel-nosed Frog

This species was present in large numbers during the wet season sampling in both eastern and western wetlands. Its larger size and distinctive black and yellow coloration distinguished it from much more common and widespread *H. marmoratum* with which it is sympatric in the study area. This species is little-recorded in Tanzania, but occurs widely in western and central Africa.

Distribution in the study area: found in both the eastern and western wetlands and occurs in large numbers during the rainy season.

Hemius marmoratum Mottled Shovel-nosed Frog

A common species of burrowing frog, widely distributed in East and southern Africa.

Distribution in the study area: Taken in all habitats except the rank grass at edge of permanent water, found in both wetlands.

Arthroleptidae

Arthroleptis sp. Bush Squeaker

Members of this genus are extremely difficult to identify using morphological features. Bush squeakers are found in a variety of habitats, but usually woodland and forest. Some species are very widespread, others are limited to certain forests or mountain blocks. Unlike most other frogs, they do not need free water for reproduction, but the female deposits fertilised eggs in moist terrestrial situations such as in soil, etc. Only a single specimen was taken in the woodland traplines.

Distribution in the study area: Only found in woodland of the eastern wetland, where a single individual was captured.

Microhylidae (often placed in a separate family, the Phrynomantidae)

Phrynomantis bifasciatus Red and Black Frog

A widely-distributed species in East and southern Africa. Able to survive long periods of drought by hiding in vegetation, in moist root masses at the bases of trees, etc. Large breeding aggregations in temporary pools occur.

Distribution in the study area: Found in both wetlands.

Ranidae "Typical" frogs

Hildebrandtia ornata Hildebrandt's Burrowing Frog

A large (up to 7 cm long) species of frog found in seasonally dry country in eastern and southern Africa. Able to withstand desiccation; usually only active after rains, apparently remaining inactive during much of the year.

Distribution in the study area: Found in both eastern and western wetlands in the rainy season.

Hylarana galamensis Golden-backed Frog

A species widely distributed in subsaharan Africa. Known from woodlands and savannas, but its distribution in Tanzania is not yet clearly defined due to undercollecting.

Distribution in the study area: Found only during the rainy season and only in the eastern wetland.

Phrynobatrachus spp. Puddle Frogs

Small frogs of savannas and woodlands, many species are widely distributed. Some are associated with water, but many can be found far from water as long as some minimal amount of water is present, for example, in leaf litter. Probably at least three species are present in the study area, in both wetlands.

Distribution in the study area: Trapped in all habitats.

Ptychadena spp. Grass or Ridged Frogs

Medium sized frogs often found, as the name suggests, in grass, but also in a variety of habitats. Probably at least three species are present in the study area.

Distribution in the study area: Trapped in all habitats.

Pyxicephalus adspersus African Bullfrog

This is the largest species of frog in eastern and southern Africa, males may reach a length of 20 cm. These animals are expert burrowers and go deep into drying mud, and are able to spend most of the year underground. They then seem to emerge "from nowhere" once the rains begin and males set up territories in shallow temporary pools. It takes only about 3 weeks from time eggs are laid until the tadpoles metamorphose into smaller versions of the adults and leave what may already be drying pools. African Bullfrogs are eaten in many places but we found no evidence of this on the Usangu Plains.

Distribution in the study area: Found in both the eastern and western wetlands; abundant in the wet season, but individuals also found inside termite mounds during the dry season in the western wetlands.

Tomopterna cryptotis. Tremelo Sand Frog

Members of this genus are difficult to identify using only morphological features and it is necessary to study tape recordings of the vocalisations in order to identify populations to the species level. The genus has not yet been studied in detail in East Africa.

Distribution in the study area: Trapped in both eastern and western wetlands, abundant during the wet season..

Hyperoliidae Tree, Sedge and Reed frogs

Hyperolius spp.

Distribution in the study area: The species so far detected appear to be restricted largely to the permanent swamps, but are probably present in other small permanent water bodies.

Hyperolius nasutus This and the next two *Hyperolius* species were all found only May, on vegetation in the permanent swamp.

Hyperolius marmoratus

Hyperolius ?pictus

Kassina senegalensis Whistling or Running Frog

The whistling calls of this species are characteristic of the savanna at many localities of subsaharan Africa during the first rains. They seem to disappear soon after, apparently hiding in crevices during the dry season.

Distribution in the study area: found in both eastern and western wetlands. In the dry season sampling in the western wetland, newly metamorphosed animals were leaving drying ponds.

Leptopelis bocagii Bocage's Leptopelis

A widespread species of dry country, ranging from Ethiopia to southern Africa. It apparently spends most of its life underground, only emerging briefly to feed and reproduce.

Distribution in the study area: Found in both eastern and western wetlands.

Species collected by hand but not trapped:

Rhacophoridae Foam-nest Frogs

Chiromantis petersi Peters' Foam-nest Frog

A dry-country Foam-nest Frog, known from eastern and southern Africa. Unlike most amphibians, adults are able to bask in full sunlight, and in the dry season, seem to aestivate on tree bark protected by their extremely cryptic coloration. When the rains begin, several males may mate with a single female, and at night they all cooperate to build a foam nest in vegetation over a temporary pool of water. The nest hardens and the eggs develop out of water, protected in the moist nest. As the eggs hatch into tadpoles, the nest disintegrates and the tadpoles drop into the water below and undergo development and eventual metamorphosis.

Distribution in the study area: Found in eastern and western wetlands.

Appendix 3: Reptiles species found in the Usangu plains

Class Reptilia

Order Chelonia: Turtles, Terrapins and Tortoises

Family Pelomedusidae

Pelusios sp. Terrapin

Several species are common and widespread in eastern and southern Africa. They may be important predators, especially in drying seasonal pans.

Distribution in the study area: Found in both eastern and western wetlands and probably very widespread in the study area.

Family Testudinidae

Geochelone pardalis Leopard Tortoise

CITES Appendix II.

A widespread species in sub-Saharan Africa. Large animals may weigh several kilograms. Able to survive the dry season by remaining sheltered and inactive. Vulnerable to fire if unable to find suitable shelter. Eaten in many places, and in the past has been important in the international live animal export trade. In addition to animals brought to us from villagers around Ikoga, a single animal was taken in a BPFL in mixed woodland. Animals were also reported from near Nyaruhanga; one was found dead on the north end of the *Ihefu* (A. Graham).

Distribution in study area: Probably present in most habitats at the edge of plains and wetlands but might not be able to survive if marooned on the plains and surrounded by water; tortoises are not regarded as strong swimmers.

Kinixys spekei Speke's Hinged Tortoise

CITES Appendix II

Until recently, East African animals were regarded as a single species, *K. belliana*. However, they have now been split, with *K. spekei* as a separate species.

Distribution in the study area: probably very widespread.

Order Lacertilia Lizards

Chamaeleonidae Chameleons

Chamaeleo dilepis Common Flap-necked Chameleon

CITES Appendix II

A common, widespread species in eastern Africa.

Distribution in the study area: Found in woodland near the eastern wetlands, probably widespread but overlooked in suitable woody vegetation.

Gekkonidae Geckos

Lygodactylus sp. Dwarf Day-Gecko

The geckos in this genus have undergone a wide radiation in eastern and southern Africa. Their species boundaries and distributions are poorly understood. The species seen at Rujewa is probably *L. capensis*.

Distribution in the study area: Not trapped but regularly seen on buildings and trees in Rujewa; probably widely distributed in the study area.

Hemidactylus sp.

Hemidactylus mabouae is a common species in eastern Africa.

Distribution in the study area: Seen on buildings in Rujewa. And probably widely distributed in the study area.

Homopholis fasciata Banded Velvet Gecko

A dry country species known from Kenya and Tanzania.

Distribution in the study area: Taken in both the eastern and western wetlands. Often lives in termite mounds or holes in rotting logs so probably widespread in the study area but overlooked.

Pachydactylus turneri Turner's Thick-toed Gecko

A typical dry country species, also known from central and northern Tanzania.

Distribution in the study area: Collected only from the western wetland during dry season sampling but probably more widespread and simply overlooked, as it prefers to remain in hiding inside rotting wood and also to hide in termite mounds.

Lacertidae Typical Lizards

Heliobolus spekei Speke's Sand Lizard

A widespread dry country species of dry country. The Tanzanian records indicate it is probably undercollected, since it is widely distributed. Little is known of its biology, but probably common.

Distribution in the study area: Only a single specimen was taken in a BPFL set in woodland, eastern wetland.

Latastia johnstoni Johnston's Long-Tailed Lizard

A species known from bordering countries of southern Africa and extending into the D.R. Congo. This is the first recent record of this species in Tanzania.

Distribution in the study area: Taken only in the western wetland.

Scincidae Skinks

Lygosoma sundevalli Sundevall's Writhing Skink

A widely distributed species in non-forested areas of sub-Saharan Africa.

Distribution in the study area: Only a single specimen was taken in woodland of the eastern wetlands.

Mabuya planifrons Tree Skink

A common species widely distributed in eastern Africa.

Distribution in the study area: Found at the edge of wetlands in both eastern and western wetland and probably generally widespread.

Panaspis wahlbergi Wahlberg's Skink

A small skink, common in much of eastern and southern Africa, often abundant in woodland. A single individual taken in a BPFL in woodland.

Distribution in the study area: Woodlands of the eastern wetland but probably much more widespread in the study area..

Panaspis megalurus Blue-tailed Snake-Eyed Skink

A Tanzanian endemic previously known only from the dry areas of central Tanzania.

Distribution in the study area: Trapped only in the western wetland.

Cordylidae Plated lizards

Gerrhosaurus major Southern Tawny Plated lizard

A widely distributed species in eastern and southern Africa.

Distribution in the study area: Trapped in woodland of the eastern wetlands. Probably also occurs in Commiphora thickets.

Family Varanidae Monitor Lizards

Varanus niloticus Nile Monitor

CITES Appendix II

Possibly a second species, the Savanna monitor, is also present in drier parts of the study area.

Distribution in the study area: Reported as common by local residents, one seen dead on road to Ikoga. Believed to be widespread. In the study area.

Order Serpentes Snakes

Boidae Pythons

Python natalensis Southern African Python
CITES Appendix II.

The species *P. natalensis* has recently been split off from *P. sebae*, of which it was formerly regarded as a subspecies.

Distribution in the study area. One found dead on road between Mafinga and Rujewa. Reported as common by local residents in the wetlands. Probably very widespread.

Colubridae "Typical" Snakes

Dasypeltis scabra
African Egg-eater

A widely distributed species in eastern and southern Africa.

Distribution in the study area: Found under tent when breaking camp in the wet season, , eastern wetland
Probably very widespread.

Lycophidion sp. Wolf Snake

Wolf snakes are widespread in sub-Saharan Africa.

Distribution in the study area: Only a single specimen was collected in the western wetland but probably widespread in the study area.

Meizodon semiornata Semi-ornate snake

This is a common widespread species in the woodlands of eastern and southern Africa.

Distribution in the study area: Although collected only in the western wetland, it no doubt occurs in the eastern wetland area as well.

Psammphis subtaeniatus
Sand Snake

Distribution in the study area: What was probably this species was observed in the eastern wetlands but it is probably much more widely distributed.

Family Viperidae Vipers

Bitis arietans Puff Adder
A widespread species in sub-Saharan Africa.

Distribution in the study area: Found under tent when breaking camp, December, eastern wetland.
Roadkill reported by A. Graham. Probably very common and widespread.

Family Elapidae: Cobras and Mambas

Dendroaspis polylepis Black Mamba

Recorded in woodland; reported by local residents as common, especially on higher ground when surrounding lower areas are flooded. Presumably present in both eastern and western wetland areas.

Naja nigricollis Black-necked Spitting Cobra

Several seen, probably very common. Specimen taken as road kill at Rujewa by A. Graham. Specimens on road in both eastern and western wetlands.

OrderCrocodylia

Crocodylidae Crocodiles

Crocodylus niloticus Nile Crocodile

CITES Appendix II

Distribution in the study area: Only a few Nile Crocodiles were reported in the aerial surveys.

Appendix 4: Avian fauna

Appendix 4A: Birds recorded in and around the *ihifu* Swamp (eastern wetland), Usangu basin, 23-26 May and 20-23 September 1999.**Total: 190 species****KEY:****WET** = Ihefu Swamp**PLAIN** = Floodplain**ARID** = Arid woodland (Acacia and Acacia/Commiphora)**MIOMBO** = Brachystegia woodland**RES** = Resident**LM** = Local migrant (wanderer)**IAM** = Intra-African Migrant (Austral Migrant)**PM** = Palearctic Migrant

SPECIES NAME		WET	PLAIN	ARID	MIOMBO	RES	LM	IAM	PM
Little Grebe	<i>Tachybaptus ruficollis</i>	X				X	X		
White Pelican	<i>Pelecanus onocrotalus</i>	X					X		
Pink-backed Pelican	<i>Pelecanus rufescens</i>	X				X	X		
Long-tailed Cormorant	<i>Phalacrocorax carbo</i>	X				X	X		
Little Bittern	<i>Ixobrychus minutus</i>	X					X		
Grey Heron	<i>Ardea cinerea</i>	X				X			
Goliath Heron	<i>Ardea goliath</i>	X				X			
Black-backed Heron	<i>Ardea melanocephala</i>	X				X			
Purple Heron	<i>Ardea purpurea</i>	X							
Squacco Heron	<i>Ardeola idae</i>	X					X	X	
Rufous-bellied Heron	<i>Ardeola rufiventris</i>	X				X			
Cattle Egret	<i>Bubulcus ibis</i>	X				X	X		
Great White Egret	<i>Egretta alba</i>	X				X			
Black Heron	<i>Egretta ardesiaca</i>	X				X			
Little Egret	<i>Egretta garzetta</i>	X				X			
Yellow-billed Egret	<i>Egretta intermedia</i>	X				X			
Night Heron	<i>Nycticorax nycticorax</i>	X				X	X		

Hamerkop	<i>Scopus umbretta</i>	X				X			
Open-billed Stork	<i>Anastomus lamelligerus</i>	X						X	
Saddle-billed Stork	<i>Ephippiorhynchus senegalensis</i>	X				X	X		
Marabou	<i>Leptoptilos crumeniferus</i>	X	X			X	X		
Yellow-billed Stork	<i>Mycteria ibis</i>	X				X	X		
Glossy Ibis	<i>Plegadis falcinellus</i>	X				X	X		
Sacred Ibis	<i>Threskiornis aethiopica</i>	X				X	X		
African Spoonbill	<i>Platalea alba</i>	X				X	X		
Fulvous Duck	<i>Dendrocygna bicolor</i>	X				X	X		
White-faced Duck	<i>Dendrocygna viduata</i>	X				X	X		
Egyptian Goose	<i>Alopochen aegyptiacus</i>	X				X	X		
Red-billed Teal	<i>Anas erythrorhynchos</i>	X				X	X		
Hottentot Teal	<i>Anas hottentota</i>	X				X	X		
Yellow-billed Duck	<i>Anas undulata</i>	X				X	X		
Southern Pochard	<i>Netta erythrophthalma</i>	X						X	
African Pygmy Goose	<i>Nettapus auritus</i>	X				X			
Spur-winged Goose	<i>Plectropterus gambensis</i>	X				X	X		
Knob-billed Duck	<i>Sarkidiornis melanotos</i>	X				X	X		
White-backed Duck	<i>Thalassornis leuconotus</i>	X				X	X		
African Marsh Harrier	<i>Circus ranivorus</i>	X	X			X			
Harrier Hawk	<i>Polyboroides radiatus</i>			X	X	X			
Black-chested Snake Eagle	<i>Circaetus gallicus</i>		X	X	X	X			
Bateleur	<i>Terathopius ecaudatus</i>		X	X	X	X			
Tawny Eagle	<i>Aquila rapax</i>			X	X	X			
Lizard Buzzard	<i>Kaupifalco monogrammicus</i>			X		X			
Gabar Goshawk	<i>Melierax gabar</i>			X		X			
Pale Chanting Goshawk	<i>Melierax poliopterus</i>			X		X			
Martial Eagle	<i>Polemaetus bellicosus</i>		X	X	X	X			
Fish Eagle	<i>Haliaeetus vocifer</i>	X	X			X			
Black Kite	<i>Milvus migrans</i>	X	X	X	X	X		X	
Black-shouldered Kite	<i>Elanus caeruleus</i>		X	X		X			
Red-necked Spurfowl	<i>Francolinus afer</i>			X	X	X			
Hildebrandt's Francolin	<i>Francolinus hildebrandti</i>			X		X			

Crowned Crane	<i>Balearica pavonina</i>	X	X			X	X		
African Crake	<i>Crex egregia</i>	X				X	X		
Lesser Moorhen	<i>Gallinula angulata</i>	X				X	X		
Common Moorhen	<i>Gallinula chloropus</i>	X				X	X		
Black Crake	<i>Limnocorax flavirostra</i>	X				X			
Allen's Gallinule	<i>Porphyryla alleni</i>	X				X	X		
Purple Gallinule	<i>Porphyrio porphyrio</i>	X				X	X		
Red-knobbed Coot	<i>Fulica cristata</i>	X				X	X		
White-bellied Bustard	<i>Eupodotis senegalensis</i>		X	X		X			
African Jacana	<i>Actophilornis africana</i>	X				X			
Lesser Jacana	<i>Microparra capensis</i>	X				X			
Painted Snipe	<i>Rostratula benghalensis</i>	X				X			
Caspian Plover	<i>Charadrius asiaticus</i>	X							X
Three-banded Sandplover	<i>Charadrius tricollaris</i>	X	X			X			
Blacksmith Plover	<i>Vanellus armatus</i>	X	X			X			
Crowned Plover	<i>Vanellus coronatus</i>	X	X			X			
Long-toed Plover	<i>Vanellus crassirostris</i>	X				X			
Wattled Plover	<i>Vanellus senegallus</i>	X	X			X			
Common Sandpiper	<i>Actitis hypoleucos</i>	X							X
Wood Sandpiper	<i>Tringa glareola</i>	X							X
Black-tailed Godwit	<i>Limosa limosa</i>	X							X
Black-winged Stilt	<i>Himantopus himantopus</i>	X				X	X		
Spotted Thicknee	<i>Burhinus capensis</i>		X	X	X	X			
Water Thicknee	<i>Burhinus vermiculatus</i>	X	X			X			
Common Pratincole	<i>Glareola pratincola</i>	X	X			X	X		
Grey-headed Gull	<i>Larus cirrocephalus</i>	X	X			X	X		
White-winged Black Tern	<i>Chlidonias leucopterus</i>	X							X
Gull-billed Tern	<i>Gelochelidon nilotica</i>	X							X
Yellow-throated Sandgrouse	<i>Pterocles gutturalis</i>		X	X		X			
Namaqua Dove	<i>Oena capensis</i>		X	X		X			
Ring-necked Dove	<i>Streptopelia capicola</i>			X	X	X			
Mourning Dove	<i>Streptopelia decipiens</i>			X		X			
Emerald-spotted Wood Dove	<i>Turtur chalcospilos</i>			X	X	X			

Brown Parrot	<i>Poicephalus meyeri</i>			X	X	X			
Bare-faced Go-away Bird	<i>Corythaixoides personata</i>			X	X	X			
Didric Cuckoo	<i>Chrysococcyx caprius</i>			X	X		X	X	
Klaas' Cuckoo	<i>Chrysococcyx klaas</i>			X	X		X	X	
Black Cuckoo	<i>Cuculus clamosus</i>				X			X	
Thick-billed Cuckoo	<i>Pachycoccyx audeberti</i>				X		X		
Coppery-tailed Coucal	<i>Centropus cupreicaudus</i>	X	X			X			
White-browed Coucal	<i>Centropus superciliosus</i>	X	X	X	X	X			
African Marsh Owl	<i>Asio capensis</i>	X	X			X			
Pearl-spotted Owlet	<i>Glaucidium perlatum</i>			X		X			
Gabon Nightjar	<i>Caprimulgus fossii</i>		X	X		X			
Fiery-necked Nightjar	<i>Caprimulgus pectoralis</i>				X	X			
Little Swift	<i>Apus affinis</i>			X	X	X			
Palm Swift	<i>Cypsiurus parvus</i>			X	X	X			
Blue-naped Mousebird	<i>Urocolius macrourus</i>			X		X			
Pied Kingfisher	<i>Ceryle rudis</i>	X				X			
Malachite Kingfisher	<i>Alcedo cristata</i>	X				X			
Striped Kingfisher	<i>Halcyon chelicuti</i>			X	X	X			
Eurasian Bee-eater	<i>Merops apiaster</i>		X	X	X				X
Blue-cheeked Bee-eater	<i>Merops persicus</i>		X	X	X				X
Little Bee-eater	<i>Merops pusillus</i>			X	X	X			
Lilac-breasted Roller	<i>Coracias caudata</i>			X	X	X	X		
Scimitarbill	<i>Phoeniculus cyanomelas</i>			X	X	X			
Green Wood Hoopoe	<i>Phoeniculus purpureus</i>				X	X			
Red-billed Hornbill	<i>Tockus erythrorhynchus</i>			X		X			
Grey Hornbill	<i>Tockus nasutus</i>				X	X			
Ground Hornbill	<i>Bucorvus cafer</i>			X	X	X			
Red-fronted Barbet	<i>Lybius diadematus</i>			X		X			
Spotted-flanked Barbet	<i>Lybius lacrymosus</i>			X	X	X			
Red-fronted Tinkerbird	<i>Pogoniulus pusillus</i>			X	X	X			
d'Arnaud's Barbet	<i>Trachyphonus darnaudii</i>			X		X			
Levaillant's Barbet	<i>Trachyphonus vaillantii</i>				X	X			
Golden-tailed Woodpecker	<i>Campethera abingoni</i>				X	X			

Nubian Woodpecker	<i>Campethera nubica</i>			X		X			
Red-capped Lark	<i>Calandrella cinerea</i>		X			X			
Fischer's Sparrow Lark	<i>Eremopterix leucopareia</i>		X			X			
White-throated Swallow	<i>Hirundo albigularis</i>	X						X	
Grey-rumped Swallow	<i>Hirundo griseopyga</i>		X	X		X			
Common Swallow	<i>Hirundo rustica</i>	X	X	X	X				X
Banded martin	<i>Riparia cincta</i>	X	X				X	X	
African Sand Martin	<i>Riparia paludicola</i>	X	X				X	X	
Drongo	<i>Dicrurus adsimilis</i>			X	X	X			
Black-headed Oriole	<i>Oriolus larvatus</i>				X	X			
Pied Crow	<i>Corvus albus</i>		X	X	X	X			
White-bellied Tit	<i>Parus albiventris</i>			X	X	X			
Arrow-marked Babbler	<i>Turdoides jardineii</i>			X	X	X			
Black Cuckoo Shrike	<i>Campephaga flava</i>			X	X	X			
Yellow-bellied Greenbul	<i>Chlorocichla flaviventris</i>			X	X	X			
Common Bulbul	<i>Pycnonotus barbatus</i>			X	X	X			
Red-tailed Chat	<i>Cercomela familiaris</i>			X	X	X			
White-browed Robin Chat	<i>Cossypha heuglini</i>				X	X			
White-headed Black Chat	<i>Thamnolaea arnoti</i>				X	X			
Kurrichane Thrush	<i>Turdus libonyanus</i>				X	X			
African Reed Warbler	<i>Acrocephalus baeticatus</i>	X				X			
Lesser Swamp Warbler	<i>Acrocephalus gracilirostris</i>	X				X			
Yellow-breasted Apalis	<i>Apalis flavida</i>			X	X	X			
Grey-backed Camaroptera	<i>Camaroptera brachyura</i>			X	X	X			
Grey Wren Warbler	<i>Camaroptera simplex</i>			X	X	X			
Rattling Cisticola	<i>Cisticola chiniana</i>			X	X	X			
Red-faced Cisticola	<i>Cisticola erythrops</i>	X				X			
Winding Cisticola	<i>Cisticola galactotes</i>	X	X			X			
Yellow-bellied Eremomela	<i>Eremomela icteropygialis</i>			X	X	X			
Tawny-flanked Prinia	<i>Prinia subflava</i>			X	X	X			
Red-faced Crombec	<i>Sylvietta whytii</i>			X		X			
Grey Flycatcher	<i>Bradornis microhynchus</i>			X		X			
Lead-coloured Flycatcher	<i>Myioparus plumbeus</i>			X	X	X			

Paradise Flycatcher	<i>Terpsiphone viridis</i>			X	X	X	X	X	
Striped Pipit	<i>Anthus lineiventris</i>				X	X			
Richard's Pipit	<i>Anthus novaeseelandiae</i>		X	X	X	X	X		
African Pied Wagtail	<i>Motacilla aguimp</i>		X	X	X	X			
Black-backed Puffback	<i>Dryoscopus cubla</i>			X	X	X			
Slate-coloured Boubou	<i>Laniarius funebris</i>			X		X			
Sulphur-breasted Bush Shrike	<i>Malaconotus sulfureopectus</i>			X	X	X			
Brubru	<i>Nilaus afer</i>			X	X	X			
White-crowned Shrike	<i>Eurocephalus rueppelli</i>			X		X			
Helmet Shrike	<i>Prionops plumata</i>				X	X			
Ashy Starling	<i>Cosmopsarus unicolor</i>			X	X	X			
Wattled Starling	<i>Creatophora cinerea</i>			X		X			
Blue-eared Glossy Starling	<i>Lamprotornis chalybaeus</i>			X	X	X			
Superb Starling	<i>Spreo superbus</i>			X		X			
Yellow-billed Oxpecker	<i>Buphagus africanus</i>		X	X	X	X			
Eastern Violet-backed Sunbird	<i>Anthreptes orientalis</i>			X		X			
Mariqua Sunbird	<i>Nectarinia mariquensis</i>			X	X	X			
Beautiful Sunbird	<i>Nectarinia pulchella</i>			X		X			
Scarlet-chested Sunbird	<i>Nectarinia senegalensis</i>			X	X	X			
Variable Sunbird	<i>Nectarinia venusta</i>			X	X	X			
Grosbeak Weaver	<i>Amblyospiza albifrons</i>	X		X	X	X			
Yellow-crowned Bishop	<i>Euplectes afer</i>	X				X			
White-winged Widowbird	<i>Euplectes albonotatus</i>	X				X	X		
Fan-tailed Widowbird	<i>Euplectes axillaris</i>	X				X			
Southern Red Bishop	<i>Euplectes orix</i>	X				X			
Black-headed Weaver	<i>Ploceus cucullatus</i>			X	X	X	X		
Golden-backed Weaver	<i>Ploceus jacksoni</i>	X	X	X		X	X		
Red-billed Quelea	<i>Quelea quelea</i>	X	X	X		X	X		
Red-billed Buffalo Weaver	<i>Bubalornis niger</i>			X		X			
Grey-headed Social Weaver	<i>Pseudonigrita arnaudi</i>			X		X			
Grey-headed Sparrow	<i>Passer griseus</i>			X	X	X			
Yellow-throated Petronia	<i>Petronia superciliaris</i>			X	X	X			
Steel-blue Whydah	<i>Vidua hypocherina</i>			X			X		

Pin-tailed Whydah	<i>Vidua macroura</i>		X	X	X	X			
Paradise Whydah	<i>Vidua paradisaea</i>				X	X			
Zebra Waxbill	<i>Amandava subflava</i>	X				X			
Common Waxbill	<i>Estrilda astrild</i>	X		X		X			
Quailfinch	<i>Ortygospiza atricollis</i>	X	X			X			
Green-winged Pytilia	<i>Pytilia melba</i>			X		X			
Bronze Mannikin	<i>Lonchura cucullata</i>			X	X	X			
Stripe-breasted Seed-eater	<i>Serinus reichardi</i>					X	X		

Appendix 4B: Sangu names for some bird species

Ostrich, <i>Struthio camelus</i>	Mbuni
White Pelican, <i>Pelecanus onocrotalus</i>	Ngami
Pink-backed Pelican, <i>Pelecanus rufescens</i>	Ngami
Long-tailed Cormorant, <i>Phalacrocorax carbo</i>	Salala
White-faced Whistling Duck, <i>Dendrocygna viduata</i>	Wilile
Spur-winged Goose, <i>Plectopterus gambensis</i>	Safu
Egyptian Goose, <i>Alopochen aegyptiacus</i>	Mongela
Knob-billed Duck, <i>Sarkidiornis melanotos</i>	Lutulutu
Marabou, <i>Leptoptilos crumeniferus</i>	Limuhule Sekinule
Open-billed Stork, <i>Anastomus lamelligerus</i>	Nyonganyonga, Holangoji
Saddle-billed Stork, <i>Ephippiorhynchus senegalensis</i>	Nyuwasa
Crowned Crane, <i>Balearica pavonina</i>	Hovanu
Hamerkop, <i>Scopus umbretta</i>	Mwalala
Cattle Egret, <i>Bubulcus ibis</i>	Yanki
Grey Heron, <i>Ardea cinerea</i>	Ngololi
Black-backed Heron, <i>Ardea melanocephala</i>	Ngololi
Grey-headed Gull, <i>Larus cirrocephalus</i>	Ndelemule
Fish Eagle, <i>Haliaeetus vocifer</i>	Ngwale
Crowned Plover, <i>Vanellus coronatus</i>	Ngaka
Blacksmith Plover, <i>Vanellus armatus</i>	Kolekole
Wattled Plover, <i>Vanellus senegallus</i>	Kivikivi
African Marsh Owl, <i>Asio capensis</i>	Tuye
Red-billed Hornbill, <i>Tockus erythrorhynchus</i>	Kwasakwasa

Appendix 5: Small mammals recorded in the Usangu plains

Species:

Order INSECTIVORA

Family Soricidae: Typical or White-toothed Shrews

Crocidura spp. Shrews

Some species of typical shrews are among the smallest of mammals; Shrews are often abundant in suitable habitats and as predators on invertebrates and as prey for other mammals, birds and reptiles are important components of the food web.

At least two species, a larger and a smaller one, were collected using BPFLs. No shrews were taken in Snap Traps. Although often thought of as associated with moister conditions and habitats, shrews were able to survive the harsh conditions of cracked, black cotton soil in the dry season in the western wetlands.

Distribution in the study area: Dry wetland edge; *Commiphora* thickets; rank grass at edge of permanent water and dry *Acacia* woodland and plains.

Order RODENTIA

Family Muridae: Muroid Rodents

Arvicanthis sp. Unstriped Grass Rat

Unstriped Grass Rats were abundant in grassland and wooded grassland, and in agricultural areas are a pest species.

Distribution in the study area: Most were collected at the edge of the dry wetland, and in woodland. None were seen in the rank grass at the edge of permanent water.

Dendromus sp. Climbing Mice

These small mice are often associated with grassland, though some species are also found in forests.

Distribution in the study area: Collected only in the rank grass at the edge of permanent water in the *Ihefu*, eastern wetland but probably occur where suitable habitat occurs, even away from the wetland.

Grammomys sp. Thicket Rats

These large rodents able to climb well; they are generally known from woodland and forest.

Distribution in the study area: Collected mostly in the mixed miombo woodland traplines, but also taken at edge of plains and in *Commiphora* thicket and termitaria vegetation associations.

Mastomys natalensis Multimammate Rat

As the common name suggests, the females of these rats may have up to 12 mammae, and raise large litters of young in rapid succession if conditions are favourable. Although found naturally in grassland and woodlands, they are also major agricultural pests, and may be involved in the transmission of plague.

Distribution in the study area: Abundant, but not found in woodland or in the rank grassland at edge of permanent water.

Mus sp. Pygmy Mouse

Pygmy mice are widely distributed in grassland, woodland and sometimes forest.

Distribution in the study area: Taken in all traplines except those at edge of permanent water; probably widespread. .

Otomys sp. Groove-toothed Rat

Groove-toothed Rats are common, sometimes abundant, when suitable food in the form of herbage is present. They are widespread in eastern and southern Africa.

Distribution in the study area: A single specimen of what may be this species was taken in poor condition in a BPFL in the rank grass near the permanent water, eastern wetland.

Steatomys pratensis Fat Mice

A layer of fat which helps these animals survive during difficult periods gives these mice their common name.

Distribution in the study area: Taken in the eastern wetland in traplines not associated with permanent water. Not found in the western wetland.

Tatera sp. Gerbils

These Gerbils are widespread in eastern and southern Africa in bushland and woodland, as well as grassland.

Distribution in the study area: Taken in the area at the edge of the plains, *Commiphora* thicket and woodland and in burrows associated with the bases of termitaria.

Other Mammals seen included small carnivores such as Slender mongoose, *Herpestes sanguinea* (also reported by A. Graham) and primates, Vervet Monkeys (also reported by A. Graham) and Baboons. A roadkill of a Zorilla *Ictonyx striatus* near Wananamgombe on 10 Dec 1998 reported by A. Graham is a useful record for this highly secretive and no doubt under reported species.