ECOLOGICAL BASELINE SURVEYS OF:
LAKE BISINA - OPETA WETLANDS SYSTEM
LAKE MBURO - NAKIVALI WETLANDS SYSTEM

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Photo: Women fishing on Lake Bisina

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LAKE MBURO - NAKIVALI WETLANDS SYSTEM

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Cover photo: By. Achilles Byaruhanga *'Women fishing in Lake Bisina'*

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CHAPTER 1: INTRODUCTION

OVERVIEW OF THE BASELINE SURVEY

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1.0 Overview of the COBWEB project

Wetlands cover about 30,000 km^2 of Uganda's land area and are considered to be important ecosystems, which contribute considerably to the national economy and rural livelihoods. However, these important ecosystems are currently under increasing pressure due to factors such as population growth, economic reforms, climate change and the desire for increase in per capita income and other pressures of the development process. Threats include among others uncontrolled conversion of the wetlands into agricultural areas and unplanned developments and wetland uses which may have adverse effects on the capacity of the wetlands to perform natural functions. In order to address these threats, there is need to promote wise use of the wetland ecosystem. This can be done using existing guidelines or by developing other guidelines that will assist the various districts in developing ordinances and bye-laws to regulate the use of wetlands in their areas of jurisdiction.

The International Union for Conservation of nature (IUCN) in collaboration with the Wetlands Management Department (WMD), Ministry of Water and Environment (MWE), ***Nature***Uganda (NU) and Uganda Wildlife Society (UWS), are implementing a four-year project titled *"Extending wetland protected areas through community conservation initiatives"* in eastern and western Uganda (COBWEB).

The project aims at strengthening the Ugandan Protected Area (PA) network by expanding the coverage of the PA network to include the country's biologically important wetland ecosystems. The project will develop, pilot and adopt suitable PA management models in two respective wetland systems adjacent to two terrestrial PA networks in Eastern and Western Uganda. Management will be geared to the specific needs of wetlands and will allow for development of protection and sustainable management strategies that shall be implemented by rural communities and be adoptable to others.

1.1 Introduction to ecological baseline surveys

In order to effectively fulfil the objectives of the project, there is a need to undertake the socio-economic, knowledge, attitude and practice (KAP) and ecological surveys. The surveys are aimed at identifying and documenting the resources, their use values and how to protect the richness and diversity of the wetland in perpetuity. Specifically the ecological study will determine the physical, chemical parameters and the biodiversity of the two wetland systems of the Bisina – Opeta and Mburo – Nakivali. The ecological surveys therefore will form part of the project output aimed at documenting the baseline information of targeted wetlands that are adjacent to the Protected Area systems. The baseline surveys shall be done on the specific selected physical, chemical parameters of Lake Mburo – Nakivale wetland system and Bisina – Opeta wetland system and their flora and fauna.

1.2 Overall objectives of the surveys

The overall objective of the survey is to assess and document baseline ecological characteristics of the wetland systems of Mburo - Nakivale and Bisina -Opeta such that the information generated can inform the subsequent delivery of project objectives. The specific objectives of the survey are:

- Establish baseline information on water physical, chemical parameters and the fauna and flora diversity or the species richness and map out surveyed areas.
- Identify indicator species that can be used for biodiversity status monitoring in Mburo – Nakivali wetland system and Bisina – Opeta wetland system.
- Establish a standard method and system that will be used for biodiversity monitoring in the two wetland systems.
- Explore relevant documentation on the flora and fauna of the two wetland system and produce a comprehensive report for the two wetland systems.

1.3 Parameters surveyed

1.3.1 Bird baseline surveys

Birds have been used as indicator taxa many times. This is because they are widespread, they are diverse, they are easy to survey and they are better known than other organisms. For some sites, there is some considerable amount of data that exists and this will be used. This included data from African Waterbird censuses where total counts of all waterbirds in an area are counted. There is also data from the surveys done during the IBA and Ramsar Sites qualification exercises.

1.3.2 Insect baseline surveys

Butterflies respond quickly to environmental changes and there is now considerable data on how particular species contend with alterations in land-use, and thus may play a valuable role in ecological monitoring (Daily and Ehrlich, 1995). There is some data on the species of Bisina – Opeta system which may be useful for comparison purposes.

1.3.3 Wetland Plant surveys

Plants offer potential advantages over other taxa as biodiversity indicators because they are the primary producers. Their abundance and diversity is likely to influence the species richness belonging to higher trophic levels (Kent *et al*. 1996). An inventory of all plants therefore is needed to establish the plant diversity. However a rapid assessment of plant community may be preferred to generate the needed checklist.

1.3.4 Physical – chemical parameters

The parameters include dissolved oxygen, surface water temperature, electrical conductivity, pH, total dissolved solids (TDS) and turbidity/water colour. Water depth may be measured at sites where is possible. On each sampling day, water quality parameters, will be measured to establish the relationship between these parameters and other biodiversity. In the Papyrus wetlands, openings accessible will be points where the water Temperature, pH, conductivity meter and BOD readings will be taken.

1.3.5 Mammals (large mammals) baseline information

There are available information from IBA qualification exercises and Ramsar designation processes. Earlier mammal surveys generated lots of information. The data obtained from these two earlier surveys and any other major surveys will be collated and a report will be produced.

1.3.6 Fish diversity baseline information

Information on fish will be obtained from earlier exercises and a report on baseline biodiversity of fish shall be produced.

CHAPTER 2: BIRDS

INVENTORY REPORT ON THE BIRDS OF THE MBURO-NAKIVALE WETLAND SYSTEMS AND OPETA-BISINA WETLAND SYSTEMS

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2.1 INTRODUCTION

Community-based Wetland Biodiversity Conservation (COBWEB) project is a collaborative project involving ***Nature***Uganda and other partners in natural resource conservation. The overall objective for the project is *"To establish and strengthen Community-based regulations and sustainable wetlands resource use within wetlands with important biodiversity"*. With most Protected areas (PAs) concentrated within terrestrial habitat, more effort is required to address conservation within wetland areas. The project therefore will serve to protect biodiversity within wetlands, encourage wise use of wetlands without compromising the resources therein and integrate communities in this wise use.

2.2 OBJECTIVES OF THE SURVEY

The Birdlife working group of ***Nature***Uganda conducted baseline surveys for two wetland systems of Mburo-Nakivale and Opeta-Bisina in western and eastern Uganda respectively. The survey was done to assess the avifauna in these areas basing on the specific objectives which were to:

- Produce guiding methods for birds to be used during surveys and follow up exercises.
- Establish baseline information on bird richness and diversity.
- Identify indicator species that can be used for biodiversity monitoring.
- Take appropriate GPS coordinates of surveyed areas (including for secondary data).
- Make field observations and descriptions as supportive information to the report.
- Explore existing surveys report and use as supporting data where appropriate.
- Produce a comprehensive report on the birds' diversity for the two wetland systems.

Previous works on birds in these areas include the bi-annual waterfowl counts done on Lake Mburo, Lake Bisina and Lake Opeta and Ramsar surveys done in the whole area. In addition, Lake. Mburo National Park also conducts monitoring by rangers/guides in the park. The common birds monitoring Scheme (a new scheme for monitoring common birds in Uganda) was introduced in L. Mburo this year while the Opeta-Bisina region is yet to be added to the scheme.

2.3 ASSESSMENT METHODS

The avifauna in the project area was surveyed using Timed Species Counts (TSCs). This method involves moving around the study area and recording the bird species you see and the time at which they are seen at ten minute intervals for a period of 60 minutes. This method assumes that the birds seen first are more abundant than those seen last. In that case, the birds seen during the first ten minutes get a score of 6. Those in the 10-20 minutes get a score of 5, while those seen in the last 50-60minutes get a score of 1. Counts were done in the morning and in the evening. GPS locations were taken for the starting points of each TSC transect. This was attributed to the birds seen on that transect. Opportunistic observations were included on the species lists. Notes were made on any breeding records observed and the different habitat types along the transects. The relative abundance of the species was calculated as the average of the TSC codes from all the counts.

2.3.1 Species identification

In the field, 8 x 42-field binoculars and field guides were used. Birds in the sites were identified using standard field guide reference books: A Field guide to the Birds of East Africa by Stevenson & Fanshawe (2002); The Uganda Bird Atlas by Carswell *et al.* (2005).

2.3.2 Bird classifications

Bird species recorded were grouped into different categories based on different criteria.

2.3.2.1 Habitat classifications

Birds recorded were classified into ecological categories where possible basing on the standard habitat classification by Bennun *et al* (1996). In this classification, we have;

- **FF** Forest specialists – these are true forest species most characteristic of the interior of undisturbed forest. Breeding also occurs in the forest.
- **F** Forest generalists – typical birds of forest edges and gaps.
- **f** Species – forest visitors where breeding is outside the forest.
- **G** Species – grassland species
- **W** Water birds normally found near water, in wetlands or open water.

2.3.2.2 Migratory classifications

Bird species with migratory tendency were also considered as derived from the Uganda Bird atlas (Carswell *et al.* 2005). There were two categories of migrant species considered below.

- **A** Afro-tropical migrants
- **P** Palearctic migrants

However some species can be both Afro-tropical and Palearctic migrants.

2.3.2.3 Conservation status

Birds were further classified according to their conservation status i.e. Whether they are species of conservation concern (C) as from (Collar & Stuart 1985, Bennun & Njoroge 1996) described as species of Global (G-) or Regional (R-) importance in the categories of;

- **CR** Critical *(Globally (G-CR) or Regionally (R-CR))*
- **EN** Endangered
- **NT** Near-threatened
- **VU** Vulnerable
- **RR** Regional Responsibility

2.4 MBURO-NAKIVALI WETLAND SYSTEM

2.4.1 SITE DESCRIPTIONS

The Mburo-Nakivali wetland is located in western Uganda in the districts of Isingiro, Kiruhura and Mbarara. Designated in 2006 as a Ramsar site, this wetland system covers an area of 26,834ha, part of which is in Lake Mburo National Park. The area is a system of open and wooded savanna, seasonal and permanent wetlands, and five lakes of which Lake Mburo is the largest. The areas are covered by extensive papyrus wetlands surrounding the lake and further areas constituting of Acacia woodland and agricultural land. The system is a unique habitat lying at the convergence of two biological zones and thus has high biodiversity.

This wetland system supports globally threatened bird species like the Papyrus Yellow Warbler *Chloropeta gracilirostris* and the Shoebill *Balaeniceps rex* and provides refuge to Palearctic and Afro-tropical migrating bird species (WMD/NU 2008). Other uses of this wetland system include water for domestic use, livestock and wildlife, pasture for the local livestock during drought, fish and materials for thatching and crafts. Hunting, habitat destruction (e.g. herbal medicine for both human and livestock) and over fishing are the main threats to the site. Livestock are common occurrences in these areas especially in the afternoon during watering but some livestock farms extend to the fringes of the lake. These threats are all placing the wetland system in great danger.

Lake Mburo is an Important Bird Area (IBA) and a small National Park covering 370km^2. Despite its size, the mosaic of habitats in this park including dry hillsides, rocky outcrops, bushy thickets, open and wooded savannas, forests, lakes and swamps,and are home to a diversity of plants and animals (UNP 1994).

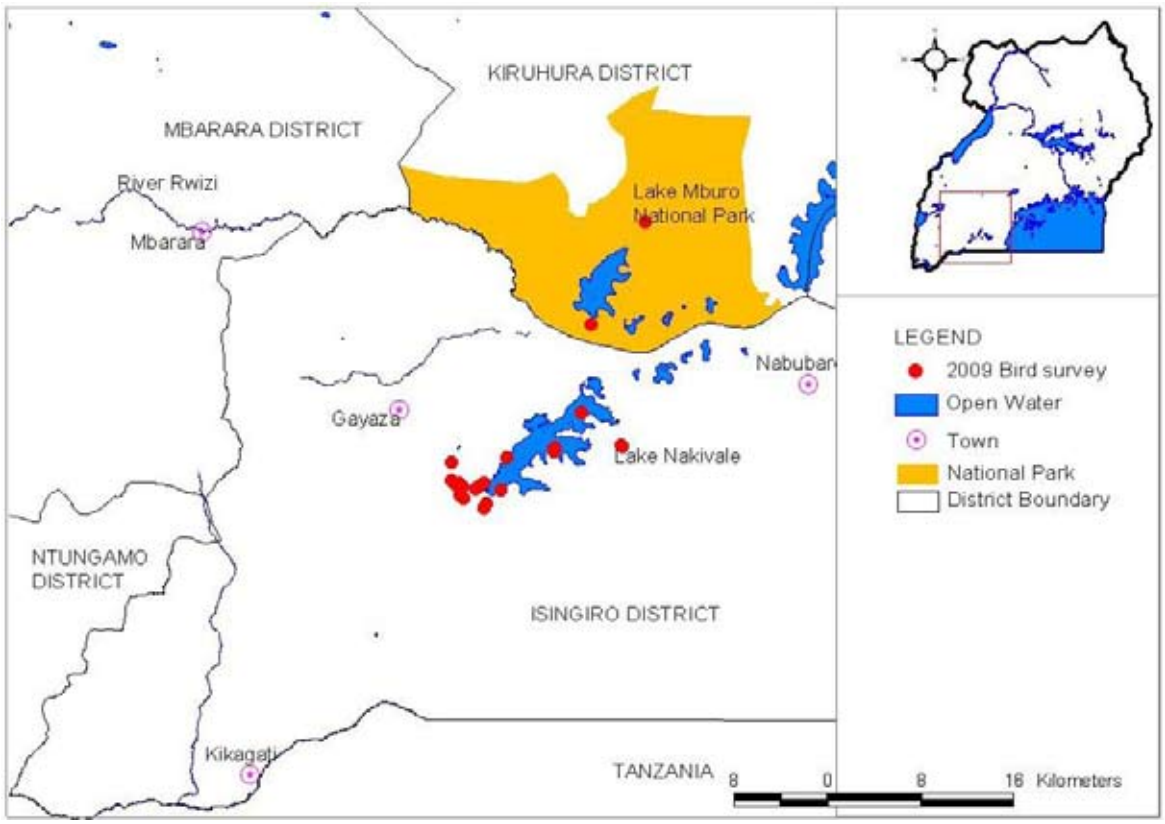

Fig. 1 Birds survey sites in Mburo – Nakivali wetland system

These areas have been reported to have high bird diversity most notably the Grey Crowned Crane (*Balearica regulorum*) which is IUCN listed as Near-threatened (Bird life, 2000). Other species of conservation concern that have been reported in these areas include the Papyrus Gonolek (*Laniarius mufumbiri*) - Near-threatened, Grauer's Rush Warbler (*Bradypterus graueri*) – Endangered, and the Papyrus Yellow Warbler (*Chloptera gracilirostris*) - Vulnerable (Birdlife, 2000, Byaruhanga *et al* 2001). As one of the surrogates of biodiversity, birds especially those with special niche requirements in fragile habitats such as wetlands are regarded as biodiversity indicators as they provide good evidence of habitat modification, change or total loss through change in numbers or total extinctions. During our initiation tour of this wetland complex, only two of the above species (Papyrus Gonolek *Laniarius mufumbiri* and Grey Crowned Crane *Balearica regulorum*) were recorded and notably with less than five individuals for each.

2.4.2 RESULTS AND DISCUSSION

The inventory concentrated more on the areas around Lake Nakivale. The Lake Mburo wetlands have been continuously monitored by various research groups in the past including ***Nature***Uganda, Wetlands Management Division, Uganda Wildlife Authority and National Environment Management Authority and other research institutions among others. Nevertheless, there are a few sites like Rubanga forest, the wetlands between L. Bwala and L. Kazuma and Kabwojo Island that are not easily accessible and thus have not been regularly surveyed. The wetlands of the Lake Nakivale area however have received less attention. That is why this survey team chose to make the counts in this area of the wetland system. The L. Mburo checklist of birds compiled during this survey has 319 species (Appendix 3) and is an improvement from the official list which had about 310 species (UNP 1994).

A total of 194 species of birds were recorded during the 14 counts conducted within the Mburo-Nakivale wetland system. These included 30 migratory species and 22 species of conservation concern. Three forest specialists and 27 forest generalists were recorded (Table 1). Although the majority of species recorded were wetland species and forest visitors, three forest specialists Grey-Headed Sunbird (*Deleornis axillaries),* Olive Sunbird (*Cyanomitra olivacea)* and Black Cuckoo (*Cuculus clamosus)* were also recorded (Table 1).

Table 1: Species recorded in the different habitat and migratory classes in the Mburo-Nakivale wetland system

Habitat	Number of species
FF	3
F	27
f	46
W	62
G	16
Migration	
A	11
P	19

The migratory species included 11 Afro-tropical and 19 Palearctic migrants. Among the species of conservation concern, we had one globally and regionally vulnerable species the Shoebill (*Balaeniceps rex),* one globally vulnerable and regionally near-threatened species the Grey Crowned Crane (*Balearica regulorum)*, one globally and regionally near-threatened species African White-backed Vulture (*Gyps africanus)*, three globally near-threatened species the Papyrus Gonolek (*Laniarius mufumbiri)*, Bateleur (*Terathopius ecaudatus)* and Sooty Falcon (*Falco concolor)*, one regionally vulnerable species the Great White Egret (*Casmerodius alba),* five regionally near-threatened species the Grey Heron (*Ardea cinerea)*, Woolly-Necked Stork (*Ciconia episcopus),* Rufous-Bellied Heron (*Ardeola rufiventris)*, African Marsh Harrier (*Circus ranivorus)* and Brown Snake-Eagle (*Circaetus cinereus)* and ten species with regional responsibility (Table 2).

The most abundant species were the Blue-Cheeked Bee-Eater *Merops persicus,* Grey-Headed Sunbird *Deleornis axillaries*, Klaas' Cuckoo *Chrysococcyx klaas*, Yellow-Fronted Tinkerbird *Pogoniulus chrysoconus*, Cardinal Woodpecker *Dendropicos fuscescens* and Red-Billed Firefinch *Lagonosticta senegala* each with a relative abundance of six (Appendix 1).

The results show that a significant number of species was recorded in the sensitive species classes which include the migrants, species of conservation concern and forest specialists. These species are usually regarded as the indicator species for habitat environmental health. The presence of these sensitive species in the area indicates that this wetland is very important in the conservation of the birds in the country and the world as a whole due to the presence of migrants. The conservation plan of this area should put into consideration the habitats of these species and ensure that they are conserved for the survival of the regional as well as the global populations.

Table 2: Threatened species recorded in the Mburo-Nakivale wetland system

Atlas No.	SPECIES NAME Scientific Name	Threat
88	BATELEUR Terathopius ecaudatus	G-NT
135	SOOTY FALCON Falco concolor	G-NT
842	PAPYRUS GONOLEK Laniarius mufumbiri	G-NT
81	AFRICAN WHITE-BACKED VULTURE Gyps africanus	G-NT, R-NT
185	GREY CROWNED CRANE Balearica regulorum	G-VU, R-NT
37	SHOEBILL Balaeniceps rex	G-VU, R-VU
16	RUFOUS-BELLIED HERON Ardeola rufiventris	R-NT
25	GREY HERON Ardea cinerea	R-NT
33	WOOLLY-NECKED STORK Ciconia episcopus	R-NT
86	BROWN SNAKE-EAGLE Circaetus cinereus	R-NT
93	AFRICAN MARSH HARRIER Circus ranivorus	R-NT
303	BARE-FACED GO-AWAY-BIRD Corythaixoides personata	R-RR
437	SPOT-FLANKED BARBET Tricholaema lachrymose	R-RR
498	WHITE-HEADED SAW-WING Psalidoprocne albiceps	R-RR
648	CARRUTHERS'S CISTICOLA Cisticola carruthersi	R-RR
701	GREY-CAPPED WARBLER Eminia lepida	R-RR
764	BLACK-LORED BABBLER Turdoides sharpei	R-RR
803	RED-CHESTED SUNBIRD Cinnyris erythrocerca	R-RR
902	NORTHERN BROWN-THROATED WEAVER Ploceus castanops	R-RR
911	GOLDEN-BACKED WEAVER Ploceus jacksoni	R-RR
943	WHITE-COLLARED OLIVEBACK Nesocharis ansorgei	R-RR
23	GREAT WHITE EGRET Casmerodius alba	R-VU

Discussions with the chief park warden and the research warden in Lake Mburo revealed that the wetland has been greatly affected by water flow with the reduction in the amount of water in the system. They further reported that the water level in Lake Nakivali has receded by about 100m in the last 10 years and this has greatly affected the amount of biodiversity in the area especially the fish. The diversion of R. Ruizi (that feeds L. Mburo) to irrigate farms has been a significant driver for the low water level in the system.

Tree cutting for farmland around the L. Nakivali wetlands has impacted negatively on the system by exposing the lake to siltation, which highly affects biodiversity in the lake. Over fishing due to inadequate monitoring and law enforcement has led to very low fish populations in the Mburo-Nakivali system, which has in turn affected the biodiversity that depend on them especially the fish-eating birds including the Shoebill.

The communities around L. Mburo national park are allowed to graze their livestock inside the park boundaries during rain shortages when the grass outside is depleted. This is facilitated by the provision of cattle corridors. This system is very important in the sustaining of livestock during droughts. This arrangement has greatly improved the park-community relationships and gives a good example of community resource management. It was also reported that the majority of people in this area do not eat bush meat and this improves their relationship with the park as the incidences of poaching is low.

Nakivali area is a refugee settlement area with camps in various parts of the area. This poses a big challenge to the conservation activities as the increased settlements continue to create the threats of deforestation and cultivation of the river banks. The high population causes pressure to the limited lake resources in the region.

2.4.3 CONCLUSIONS AND RECOMMENDATIONS

As indicated in the results, this area is of high biodiversity value with not only birds, but also a variety of other ecological factors on which they depend. The presence of the large numbers of migrants and threatened species puts these wetland systems in urgent need for conservation action to protect the various species and their habitat.

Tree planting programmes in the area should be strengthened and new initiatives supported to curve down the rate of deforestation in the area. Communities in these wetland systems need to be sensitized on how to sustainably use resources in this area while conserving them. For example the river banks should be reforested to reduce runoff and silting of the river and Lakes. These trees can in the long run act as sources of firewood and food for the communities. Farming in the buffer zones of the wetland system should be discouraged and laws regarding this enforced to conserve the wetlands and its biodiversity.

Future researches should concentrate on the gaps in the present research which are mainly the Rubanga forest, wetlands between L. Bwala and L. Kazuma and Kabwojo Island and the L. Nakivali wetlands in the Mburo-Nakivali system. If these areas are covered and their biodiversity state assessed, this will give a firm basis for the conservation actions to be implemented in the two wetland systems.

At the moment ***Nature***Uganda is the only organization doing research on birds in this area. This is mainly through its waterfowl counts, vulture census and Ramsar surveys. Other organizations are encouraged to come in and support the avian research work in this region.

2.5 OPETA - BISINA WETLAND SYSTEM

2.5.1 SITE DESCRIPTIONS

Located in Eastern Uganda, this system is a combination of the Lake Opeta Ramsar site and Lake Bisina Ramsar site both designated as Ramsar sites in 2006. They are both Important Bird Areas (IBAs). Together, this wetland system covers an area of 123,141ha and is shared by the districts of Kumi, Katakwi, Soroti, Bukedea, Nakapiripiriti and Sironko. This system consists of one of the remaining most important and intact wetland marshes in Uganda (WMD/NU 2008). It is predominantly an extensive swamp of Hippo grass (*Vossia cuspidata)* graduating into dry *Hyparrhenia* grassland savannas. The wetland is very important for the conservation of dry land bird species especially the Fox's Weaver *Ploceus spekeoides*, Uganda's only endemic bird that breeds in this wetland. Part of the system covers the Pian-Upe Wildlife Reserve that provides a refuge for the local animals during the dry season. Pian-Upe constitutes the drier parts of the Karamoja region and hence is richer in the drier-terrestrial biodiversity. It is adjoined to the Bisina - Opeta wetland system by a series of marshes and papyrus swamps.

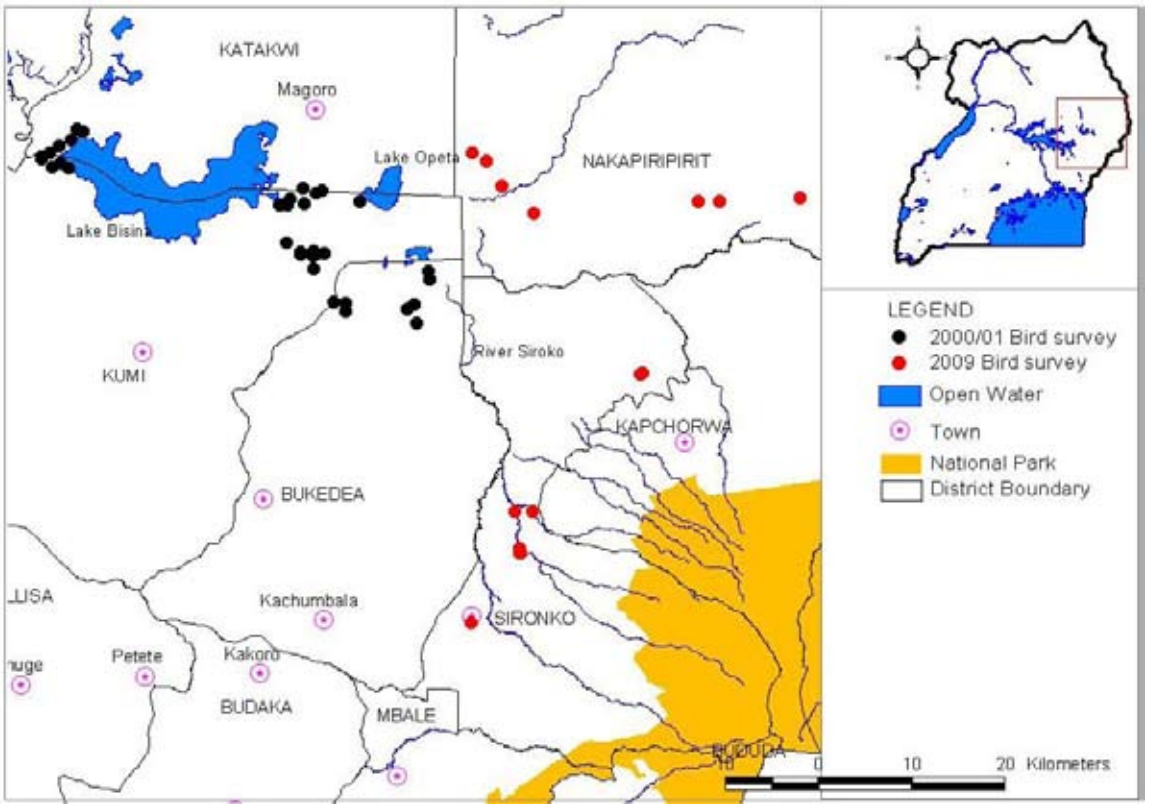

Fig. 2 Birds survey sites in Opeta – Bisina wetland system

Lake Bisina is a shallow lake covering an area of 192km^2 with a flood plain of 30km long and 6.5km wide. The wetland system is also home to Uganda's endemic Fox's Weaver *P spekeoides* for which 47 nests were counted in the area in early August 1996 (Byaruhanga *et al*, 2001). Other species of conservation concern with previous records in the area include seven Lake Victoria Biome species; Papyrus Gonolek *Laniarius mufumbiri,* Norther Brown-throated Weaver *P.castanops*, White-winged Warbler *Bradypterus carpalis*, Carruthers' Cisticola *Cisticola carruthersi*, Papyrus Canary *Serinus koliensis* among others. However, none of these were recorded during our TSC counts.

Lake Opeta and its marshes are the only significant wetland in Karamoja area. Like L. Bisina, it is home to at least five L. Victoria Biome species but the Shoebill *Baleaniceps rex* and the Papyrus Gonolek *L. Mufumbiri* are outstanding as Near-threatened species of bird in this wetland system. Fox's Weaver *P.spekeoides* has also been recorded to breed here (Byaruhanga *et al*, 2001).

Several human activities with negative impacts in the catchment including rice growing, livestock grazing, papyrus harvesting and fishing among others take place within this area. However, the wetlands are also home to migratory birds and other species of conservation concern such as the Shoebill (*B. rex*). The lakes are very important for the surrounding communities in terms of fishing, transport and supply of water for domestic use and livestock. A rhizome of the Nymphea genus also acts as a source of food during the dry season.

With the changing seasons and extreme weather patterns as a result of climate change, the dry seasons in this region pose potential challenges for wildlife, livestock and farming systems. Most of the wetland fringes have been converted into rice schemes while other areas are being continuously degraded through over use by livestock. Data used in this report was derived from counts conducted in 2001 and 2009 making a total of 58 counts in the districts of Kumi, Katakwi, Soroti, Nakapiripiriti

and Sironko. The species list for this wetland system has about 234 species (Appendix 4) is a combination of our survey, the Ramsar survey and the waterfowl count records.

2.5.2 RESULTS AND DISCUSSION

A total of 194 species of birds were recorded during the survey conducted in this area (Appendix 2). These included 41 migratory species and 26 species of conservation concern (Threatened species). The migratory species included nine Afro-tropical migrants, 31 Palearctic migrants and one species which is both an Afro-tropical and Palearctic migrant (Table 3). The majority of species recorded in this area are Wetland species or species associated with the wetland habitat. However one forest specialist and eight forest generalists were also recorded in this area.

Table 3: Species recorded in the different habitat and migratory classes in the Opeta-Bisina wetland system

Habitat	Species
F	8
f	22
FF	1
G	19
W	79
Migration	
A	9
P	31
PA	1

Among the threatened species recorded are six species of global concern and 20 species of regional concern (Table 4). The species of global concern include three globally and regionally vulnerable species Shoebill (*Balaeniceps rex),* White-headed Vulture (*Trigonoceps occipitalis)* and Lesser Kestrel (*Falco naumanni),* two globally and regionally near threatened species Fox's Weaver (*Ploceus spekeoides)* and Pallid Harrier (*Circus macrourusi)* and one globally near threatened species Bateleur (*Terathopius ecaudatus)*.

The most abundant species in this area included the Woolly-necked Stork (*Ciconia episcopus),* African Pied Wagtail (*Motacilla aguimp),* Hadada (*Bostrychia hagedash)*, Red-knobbed Coot (*Fulica cristata),* Spotted Flycatcher (*Muscicapa striata),* Chubb's Cisticola (*Cisticola chubbi),* Yellow-rumped Tinkerbird (*Pogoniulus bilineatus),* Yellow-throated Leaflove (*Chlorocichla flavicollis)* and African Black Swift (*Apus barbatus)*, all with abundances of 6 (Appendix 2).

The presence of these sensitive species in the area, which include migrants, species of conservation concern and forest specialist, indicates that this wetland is very important in the conservation of the birds in the country and the world as a whole due to the presence of a noticeably high number of migrants. These species are usually considered as the indicator species for environmental health. The conservation plan of this area should therefore put into consideration the habitats of these species and ensure that they are conserved for the sustainability of their global populations.

The Fox's Weaver *P spekeoides*, Uganda's only endemic was recorded breeding in this area during the counts done in 2001, but new records of this species have been very rare in recent visits. Further efforts are needed to ascertain the population size of this species and ensure that its conservation is prioritized.

Table 4: Threatened species recorded in the Opeta-Bisina wetland system

Atlas	SPECIES NAME Scientific Name	Threat
1	COMMON OSTRICH Struthio camelus	R-VU
23	GREAT WHITE EGRET Casmerodius alba	R-VU
24	PURPLE HERON Ardea purpurea	R-NT
25	GREY HERON Ardea cinerea	R-NT
27	GOLIATH HERON Ardea goliath	R-NT
33	WOOLLY-NECKED STORK Ciconia episcopus	R-NT
35	SADDLE-BILLED STORK Ephippiorhynchus senegalensis	R-VU
37	SHOEBILL Balaeniceps rex	G-VU, R-VU
49	WHITE-BACKED DUCK Thalassornis leuconotus	R-VU
84	WHITE-HEADED VULTURE Trigonoceps occipitalis	G-VU, R-VU
86	BROWN SNAKE-EAGLE Circaetus cinereus	R-NT
88	BATELEUR Terathopius ecaudatus	G-NT
91	PALLID HARRIER Circus macrourus	G-NT, R-NT
92	MONTAGU'S HARRIER Circus pygargus	R-NT
93	AFRICAN MARSH HARRIER Circus ranivorus	R-NT
128	LESSER KESTREL Falco naumanni	G-VU, R-VU
133	RED-NECKED FALCON Falco chicquera	R-NT
194	LESSER JACANA Microparra capensis	R-NT
437	SPOT-FLANKED BARBET Tricholaema lachrymose	R-RR
498	WHITE-HEADED SAW-WING Psalidoprocne albiceps	R-RR
648	CARRUTHERS'S CISTICOLA Cisticola carruthersi	R-RR
803	RED-CHESTED SUNBIRD Cinnyris erythrocerca	R-RR
902	NORTHERN BROWN-THROATED WEAVER Ploceus castanops	R-RR
906	FOX'S WEAVER Ploceus spekeoides	G-NT/RR, R-NT/RR
936	HARTLAUB'S MARSH WIDOWBIRD Euplectes hartlaubi	R-VU
992	PAPYRUS CANARY Serinus koliensis	R-RR

Reports from the environmental officer and residents of Sironko indicate that the river Sironko that usually supplies the seasonal wetlands has been un-sustainably drained to irrigate mainly rice fields in the area. This poses a threat of droughts as a number of sections of the river have now dried out in some areas and so can not continue to serve as a constant source of water especially during the droughts.

2.5.3 CONCLUSIONS AND RECOMMENDATIONS

This area is still a high biodiversity area in the country with unique bird species especially in the Karamoja region that is not often covered by most research organizations mainly due to the past instability in the region. The presence of the large numbers of migrants and threatened species puts this wetland system in urgent need for conservation action to protect the species and their habitat.

Communities in these wetland systems need to be sensitized on how to sustainably use resources in this area while conserving them. For example the Sironko rice growers seemed not to like the idea of researchers going in the wetlands because they think they researchers could be planning to chase them away from this wetland. They therefore need to be made aware that the wetland is for them to use in a proper way through inter-district interventions.

Future research should concentrate on the gaps in the present research which are mainly the eastern part of the Opeta-Bisina system in Karamoja region. If these areas are covered and their biodiversity state assessed, this will give a firm basis for the conservation actions to be implemented in the wetland systems including trans boundary management options.

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APENDICES

Appendix 1: Relative abundances of the bird species recorded in the Mburo - Nakivale wetland system

Atlas No.	SPECIES NAME Scientific Name	Relative Abundance	Habitat	Threat
14	COMMON SQUACCO HERON Ardeola ralloides	0.00	W	0
16	RUFOUS-BELLIED HERON Ardeola rufiventris	0.00	W	R-NT
17	CATTLE EGRET Bubulcus ibis	0.00	G	0
23	GREAT [=WHITE] EGRET Casmerodius alba	0.00	W	R-VU
25	GREY HERON Ardea cinerea	0.00	W	R-NT
26	BLACK-HEADED HERON Ardea melanocephala	3.50	w	0
28	HAMERKOP Scopus umbretta	2.20	w	0
29	YELLOW-BILLED STORK Mycteria ibis	0.00	W	0
30	AFRICAN OPEN-BILLED STORK Anastomus lamelligerus	3.00	AwG	0
32	ABDIM'S STORK Ciconia abdimii	3.00	AG	0
33	WOOLLY-NECKED STORK Ciconia episcopus	0.00	W	R-NT
36	MARABOU STORK Leptoptilos crumeniferus	0.00	w	0
37	SHOEBILL Balaeniceps rex	0.00	W	G-VU, R-VU
39	HADADA Bostrychia hagedash	3.60	w	0
42	SACRED IBIS Threskiornis aethiopica	0.00	W	0
48	WHITE-FACED WHISTLING DUCK Dendrocygna viduata	0.00	W	0
50	EGYPTIAN GOOSE Alopochen aegyptiacus	0.00	WG	0
51	SPUR-WINGED GOOSE Plectopterus gambensis	0.00	W	0
57	YELLOW-BILLED DUCK Anas undulata	0.00	W	0
60	RED-BILLED TEAL Anas erythrorhyncha	0.00	W	0
71	EUROPEAN HONEY-BUZZARD Pernis apivorus	4.00	PF	0
76	AFRICAN FISH EAGLE Haliaeetus vocifer	3.00	W	0
77	PALM-NUT VULTURE Gypohierax angolensis	0.00	0	0
81	AFRICAN WHITE-BACKED VULTURE Gyps africanus	0.00	G	G-NT, R-NT
86	BROWN SNAKE-EAGLE Circaetus cinereus	4.00	0	R-NT
88	BATELEUR Terathopius ecaudatus	0.00	G	G-NT
90	AFRICAN HARRIER-HAWK Polyboroides typus	5.33	f	0
93	AFRICAN MARSH HARRIER Circus ranivorus	0.00	W	R-NT
94	EURASIAN MARSH HARRIER Circus aeruginosus	1.00	Pw	0
112	LONG-LEGGED BUZZARD Buteo rufinus	0.00	P	0
120	BOOTED EAGLE Hieraaetus pennatus	5.00	P	0
135	SOOTY FALCON Falco concolor	4.00	A	G-NT
137	AFRICAN HOBBY Falco cuvieri	5.00	F	0
142	HELMETED GUINEAFOWL Numida meleagris	0.00	G	0
154	CRESTED FRANCOLIN Francolinus sephaena	3.00	0	0
161	RED-NECKED SPURFOWL Francolinus afer	4.60	0	0
185	GREY CROWNED CRANE Balearica regulorum	3.75	WG	G-VU, R-NT

193	JACANA Actophilornis africana	0.00	W	0
201	WATER THICK-KNEE Burhinus vermiculatus	0.00	W	0
221	AFRICAN WATTLED LAPWING [=PLOVER] Vanellus senegallus	0.00	W	0
226	CROWNED LAPWING [=PLOVER] Vanellus coronatus	0.00	G	0
227	LONG-TOED LAPWING [=PLOVER] Vanellus crassirostris	3.00	W	0
245	MARSH SANDPIPER Tringa stagnatilis	0.00	PW	0
247	GREEN SANDPIPER Tringa ochropus	0.00	PW	0
248	WOOD SANDPIPER Tringa glareola	0.00	PW	0
Atlas No.	**SPECIES NAME Scientific Name**	**Relative Abundance**	**Habitat**	**Threat**
250	COMMON SANDPIPER Actitis hypoleucos	0.00	PW	0
268	AFRICAN GREEN-PIGEON Treron calva	2.25	F	0
270	TAMBOURINE DOVE Turtur tympanistria	3.83	F	0
271	BLUE-SPOTTED WOOD-DOVE Turtur afer	3.75	F	0
273	EMERALD-SPOTTED WOOD-DOVE Turtur chalcospilos	5.40	F	0
283	RED-EYED DOVE Streptopelia semitorquata	5.67	f	0
284	AFRICAN MOURNING DOVE Streptopelia decipiens	3.67	0	0
286	RING-NECKED DOVE Streptopelia capicola	5.80	f	0
289	LAUGHING DOVE Streptopelia senegalensis	5.00	0	0
292	BROWN PARROT Poicephalus meyeri	5.40	0	0
302	ROSS'S TURACO Musophaga rossae	3.00	F	0
303	BARE-FACED GO-AWAY-BIRD Corythaixoides personata	4.83	0	R-RR
305	EASTERN GREY PLANTAIN-EATER Crinifer zonurus	4.75	0	0
307	LEVAILLANT'S CUCKOO Oxylophus levaillantii	4.00	Af	0
309	RED-CHESTED CUCKOO Cuculus solitarius	5.22	AF	0
310	BLACK CUCKOO Cuculus clamosus	3.00	AFF	0
312	AFRICAN CUCKOO Cuculus gularis	0.00	A	0
319	KLAAS' CUCKOO Chrysococcyx klaas	6.00	f	0
320	DIEDERIK [=DIDRIC] CUCKOO Chrysococcyx caprius	4.50	0	0
323	WHITE-BROWED COUCAL Centropus superciliosus	3.17	0	0
326	BLUE-HEADED COUCAL Centropus monachus	4.38	W	0
363	WHITE-RUMPED SWIFT Apus caffer	5.00	0	0
365	LITTLE SWIFT Apus affinis	0.00	0	0
368	BLUE-NAPED MOUSEBIRD Urocolius macrourus	4.20	0	0
369	SPECKLED MOUSEBIRD Colius striatus	5.50	0	0
375	WOODLAND KINGFISHER Halcyon senegalensis	5.44	A	0
376	STRIPED KINGFISHER Halcyon chelicuti	0.00	0	0
378	AFRICAN PYGMY KINGFISHER Ceyx picta	2.00	fw	0
383	PIED KINGFISHER Ceryle rudis	4.00	W	0
385	LITTLE BEE-EATER Merops pusillus	3.67	G	0
392	BLUE-CHEEKED BEE-EATER Merops persicus	6.00	P	0
399	LILAC-BREASTED ROLLER Coracias caudata	4.75	0	0
401	BROAD-BILLED ROLLER Eurystomus glaucurus	4.50	Afw	0
404	GREEN WOOD-HOOPOE Phoeniculus purpureus	2.50	0	0

405	COMMON SCIMITARBILL Rhinopmastus cyanomelas	0.00	0	0
406	BLACK SCIMITARBILL [=BLACK WOOD HOOPOE] Rhinopmastus aterrimus	5.00	0	0
408	HOOPOE Upupa epops	0.00	p	0
418	AFRICAN PIED HORNBILL Tockus fasciatus	2.00	F	0
419	CROWNED HORNBILL Tockus alboterminatus	4.25	f	0
420	AFRICAN GREY HORNBILL Tockus nasutus	4.00	0	0
426	SPECKLED TINKERBIRD Pogoniulus scolopaceus	3.00	F	0
431	YELLOW-RUMPED TINKERBIRD Pogoniulus bilineatus	5.40	F	0
433	YELLOW-FRONTED TINKERBIRD Pogoniulus chrysoconus	6.00	f	0
437	SPOT-FLANKED BARBET Tricholaema lachrymose	4.17	0	R-RR
443	DOUBLE-TOOTHED BARBET Lybius bidentatus	5.50	f	0
455	GREATER [=BLACK-THROATED] HONEYGUIDE Indicator indicator	1.00	f	0
465	NUBIAN WOODPECKER Campethera nubica	4.33	0	0
471	SPECKLE-BREASTED [=UGANDA SPOTTED] WOODPECKER Dendropicos poecilolaemus	3.33	0	0
Atlas No.	**SPECIES NAME Scientific Name**	**Relative Abundance**	**Habitat**	**Threat**
473	CARDINAL WOODPECKER Dendropicos fuscescens	6.00	0	0
477	GREY WOODPECKER Dendropicos goertae	4.00	f	0
489	FLAPPET LARK Mirafra rufocinnamomea	1.00	G	0
498	WHITE-HEADED SAW-WING [=ROUGHWING] Psalidoprocne albiceps	3.75	f	R-RR
504	MOSQUE SWALLOW Hirundo senegalensis	0.00	0	0
505	LESSER STRIPED SWALLOW Hirundo abyssinica	4.00	0	0
506	RED-RUMPED SWALLOW Hirundo daurica	4.50	0	0
512	ANGOLA SWALLOW Hirundo angolensis	2.00	w	0
513	BARN [=EURASIAN] SWALLOW Hirundo rustica	5.17	Pw	0
515	YELLOW WAGTAIL Motacilla flava	0.00	PwG	0
520	AFRICAN PIED WAGTAIL Motacilla aguimp	1.00	w	0
529	YELLOW-THROATED LONGCLAW Macronyx croceus	3.20	G	0
538	LITTLE GREENBUL Andropadus virens	5.00	F	0
542	YELLOW-WHISKERED GREENBUL Andropadus latirostris	3.67	F	0
547	YELLOW-THROATED GREENBUL [=LEAFLOVE] Chlorocichla flavicollis	4.60	f	0
549	LEAF-LOVE Pyrrhurus scandens	3.00	F	0
562	COMMON BULBUL Pycnonotus barbatus	5.58	f	0
576	WHITE-BROWED ROBIN-CHAT Cossypha heuglini	5.20	f	0
578	SNOWY-HEADED ROBIN-CHAT Cossypha niveicapilla	4.00	Fw	0
588	BROWN-BACKED SCRUB-ROBIN Cercotrichas hartlaubi	4.83	f	0
589	WHITE-BROWED SCRUB-ROBIN Cercotrichas leucophrys	3.33	0	0
593	WHINCHAT Saxicola rubetra	1.00	P	0
612	AFRICAN THRUSH Turdus pelios	4.00	f	0

615	WHITE-WINGED WARBLER Bradypterus carpalis	3.00	W	0
630	GREATER SWAMP WARBLER Acrocephalus rufescens	3.00	W	0
632	DARK-CAPPED YELLOW WARBLER Chloropeta natalensis	5.00	w	0
638	RED-FACED CISTICOLA Cisticola erythrops	4.71	w	0
641	TRILLING CISTICOLA Cisticola woosnami	2.00	0	0
642	CHUBB'S CISTICOLA Cisticola chubbi	4.33	Fw	0
647	WINDING CISTICOLA Cisticola galactotes	4.83	w	0
648	CARRUTHERS'S CISTICOLA Cisticola carruthersi	4.50	W	R-RR
658	TAWNY-FLANKED PRINIA Prinia subflava	5.33	fw	0
662	WHITE-CHINNED PRINIA Prinia leucopogon	4.40	F	0
664	BUFF-BELLIED WARBLER Phyllolais pulchella	2.00	f	0
677	GREY-BACKED CAMAROPTERA Camaroptera brachyura	5.58	f	0
690	NORTHERN CROMBEC Sylvietta brachyura	2.00	0	0
695	WILLOW WARBLER Phylloscopus trochilus	4.50	Pf	0
701	GREY-CAPPED WARBLER Eminia lepida	5.80	fw	R-RR
703	GARDEN WARBLER Sylvia borin	1.00	Pf	0
713	NORTHERN BLACK FLYCATCHER Melaenornis edoliodides	4.33	0	0
719	ASHY FLYCATCHER Muscicapa caerulescens	3.50	F	0
720	SWAMP FLYCATCHER Muscicapa aquatica	4.50	W	0
723	AFRICAN DUSKY FLYCATCHER Muscicapa adusta	5.00	F	0
725	DUSKY-BLUE FLYCATCHER Muscicapa comitata	3.00	F	0
739	AFRICAN PARADISE-FLYCATCHER Terpsiphone viridis	3.00	f	0
746	BROWN-THROATED WATTLE-EYE Platysteira cyanea	2.83	f	0
761	BROWN BABBLER Turdoides plebejus	2.00	0	0
764	BLACK-LORED BABBLER Turdoides sharpei	4.44	0	R-RR
Atlas No.	**SPECIES NAME Scientific Name**	**Relative Abundance**	**Habitat**	**Threat**
780	GREY-HEADED SUNBIRD Deleornis axillaries	6.00	FF	0
781	GREEN-HEADED SUNBIRD Cyanomitra verticalis	3.50	F	0
784	OLIVE SUNBIRD Cyanomitra olivacea	0.00	FF	0
787	SCARLET-CHESTED SUNBIRD Chalcomitra senegalensis	5.50	f	0
790	BRONZE SUNBIRD Nectarinia kilimensis	4.50	f	0
794	COLLARED SUNBIRD Hedydipna collaris	3.00	F	0
796	OLIVE-BELLIED SUNBIRD Cinnyris chloropygia	4.00	F	0
802	MARICO [=MARIQUA] SUNBIRD Cinnyris mariquensis	3.67	0	0
803	RED-CHESTED SUNBIRD Cinnyris erythrocerca	5.40	W	R-RR
808	VARIABLE SUNBIRD Cinnyris venusta	5.75	f	0
810	COPPER SUNBIRD Cinnyris cuprea	4.40	fw	0
811	YELLOW WHITE-EYE Zosterops senegalensis	4.00	f	0
812	COMMON FISCAL Lanius collaris	1.00	G	0
814	MACKINNON'S FISCAL [=SHRIKE] Lanius mackinnoni	0.00	f	0
815	GREY-BACKED FISCAL Lanius excubitoroides	4.67	Afw	0
818	RED-BACKED SHRIKE Lanius collurio	1.50	P	0

831	BROWN-CROWNED [=HEADED] TCHAGRA Tchagra australi	3.00	0	0
833	BLACK-HEADED TCHAGRA Tchagra senegala	5.00	0	0
836	NORTHERN PUFFBACK Dryoscopus gambensis	3.00	F	0
841	TROPICAL BOUBOU Laniarius aethiopicus	5.50	f	0
842	PAPYRUS GONOLEK Laniarius mufumbiri	3.40	w	G-NT
843	BLACK-HEADED GONOLEK Laniarius erythrogaster	5.43	f	0
850	AFRICAN BLACK-HEADED ORIOLE Oriolus larvatus	4.00	f	0
853	FORK-TAILED DRONGO Dicrurus adsimilis	5.33	f	0
855	PIED CROW Corvus albus	0.00	0	0
871	SPLENDID [=GLOSSY] STARLING Lamprotornis splendidus	4.88	F	0
872	RÜPPELL'S LONG-TAILED [=GLOSSY] STARLINGLamprotornispurpuropterus	5.50	0	0
881	GREY-HEADED SPARROW Passer griseus	3.50	0	0
893	BAGLAFECHT WEAVER Ploceus baglafecht	2.50	f	0
894	SLENDER-BILLED WEAVER Ploceus pelzelni	3.67	fW	0
896	BLACK-NECKED WEAVER Ploceus nigricollis	4.67	f	0
897	SPECTACLED WEAVER Ploceus ocularis	3.67	f	0
900	HOLUB'S GOLDEN WEAVER Ploceus xanthops	3.33	w	0
902	NORTHERN BROWN-THROATED WEAVER Ploceus castanops	2.50	fW	R-RR
908	BLACK-HEADED WEAVER Ploceus cucullatus	5.17	0	0
911	GOLDEN-BACKED WEAVER Ploceus jacksoni	3.00	w	R-RR
915	COMPACT WEAVER Ploceus superciliosus	1.00	fw	0
925	RED-BILLED QUELEA Quelea quelea	1.00	A	0
932	FAN-TAILED WIDOWBIRD Euplectes axillaris	3.67	w	0
937	GROSBEAK WEAVER Amblyospiza albifrons	2.00	fW	0
939	GREY-HEADED NEGROFINCH Nigrita canicapilla	5.00	F	0
943	WHITE-COLLARED OLIVEBACK Nesocharis ansorgei	4.00	fw	R-RR
947	RED-WINGED PYTILIA Pytilia phoenicoptera	1.00	0	0
959	RED-BILLED FIREFINCH Lagonosticta senegala	6.00	0	0
963	AFRICAN FIREFINCH Lagonosticta rubricata	3.00	0	0
966	FAWN-BREASTED WAXBILL Estrilda paludicola	4.50	0	0
967	CRIMSON-RUMPED WAXBILL Estrilda rhodopyga	2.50	0	0
969	COMMON WAXBILL Estrilda astrild	2.83	wG	0
Atlas No.	**SPECIES NAME Scientific Name**	**Relative Abundance**	**Habitat**	**Threat**
970	BLACK-CROWNED WAXBILL Estrilda nonnula	2.50	f	0
980	BRONZE MANNIKIN Lonchura cucullata	3.33	0	0
985	PIN-TAILED WHYDAH Vidua macroura	4.00	G	0
991	AFRICAN CITRIL Serinus citrinelloides	1.00	f	0
995	YELLOW-FRONTED CANARY Serinus mozambicus	5.20	0	0

Appendix 2: Relative abundances of the bird species recorded in the Opeta-Bisina wetland system

Atlas No.	SPECIES NAME Scientific Name	Relative Abundance	Habitat	Threat
1	COMMON OSTRICH Struthio camelus	1.00	G	R-VU
5	GREATER CORMORANT Phalacrocorax carbo	1.00	W	0
6	LONG-TAILED CORMORANT Phalacrocorax africanus	3.83	W	0
9	PINK-BACKED PELICAN Pelecanus rufescens	3.43	W	0
11	DWARF BITTERN Ixobrychus sturmii	0.00	Aw	0
14	COMMON SQUACCO HERON Ardeola ralloides	3.53	W	0
17	CATTLE EGRET Bubulcus ibis	4.43	G	0
21	LITTLE EGRET Egretta garzetta	2.75	W	0
22	INTERMEDIATE [=YELLOW-BILLED] EGRET Mesophoyx intermedia	2.67	W	0
23	GREAT [=WHITE] EGRET Casmerodius alba	3.00	W	R-VU
24	PURPLE HERON Ardea purpurea	3.27	W	R-NT
25	GREY HERON Ardea cinerea	2.60	W	R-NT
26	BLACK-HEADED HERON Ardea melanocephala	4.00	w	0
27	GOLIATH HERON Ardea goliath	4.00	W	R-NT
28	HAMERKOP Scopus umbretta	4.00	w	0
30	AFRICAN OPEN-BILLED STORK Anastomus lamelligerus	4.25	AwG	0
33	WOOLLY-NECKED STORK Ciconia episcopus	6.00	W	R-NT
34	WHITE STORK Ciconia ciconia	2.00	P	0
35	SADDLE-BILLED STORK Ephippiorhynchus senegalensis	2.67	W	R-VU
37	SHOEBILL Balaeniceps rex	2.33	W	G-VU, R-VU
39	HADADA Bostrychia hagedash	6.00	w	0
42	SACRED IBIS Threskiornis aethiopica	0.00	W	0
47	FULVOUS WHISTLING DUCK Dendrocygna bicolor	0.00	W	0
48	WHITE-FACED WHISTLING DUCK Dendrocygna viduata	3.50	W	0
49	WHITE-BACKED DUCK Thalassornis leuconotus	3.29	W	R-VU
53	KNOB-BILLED DUCK Sarkidiornis melanotos	0.00	W	0
54	AFRICAN PYGMY GOOSE Nettapus auritus	2.00	W	0
69	OSPREY Pandion haliaetus	2.50	PW	0
73	BLACK-SHOULDERED KITE Elanus caeruleus	3.22	G	0
75	BLACK KITE Milvus migrans	3.43	pA	0
76	AFRICAN FISH EAGLE Haliaeetus vocifer	1.50	W	0
84	WHITE-HEADED VULTURE Trigonoceps occipitalis	2.00	0	G-VU, R-VU
85	SHORT-TOED SNAKE-EAGLE Circaetus gallicus	1.00	0	0
86	BROWN SNAKE-EAGLE Circaetus cinereus	2.50	0	R-NT
88	BATELEUR Terathopius ecaudatus	1.00	G	G-NT
90	AFRICAN HARRIER-HAWK Polyboroides typus	1.00	f	0
91	PALLID HARRIER Circus macrourus	2.00	PG	G-NT, R-NT

92	MONTAGU'S HARRIER Circus pygargus	1.00	P	R-NT
93	AFRICAN MARSH HARRIER Circus ranivorus	3.08	W	R-NT
94	EURASIAN MARSH HARRIER Circus aeruginosus	3.54	Pw	0
116	TAWNY EAGLE (including STEPPE EAGLE) Aquila rapax	3.00	PG	0
120	BOOTED EAGLE Hieraaetus pennatus	5.00	P	0
122	LONG-CRESTED EAGLE Lophaetus occipitalis	2.67	F	0
128	LESSER KESTREL Falco naumanni	1.00	P	G-VU, R-VU
129	COMMON KESTREL Falco tinnunculus	1.00	P	0
131	FOX KESTREL Falco alopex	1.00	0	0
133	RED-NECKED FALCON Falco chicquera	1.00	0	R-NT
136	EURASIAN HOBBY Falco subbuteo	4.00	P	0

Atlas No.	SPECIES NAME Scientific Name	Relative Abundance	Habitat	Threat
138	LANNER FALCON Falco biarmicus	4.00	0	0
178	BLACK CRAKE Amaurornis flavirostris	3.23	W	0
180	PURPLE SWAMPHEN [=PURPLE GALLINULE] Porphyrio porphyrio	0.00	W	0
181	COMMON MOORHEN Gallinula chloropus	4.67	W	0
183	RED-KNOBBED COOT Fulica cristata	6.00	W	0
191	BLACK-BELLIED BUSTARD Eupodotis melanogaster	2.25	0	0
193	JACANA Actophilornis africana	3.95	W	0
194	LESSER JACANA Microparra capensis	4.09	W	R-NT
211	COMMON RINGED PLOVER Charadrius hiaticula	4.00	PW	0
221	AFRICAN WATTLED LAPWING [=PLOVER] Vanellus senegallus	3.25	W	0
227	LONG-TOED LAPWING [=PLOVER] Vanellus crassirostris	2.67	W	0
230	TEMMINCK'S STINT Calidris temminckii	5.00	PW	0
236	COMMON SNIPE Gallinago gallinago	3.00	PW	0
247	GREEN SANDPIPER Tringa ochropus	4.00	PW	0
248	WOOD SANDPIPER Tringa glareola	3.74	PW	0
259	GULL-BILLED TERN Sterna nilotica	3.53	PW	0
263	WHISKERED TERN Chlidonias hybridus	4.10	W	0
264	WHITE-WINGED [=BLACK] TERN Chlidonias leucopterus	4.12	PW	0
268	AFRICAN GREEN-PIGEON Treron calva	2.60	F	0
271	BLUE-SPOTTED WOOD-DOVE Turtur afer	4.33	F	0
274	NAMAQUA DOVE Oena capensis	2.40	0	0
281	SPECKLED PIGEON Columba guinea	4.00	0	0
283	RED-EYED DOVE Streptopelia semitorquata	3.67	f	0
284	AFRICAN MOURNING DOVE Streptopelia decipiens	3.00	0	0
285	VINACEOUS DOVE Streptopelia vinacea	2.67	0	0
286	RING-NECKED DOVE Streptopelia capicola	3.75	f	0
289	LAUGHING DOVE Streptopelia senegalensis	2.25	0	0
305	EASTERN GREY PLANTAIN-EATER Crinifer zonurus	5.00	0	0
309	RED-CHESTED CUCKOO Cuculus solitarius	5.00	AF	0
310	BLACK CUCKOO Cuculus clamosus	2.00	A/FF	0
311	COMMON [=EURASIAN] CUCKOO Cuculus canorus	3.00	P	0
323	WHITE-BROWED COUCAL Centropus superciliosus	3.86	0	0

325	SENEGAL COUCAL Centropus senegalensis	3.33	f	0
326	BLUE-HEADED COUCAL Centropus monachus	3.75	W	0
331	SPOTTED EAGLE-OWL Bubo africanus	5.00	0	0
341	SWAMP [=WHITE-TAILED] NIGHTJAR Caprimulgus natalensis	3.33	Wg	0
358	AFRICAN PALM SWIFT Cypsiurus parvus	3.25	0	0
359	AFRICAN BLACK SWIFT Apus barbatus	6.00	0	0
362	EURASIAN SWIFT Apus apus	3.25	P	0
363	WHITE-RUMPED SWIFT Apus caffer	3.00	0	0
365	LITTLE SWIFT Apus affinis	3.00	0	0
368	BLUE-NAPED MOUSEBIRD Urocolius macrourus	4.00	0	0
369	SPECKLED MOUSEBIRD Colius striatus	3.43	0	0
373	GREY-HEADED KINGFISHER Halcyon leucocepha	3.50	Afw	0
375	WOODLAND KINGFISHER Halcyon senegalensis	4.00	A	0
376	STRIPED KINGFISHER Halcyon chelicuti	3.60	0	0
380	MALACHITE KINGFISHER Alcedo cristata	3.67	W	0
383	PIED KINGFISHER Ceryle rudis	3.41	W	0
392	BLUE-CHEEKED BEE-EATER Merops persicus	2.82	P	0
404	GREEN WOOD-HOOPOE Phoeniculus purpureus	1.00	0	0

Atlas No.	SPECIES NAME Scientific Name	Relative Abundance	Habitat	Threat
431	YELLOW-RUMPED TINKERBIRD Pogoniulus bilineatus	6.00	F	0
433	YELLOW-FRONTED TINKERBIRD Pogoniulus chrysoconus	5.00	f	0
437	SPOT-FLANKED BARBET Tricholaema lachrymose	3.83	0	R-RR
439	WHITE-HEADED BARBET Lybius leucocephalus	1.00	0	0
441	BLACK-BILLED BARBET Lybius guifsobalito	3.42	0	0
443	DOUBLE-TOOTHED BARBET Lybius bidentatus	3.00	f	0
473	CARDINAL WOODPECKER Dendropicos fuscescens	5.00	0	0
487	RUFOUS-NAPED LARK Mirafra africana	3.00	0	0
489	FLAPPET LARK Mirafra rufocinnamomea	4.00	G	0
498	WHITE-HEADED SAW-WING [=ROUGHWING] Psalidoprocne albiceps	2.00	f	R-RR
500	SAND MARTIN Riparia riparia	4.05	PW	0
501	BANDED MARTIN Riparia cincta	2.50	AG	0
502	GREY-RUMPED SWALLOW Pseudhirundo griseopyga	2.00	G	0
503	RUFOUS-CHESTED SWALLOW Hirundo semirufa	0.00	0	0
505	LESSER STRIPED SWALLOW Hirundo abyssinica	4.17	0	0
509	WIRE-TAILED SWALLOW Hirundo smithii	3.00	w	0
512	ANGOLA SWALLOW Hirundo angolensis	4.50	w	0
513	BARN [=EURASIAN] SWALLOW Hirundo rustica	3.57	Pw	0
515	YELLOW WAGTAIL Motacilla flava	3.60	PwG	0
520	AFRICAN PIED WAGTAIL Motacilla aguimp	6.00	w	0
529	YELLOW-THROATED LONGCLAW Macronyx croceus	3.75	G	0
547	YELLOW-THROATED GREENBUL [=LEAFLOVE] Chlorocichla flavicollis	6.00	f	0
562	COMMON BULBUL Pycnonotus barbatus	4.40	f	0
576	WHITE-BROWED ROBIN-CHAT Cossypha heuglini	4.71	f	0

593	WHINCHAT Saxicola rubetra	3.00	P	0
594	NORTHERN WHEATEAR Oenanthe oenanthe	0.33	P	0
612	AFRICAN THRUSH Turdus pelios	3.00	f	0
615	WHITE-WINGED WARBLER Bradypterus carpalis	3.75	W	0
621	AFRICAN MOUSTACHED WARBLER Melocichla mentalis	3.00	0	0
622	BROAD [=FAN] -TAILED WARBLER Schoenicola brevirostris	3.00	fw	0
624	SEDGE WARBLER Acrocephalus schoenobaenus	2.00	Pw	0
630	GREATER SWAMP WARBLER Acrocephalus rufescens	3.27	W	0
631	LESSER SWAMP WARBLER Acrocephalus gracilirostris	3.00	w	0
635	OLIVACEOUS WARBLER Hippolais pallida	3.00	P	0
638	RED-FACED CISTICOLA Cisticola erythrops	4.00	w	0
640	WHISTLING CISTICOLA Cisticola lateralis	2.33	0	0
641	TRILLING CISTICOLA Cisticola woosnami	3.33	0	0
642	CHUBB'S CISTICOLA Cisticola chubbi	6.00	Fw	0
647	WINDING CISTICOLA Cisticola galactotes	3.71	w	0
648	CARRUTHERS'S CISTICOLA Cisticola carruthersi	2.00	W	R-RR
650	CROAKING CISTICOLA Cisticola natalensis	3.33	G	0
655	ZITTING CISTICOLA Cisticola juncidis	3.00	wG	0
658	TAWNY-FLANKED PRINIA Prinia subflava	3.80	fw	0
677	GREY-BACKED CAMAROPTERA Camaroptera brachyura	4.17	f	0
691	RED-FACED CROMBEC Sylvietta whytii	0.00	F	0
695	WILLOW WARBLER Phylloscopus trochilus	3.88	Pf	0
716	SILVERBIRD Empidornis semipartitus	1.00	0	0
717	SPOTTED FLYCATCHER Muscicapa striata	6.00	P	0
720	SWAMP FLYCATCHER Muscicapa aquatica	3.66	W	0
739	AFRICAN PARADISE-FLYCATCHER Terpsiphone viridis	5.50	f	0

Atlas No.	SPECIES NAME Scientific Name	Relative Abundance	Habitat	Threat
751	BLACK-HEADED BATIS Batis minor	3.50	f	0
781	GREEN-HEADED SUNBIRD Cyanomitra verticalis	2.00	F	0
787	SCARLET-CHESTED SUNBIRD Chalcomitra senegalensis	1.50	f	0
790	BRONZE SUNBIRD Nectarinia kilimensis	3.00	f	0
802	MARICO [=MARIQUA] SUNBIRD Cinnyris mariquensis	3.75	0	0
803	RED-CHESTED SUNBIRD Cinnyris erythrocerca	3.17	W	R-RR
810	COPPER SUNBIRD Cinnyris cuprea	3.00	fw	0
811	YELLOW WHITE-EYE Zosterops senegalensis	1.00	f	0
812	COMMON FISCAL Lanius collaris	5.00	G	0
815	GREY-BACKED FISCAL Lanius excubitoroides	3.25	Afw	0
817	ISABELLINE [=RED-TAILED] SHRIKE Lanius isabellinus	4.00	P	0
820	WOODCHAT SHRIKE Lanius senator	3.36	P	0
830	MARSH TCHAGRA Tchagra minutus	5.00	w	0
831	BROWN-CROWNED [=HEADED] TCHAGRA Tchagra australi	0.00	0	0

833	BLACK-HEADED TCHAGRA Tchagra senegala	3.33	0	0
843	BLACK-HEADED GONOLEK Laniarius erythrogaster	4.67	f	0
853	FORK-TAILED DRONGO Dicrurus adsimilis	3.00	f	0
855	PIED CROW Corvus albus	5.00	0	0
858	PIAPIAC Ptilostomus afer	1.00	0	0
869	GREATER BLUE-EARED GLOSSY STARLING Lamprotornis chalybaeus	4.00	0	0
872	RÜPPELL'S LONG-TAILED STARLINGLamprotornispurpuropterus	3.50	0	0
873	SUPERB STARLING Lamprotornis superbus	1.00	0	0
881	GREY-HEADED SPARROW Passer griseus	5.00	0	0
890	WHITE-BROWED SPARROW-WEAVER Plocepasser mahali	1.00	0	0
894	SLENDER-BILLED WEAVER Ploceus pelzelni	3.83	fW	0
902	NORTHERN BROWN-THROATED WEAVER Ploceus castanops	3.20	fW	R-RR
904	VITELLINE MASKED WEAVER Ploceus velatus	5.00	0	0
906	FOX'S WEAVER Ploceus spekeoides	0.00	w	G-NT/R-NT
907	VIEILLOT'S BLACK WEAVER Ploceus nigerrimus	1.00	f	0
908	BLACK-HEADED WEAVER Ploceus cucullatus	2.00	0	0
910	YELLOW-BACKED WEAVER Ploceus melanocephalus	3.38	W	0
925	RED-BILLED QUELEA Quelea quelea	3.00	A	0
930	NORTHERN RED BISHOP Euplectes franciscanus	5.00	G	0
932	FAN-TAILED WIDOWBIRD Euplectes axillaris	2.40	w	0
936	HARTLAUB'S MARSH WIDOWBIRD Euplectes hartlaubi	4.00	w	R-VU
959	RED-BILLED FIREFINCH Lagonosticta senegala	5.00	0	0
966	FAWN-BREASTED WAXBILL Estrilda paludicola	0.00	0	0
969	COMMON WAXBILL Estrilda astrild	1.50	wG	0
974	RED-CHEEKED CORDON-BLEU Uraeginthus bengalus	0.33	0	0
980	BRONZE MANNIKIN Lonchura cucullata	0.50	0	0
985	PIN-TAILED WHYDAH Vidua macroura	2.33	G	0
991	AFRICAN CITRIL Serinus citrinelloides	4.00	f	0
992	PAPYRUS CANARY Serinus koliensis	3.33	W	R-RR
995	YELLOW-FRONTED CANARY Serinus mozambicus	4.00	0	0
266a	BLACK-FACED SANDGROUSE Pterocles decoratus	1.00	0	0
787a	HUNTER'S SUNBIRD Chalcomitra hunteri	2.00	0	0

Appendix 3: Bird species list for the Mburo-Nakivale wetland system

Atlas No	SPECIES NAME Scientific Name	Habitat	Threat
2	LITTLE GREBE Tachybaptus ruficollis	W	
5	GREATER CORMORANT Phalacrocorax carbo	W	
6	LONG-TAILED CORMORANT Phalacrocorax africanus	W	
7	AFRICAN DARTER Anhinga melanogaster	W	R-VU
8	WHITE PELICAN Pelecanus onocrotalus	W	R-RR
9	PINK-BACKED PELICAN Pelecanus rufescens	W	
10	LITTLE BITTERN Ixobrychus minutus	pW	
11	DWARF BITTERN Ixobrychus sturmii	Aw	
12	WHITE-BACKED NIGHT HERON Gorsachius leuconotus	W	R-NT
13	BLACK-CROWNED NIGHT HERON Nycticorax nycticorax	pW	
14	COMMON SQUACCO HERON Ardeola ralloides	W	
16	RUFOUS-BELLIED HERON Ardeola rufiventris	W	R-NT
17	CATTLE EGRET Bubulcus ibis	G	
18	STRIATED [=GREEN-BACKED] HERON Butorides striatus	W	R-NT
21	LITTLE EGRET Egretta garzetta	W	
22	INTERMEDIATE [=YELLOW-BILLED] EGRET Mesophoyx intermedia	W	
23	GREAT [=WHITE] EGRET Casmerodius alba	W	R-VU
24	PURPLE HERON Ardea purpurea	W	R-NT
25	GREY HERON Ardea cinerea	W	R-NT
26	BLACK-HEADED HERON Ardea melanocephala	w	
27	GOLIATH HERON Ardea goliath	W	R-NT
28	HAMERKOP Scopus umbretta	w	
29	YELLOW-BILLED STORK Mycteria ibis	W	
30	AFRICAN OPEN-BILLED STORK Anastomus lamelligerus	AwG	
32	ABDIM'S STORK Ciconia abdimii	AG	
33	WOOLLY-NECKED STORK Ciconia episcopus	W	R-NT
35	SADDLE-BILLED STORK Ephippiorhynchus senegalensis	W	R-VU
36	MARABOU STORK Leptoptilos crumeniferus	w	
37	SHOEBILL Balaeniceps rex	W	G-VU, R-VU
39	HADADA Bostrychia hagedash	w	
42	SACRED IBIS Threskiornis aethiopica	W	
50	EGYPTIAN GOOSE Alopochen aegyptiacus	WG	
51	SPUR-WINGED GOOSE Plectopterus gambensis	W	
57	KNOB-BILLED DUCK Sarkidiornis melanotos	W	
57	YELLOW-BILLED DUCK Anas undulata	W	
69	OSPREY Pandion haliaetus	PW	
71	EUROPEAN HONEY-BUZZARD Pernis apivorus	PF	
72	BAT HAWK Machaerhamphus alcinus	F	R-NT
73	BLACK-SHOULDERED KITE Elanus caeruleus	G	
75	BLACK KITE Milvus migrans	pA	
76	AFRICAN FISH EAGLE Haliaeetus vocifer	W	
80	HOODED VULTURE Necrosyrtes monachus	f	
81	AFRICAN WHITE-BACKED VULTURE Gyps africanus	G	G-NT, R-NT
82	RÜPPELL'S VULTURE Gyps rueppellii	G	G-NT, R-NT
83	LAPPET-FACED VULTURE Torgos tracheliotus		G-VU, R-NT
84	WHITE-HEADED VULTURE Trigonoceps occipitalis		G-VU, R-VU

85	SHORT-TOED SNAKE-EAGLE Circaetus gallicus		
86	BROWN SNAKE-EAGLE Circaetus cinereus		R-NT
87	WESTERN BANDED SNAKE-EAGLE Circaetus cinerascens	F	R-VU
88	BATELEUR Terathopius ecaudatus	G	G-NT
90	AFRICAN HARRIER-HAWK Polyboroides typus	f	
93	AFRICAN MARSH HARRIER Circus ranivorus	W	R-NT
94	EURASIAN MARSH HARRIER Circus aeruginosus	Pw	
95	GABAR GOSHAWK Micronisus gabar		
96	DARK CHANTING-GOSHAWK Melierax metabates		
98	AFRICAN GOSHAWK Accipiter tachiro	F	
Atlas No	**SPECIES NAME Scientific Name**	**Habitat**	**Threat**
100	SHIKRA Accipiter badius	F	
109	LIZARD BUZZARD Kaupifalco monogrammicus	F	
110	COMMON BUZZARD Buteo buteo	P	
114	AUGUR BUZZARD Buteo augur		
115	LESSER SPOTTED EAGLE Aquila pomarina	P	
116	TAWNY EAGLE (including STEPPE EAGLE) Aquila rapax	PG	
117	WAHLBERG'S EAGLE Aquila wahlbergi	Af	
119	AFRICAN HAWK-EAGLE Hieraaetus spilogaster		
122	LONG-CRESTED EAGLE Lophaetus occipitalis	F	
125	MARTIAL EAGLE Polemaetus bellicosus		G-NT, R-EN
129	COMMON KESTREL Falco tinnunculus	P	
130	GREATER [=WHITE-EYED] KESTREL Falco rupicoloides	A	R-NT
132	GREY KESTREL Falco ardosiaceus		
136	EURASIAN HOBBY Falco subbuteo	P	
136	EURASIAN HOBBY Falco subbuteo	P	
139	PEREGRINE FALCON Falco peregrinus		
142	HELMETED GUINEAFOWL Numida meleagris	G	
143	COMMON QUAIL Coturnix coturnix	P	
145	HARLEQUIN QUAIL Coturnix delegorguei	G	
148	COQUI FRANCOLIN Francolinus coqui		
149	RING-NECKED FRANCOLIN Francolinus streptophorus		G-NT, R-VU
154	CRESTED FRANCOLIN Francolinus sephaena		
155	SCALY FRANCOLIN Francolinus squamatus	F	
161	RED-NECKED SPURFOWL Francolinus afer		
164	BUTTON QUAIL Turnix sylvatica	G	
165	BLACK-RUMPED BUTTON QUAIL Turnix hottentota		R-EN
169	BUFF-SPOTTED FLUFFTAIL [=PYGMY CRAKE] Sarothrura elegans	FF	
173	AFRICAN WATER RAIL Rallus caerulescens	W	
178	BLACK CRAKE Amaurornis flavirostris	W	
181	COMMON MOORHEN Gallinula chloropus	W	
182	LESSER MOORHEN Gallinula angulata	AW	
185	GREY CROWNED CRANE Balearica regulorum	WG	G-VU, R-NT
186	AFRICAN FINFOOT Podica senegalensis	W	R-VU
191	BLACK-BELLIED BUSTARD Eupodotis melanogaster		
193	JACANA Actophilornis africana	W	
195	PAINTED SNIPE Rostratula benghalensis	W	
197	BLACK-WINGED STILT Himantopus himantopus	pW	

204	TEMMINCK'S COURSER Cursorius temminckii	AG	
206	VIOLET-TIPPED COURSER Cursorius chalcopterus	A	
213	THREE-BANDED PLOVER Charadrius tricollaris	W	
221	AFRICAN WATTLED LAPWING [=PLOVER] Vanellus senegallus	W	
224	BROWN-CHESTED LAPWING [=WATTLED PLOVER] Vanellus superciliosus	Aw	R-NT
225	SENEGAL LAPWING [=PLOVER] Vanellus lugubris	AG	
226	CROWNED LAPWING [=PLOVER] Vanellus coronatus	G	
227	LONG-TOED LAPWING [=PLOVER] Vanellus crassirostris	W	
236	COMMON SNIPE Gallinago gallinago	PW	
238	GREAT SNIPE Gallinago media	PW	G-NT, R-NT
243	SPOTTED REDSHANK Tringa erythropus	PW	
246	COMMON GREENSHANK Tringa nebularia	PW	
247	GREEN SANDPIPER Tringa ochropus	PW	
248	WOOD SANDPIPER Tringa glareola	PW	
250	COMMON SANDPIPER Actitis hypoleucos	PW	
264	WHITE-WINGED [=BLACK] TERN Chlidonias leucopterus	PW	
268	AFRICAN GREEN-PIGEON Treron calva	F	
270	TAMBOURINE DOVE Turtur tympanistria	F	
273	EMERALD-SPOTTED WOOD-DOVE Turtur chalcospilos	F	
281	SPECKLED PIGEON Columba guinea		
283	RED-EYED DOVE Streptopelia semitorquata	f	
Atlas No	**SPECIES NAME Scientific Name**	**Habitat**	**Threat**
286	RING-NECKED DOVE Streptopelia capicola	f	
289	LAUGHING DOVE Streptopelia senegalensis		
292	BROWN PARROT Poicephalus meyeri		
293	RED-HEADED LOVEBIRD Agapornis pullaria	F	
302	ROSS'S TURACO Musophaga rossae	F	
303	BARE-FACED GO-AWAY-BIRD Corythaixoides personata		R-RR
305	EASTERN GREY PLANTAIN-EATER Crinifer zonurus		
306	BLACK-AND-WHITE CUCKOO Oxylophus jacobinus	A	
307	LEVAILLANT'S CUCKOO Oxylophus levaillantii	Af	
309	RED-CHESTED CUCKOO Cuculus solitarius	AF	
310	BLACK CUCKOO Cuculus clamosus	Af/FF	
311	COMMON [=EURASIAN] CUCKOO Cuculus canorus	P	
312	AFRICAN CUCKOO Cuculus gularis	A	
317	AFRICAN EMERALD CUCKOO Chrysococcyx cupreus	F	
319	KLAAS' CUCKOO Chrysococcyx klaas	f	
320	DIEDERIK [=DIDRIC] CUCKOO Chrysococcyx caprius		
321	YELLOWBILL Ceuthmochares aereus	F	
323	WHITE-BROWED COUCAL Centropus superciliosus		
326	BLUE-HEADED COUCAL Centropus monachus	W	
329	SCOPS OWL Otus scops	P	
331	SPOTTED EAGLE-OWL Bubo africanus		
333	VERREAUX'S EAGLE-OWL Bubo lacteus		
335	PEARL-SPOTTED OWLET Glaucidium perlatum		
341	SWAMP [=WHITE-TAILED] NIGHTJAR Caprimulgus natalensis	Wg	
349	FRECKLED NIGHTJAR Caprimulgus tristigma		

353	PENNANT-WINGED NIGHTJAR Macrodipteryx vexillaria	A	
358	AFRICAN PALM SWIFT Cypsiurus parvus		
362	EURASIAN SWIFT Apus apus	P	
363	WHITE-RUMPED SWIFT Apus caffer		
365	LITTLE SWIFT Apus affinis		
368	BLUE-NAPED MOUSEBIRD Urocolius macrourus		
369	SPECKLED MOUSEBIRD Colius striatus		
371	NARINA [='S] TROGON Apaloderma narina	F	
373	GREY-HEADED [=CHESTNUT-BELLIED] KINGFISHER Halcyon leucocepha	Afw	
374	BLUE-BREASTED KINGFISHER Halcyon malimbica	Fw	
375	WOODLAND KINGFISHER Halcyon senegalensis	A	
376	STRIPED KINGFISHER Halcyon chelicuti		
377	AFRICAN DWARF KINGFISHER Ceyx lecontei	FF	
378	AFRICAN PYGMY KINGFISHER Ceyx picta	fw	
380	MALACHITE KINGFISHER Alcedo cristata	W	
382	GIANT KINGFISHER Megaceryle maxima	W	R-NT
383	PIED KINGFISHER Ceryle rudis	W	
385	LITTLE BEE-EATER Merops pusillus	G	
390	WHITE-THROATED BEE-EATER Merops albicollis	Af	
392	BLUE-CHEEKED BEE-EATER Merops persicus	P	
393	MADAGASCAR BEE-EATER Merops superciliosus	A	
394	EUROPIAN [=EURASIAN] BEE-EATER Merops apiaster	Pf	
397	ABYSSINIAN ROLLER Coracias abyssinica	A	
399	LILAC-BREASTED ROLLER Coracias caudata		
401	BROAD-BILLED ROLLER Eurystomus glaucurus	Afw	
404	GREEN WOOD-HOOPOE Phoeniculus purpureus		
405	COMMON SCIMITARBILL Rhinopmastus cyanomelas		
408	HOOPOE Upupa epops	p	
409	ABYSSINIAN GROUND-HORNBILL Bucorvus abyssinicus		
410	SOUTHERN GROUND-HORNBILL Bucorvus leadbeateri		
419	CROWNED HORNBILL Tockus alboterminatus	f	
420	AFRICAN GREY HORNBILL Tockus nasutus		
431	YELLOW-RUMPED TINKERBIRD Pogoniulus bilineatus	F	
Atlas No	**SPECIES NAME Scientific Name**	**Habitat**	**Threat**
433	YELLOW-FRONTED TINKERBIRD Pogoniulus chrysoconus	f	
436	RED-FRONTED BARBET Tricholaema diademata		
437	SPOT-FLANKED BARBET Tricholaema lachrymose		R-RR
438	BLACK-THROATED BARBET Tricholaema melanocephala		
439	WHITE-HEADED BARBET Lybius leucocephalus		
440	RED-FACED BARBET Lybius rubrifacies	F	G-NT, R-NT
443	DOUBLE-TOOTHED BARBET Lybius bidentatus	f	
446	CRESTED [=LEVAILLANT'S] BARBET Trachyphonus vaillantii	f	
455	GREATER [=BLACK-THROATED] HONEYGUIDE Indicator indicator	f	
456	LESSER HONEYGUIDE Indicator minor	f	
465	NUBIAN WOODPECKER Campethera nubica		
467	GREEN-BACKED [=LITTLE SPOTTED] WOODPECKER Campethera caillautii	f	

469	BUFF-SPOTTED WOODPECKER Campethera nivosa	FF	
473	CARDINAL WOODPECKER Dendropicos fuscescens		
474	BEARDED WOODPECKER Dendropicos namaquus	f	
477	GREY WOODPECKER Dendropicos goertae	f	
481	RUFOUS [=RED] -SIDED BROADBILL Smithornis rufolateralis	FF	
487	RUFOUS-NAPED LARK Mirafra africana		
489	FLAPPET LARK Mirafra rufocinnamomea	G	
493	RED-CAPPED LARK Calandrella cinerea	G	
498	WHITE-HEADED SAW-WING [=ROUGHWING] Psalidoprocne albiceps	f	R-RR
500	SAND MARTIN Riparia riparia	PW	
501	BANDED MARTIN Riparia cincta	AG	
503	RUFOUS-CHESTED SWALLOW Hirundo semirufa		
504	MOSQUE SWALLOW Hirundo senegalensis		
505	LESSER STRIPED SWALLOW Hirundo abyssinica		
507	[=AFRICAN] ROCK MARTIN Hirundo fuligula		
512	ANGOLA SWALLOW Hirundo angolensis	w	
513	BARN [=EURASIAN] SWALLOW Hirundo rustica	Pw	
515	YELLOW WAGTAIL Motacilla flava	PwG	
520	AFRICAN PIED WAGTAIL Motacilla aguimp	w	
522	GRASSLAND [= RICHARD'S] PIPIT Anthus cinnamomeus	G	
525	PLAIN-BACKED PIPIT Anthus leucophrys	G	
529	YELLOW-THROATED LONGCLAW Macronyx croceus	G	
530	RED-SHOULDERED CUCKOO-SHRIKE Campephaga phoenicea		
531	BLACK CUCKOO-SHRIKE Campephaga flava	Af	
538	LITTLE GREENBUL Andropadus virens	F	
541	SLENDER-BILLED GREENBUL Andropadus gracilirostris	FF	
547	YELLOW-THROATED GREENBUL [=LEAFLOVE] Chlorocichla flavicollis	f	
562	COMMON BULBUL Pycnonotus barbatus	f	
574	GREY-WINGED GROUND-ROBIN Cossypha polioptera	FF	R-VU
576	WHITE-BROWED ROBIN-CHAT Cossypha heuglini	f	
577	RED-CAPPED ROBIN-CHAT Cossypha natalensis	F	
578	SNOWY-HEADED ROBIN-CHAT Cossypha niveicapilla	Fw	
588	BROWN-BACKED SCRUB-ROBIN Cercotrichas hartlaubi	f	
593	WHINCHAT Saxicola rubetra	P	
594	NORTHERN WHEATEAR Oenanthe oenanthe	P	
601	SOOTY CHAT Myrmecocichla nigra		
612	AFRICAN THRUSH Turdus pelios	f	
621	AFRICAN MOUSTACHED WARBLER Melocichla mentalis		
624	SEDGE WARBLER Acrocephalus schoenobaenus	Pw	
626	AFRICAN REED WARBLER Acrocephalus baeticatus	w	R-NT
630	GREATER SWAMP WARBLER Acrocephalus rufescens	W	
631	LESSER SWAMP WARBLER Acrocephalus gracilirostris	w	
634	PAPYRUS YELLOW WARBLER Chloropeta gracilirostris	W	G-VU, R-VU
638	RED-FACED CISTICOLA Cisticola erythrops	w	
647	WINDING CISTICOLA Cisticola galactotes	w	
648	CARRUTHERS'S CISTICOLA Cisticola carruthersi	W	R-RR

Atlas No	SPECIES NAME Scientific Name	Habitat	Threat
649	STOUT CISTICOLA Cisticola robustus		
650	CROAKING CISTICOLA Cisticola natalensis	G	
652	SIFFLING CISTICOLA Cisticola brachypterus		
654	LONG-TAILED CISTICOLA Cisticola angusticaudus		
655	ZITTING CISTICOLA Cisticola juncidis	wG	
658	TAWNY-FLANKED PRINIA Prinia subflava	fw	
662	WHITE-CHINNED PRINIA Prinia leucopogon	F	
667	YELLOW-BREASTED APALIS Apalis flavida	f	
673	BUFF-THROATED APALIS Apalis rufogularis	FF	
677	GREY-BACKED CAMAROPTERA Camaroptera brachyura	f	
679	OLIVE-GREEN CAMAROPTERA Camaroptera chloronota	FF	
687	GREEN-CAPPED EREMOMELA Eremomela scotops	F	
691	RED-FACED CROMBEC Sylvietta whytii	F	
695	WILLOW WARBLER Phylloscopus trochilus	Pf	
701	GREY-CAPPED WARBLER Eminia lepida	fw	R-RR
703	GARDEN WARBLER Sylvia borin	Pf	
709	GREEN HYLIA Hylia prasina	F	
713	NORTHERN BLACK FLYCATCHER Melaenornis edoliodides		
714	PALE FLYCATCHER Melaenornis pallidus		
717	SPOTTED FLYCATCHER Muscicapa striata	P	
719	ASHY FLYCATCHER Muscicapa caerulescens	F	
720	SWAMP FLYCATCHER Muscicapa aquatica	W	
723	AFRICAN DUSKY FLYCATCHER Muscicapa adusta	F	
728	LEAD-COLOURED FLYCATCHER Myioparus plumbeus	F	
739	AFRICAN PARADISE-FLYCATCHER Terpsiphone viridis	f	
746	BROWN-THROATED WATTLE-EYE Platysteira cyanea	f	
749	CHIN-SPOT BATIS Batis molitor	f	
761	BROWN BABBLER Turdoides plebejus		
762	ARROW-MARKED BABBLER Turdoides jardineii		
764	BLACK-LORED BABBLER Turdoides sharpei		R-RR
771	BLACK TIT Parus leucomelas	f	
773	AFRICAN PENDULINE TIT Anthoscopus caroli	f	
781	GREEN-HEADED SUNBIRD Cyanomitra verticalis	F	
784	OLIVE SUNBIRD Cyanomitra olivacea	FF	
787	SCARLET-CHESTED SUNBIRD Chalcomitra senegalensis	f	
794	COLLARED SUNBIRD Hedydipna collaris	F	
796	OLIVE-BELLIED SUNBIRD Cinnyris chloropygia	F	
802	MARICO [=MARIQUA] SUNBIRD Cinnyris mariquensis		
803	RED-CHESTED SUNBIRD Cinnyris erythrocerca	W	R-RR
808	VARIABLE SUNBIRD Cinnyris venusta	f	
810	COPPER SUNBIRD Cinnyris cuprea	fw	
811	YELLOW WHITE-EYE Zosterops senegalensis	f	
812	COMMON FISCAL Lanius collaris	G	
815	GREY-BACKED FISCAL Lanius excubitoroides	Afw	
818	RED-BACKED SHRIKE Lanius collurio	P	
828	SULPHUR-BREASTED BUSH-SHRIKE Malaconotus sulfureopectus	f	
831	BROWN-CROWNED [=HEADED] TCHAGRA Tchagra australi		

833	BLACK-HEADED TCHAGRA Tchagra senegala		
836	NORTHERN PUFFBACK Dryoscopus gambensis	F	
841	TROPICAL BOUBOU Laniarius aethiopicus	f	
842	PAPYRUS GONOLEK Laniarius mufumbiri	w	G-NT
843	BLACK-HEADED GONOLEK Laniarius erythrogaster	f	
844	BRUBRU Nilaus afer		
845	WHITE-CRESTED HELMET-SHRIKE Prionops plumatus	f	
850	AFRICAN BLACK-HEADED ORIOLE Oriolus larvatus	f	
853	FORK-TAILED DRONGO Dicrurus adsimilis	f/F	
855	PIED CROW Corvus albus		
Atlas No	**SPECIES NAME Scientific Name**	**Habitat**	**Threat**
870	LESSER BLUE-EARED [=GLOSSY] STARLINGLamprotornis chloropterus		
871	SPLENDID [=GLOSSY] STARLING Lamprotornis splendidus	F	
872	RÜPPELL'S LONG-TAILED [=GLOSSY] STARLINGLamprotornispurpuropterus		
876	VIOLET-BACKED STARLING Cinnyricinclus leucogaster	Af	
877	WATTLED STARLING Creatophora cinerea		
878	YELLOW-BILLED OXPECKER Buphagus africanus		R-VU
881	GREY-HEADED SPARROW Passer griseus		
889	SPECKLED-FRONTED WEAVER Sporopipes frontalis		
890	WHITE-BROWED SPARROW-WEAVER Plocepasser mahali		
893	BAGLAFECHT WEAVER Ploceus baglafecht	f	
894	SLENDER-BILLED WEAVER Ploceus pelzelni	fW	
895	LITTLE WEAVER Ploceus luteolus		
896	BLACK-NECKED WEAVER Ploceus nigricollis	f	
897	SPECTACLED WEAVER Ploceus ocularis	f	
900	HOLUB'S GOLDEN WEAVER Ploceus xanthops	w	
902	NORTHERN BROWN-THROATED WEAVER Ploceus castanops	fW	R-RR
908	BLACK-HEADED WEAVER Ploceus cucullatus		
910	YELLOW-BACKED WEAVER Ploceus melanocephalus	W	
911	GOLDEN-BACKED WEAVER Ploceus jacksoni	w	R-RR
922	RED-HEADED WEAVER Anaplectes rubriceps		
923	CARDINAL QUELEA Quelea cardinalis	A	R-RR
925	RED-BILLED QUELEA Quelea quelea	A	
929	SOUTHERN RED BISHOP Euplectes orix	G	
932	FAN-TAILED WIDOWBIRD Euplectes axillaris	w	
934	WHITE-WINGED WIDOWBIRD Euplectes albonotatus	G	
935	RED-COLLARED [=NAPED] WIDOWBIRD Euplectes ardens		
937	GROSBEAK WEAVER Amblyospiza albifrons	fW	
969	COMMON WAXBILL Estrilda astrild	wG	
976	ZEBRA WAXBILL Amandava subflava		
984	VILLAGE [=RED-BILLED FIREFINCH] INDIGOBIRD Vidua chalybeata		
985	PIN-TAILED WHYDAH Vidua macroura	G	
902a	[NORTHERN MASKED WEAVER Ploceus taeniopterus]		

Appendix 4: Bird species list for the Opeta-Bisina wetland system

Atlas No.	SPECIES NAME Scientific Name	Habitat	Threat
1	COMMON OSTRICH Struthio camelus	G	R-VU
2	LITTLE GREBE Tachybaptus ruficollis	W	
5	GREATER CORMORANT Phalacrocorax carbo	W	0
6	LONG-TAILED CORMORANT Phalacrocorax africanus	W	0
8	WHITE PELICAN Pelecanus onocrotalus	W	R-RR
9	PINK-BACKED PELICAN Pelecanus rufescens	W	0
10	LITTLE BITTERN Ixobrychus minutus	pW	
11	DWARF BITTERN Ixobrychus sturmii	Aw	0
14	COMMON SQUACCO HERON Ardeola ralloides	W	0
15	MADAGASCAR SQUACCO HERON Ardeola idae	AW	G-EN, R-VU
16	RUFOUS-BELLIED HERON Ardeola rufiventris	W	R-NT
17	CATTLE EGRET Bubulcus ibis	G	0
18	STRIATED [=GREEN-BACKED] HERON Butorides striatus	W	R-NT
21	LITTLE EGRET Egretta garzetta	W	0
22	INTERMEDIATE [=YELLOW-BILLED] EGRET Mesophoyx intermedia	W	0
22	INTERMEDIATE [=YELLOW-BILLED] EGRET Mesophoyx intermedia	W	
23	GREAT [=WHITE] EGRET Casmerodius alba	W	R-VU
24	PURPLE HERON Ardea purpurea	W	R-NT
25	GREY HERON Ardea cinerea	W	R-NT
26	BLACK-HEADED HERON Ardea melanocephala	w	0
27	GOLIATH HERON Ardea goliath	W	R-NT
28	HAMERKOP Scopus umbretta	w	0
29	YELLOW-BILLED STORK Mycteria ibis	W	
30	AFRICAN OPEN-BILLED STORK Anastomus lamelligerus	AwG	0
33	WOOLLY-NECKED STORK Ciconia episcopus	W	R-NT
34	WHITE STORK Ciconia ciconia	P	0
35	SADDLE-BILLED STORK Ephippiorhynchus senegalensis	W	R-VU
37	SHOEBILL Balaeniceps rex	W	G-VU, R-VU
38	GLOSSY IBIS Plegadis falcinellus	pW	
39	HADADA Bostrychia hagedash	w	0
42	SACRED IBIS Threskiornis aethiopica	W	0
44	AFRICAN SPOONBILL Platalea alba	W	
47	FULVOUS WHISTLING DUCK Dendrocygna bicolor	W	0
48	WHITE-FACED WHISTLING DUCK Dendrocygna viduata	W	0
49	WHITE-BACKED DUCK Thalassornis leuconotus	W	R-VU
50	EGYPTIAN GOOSE Alopochen aegyptiacus	WG	
51	SPUR-WINGED GOOSE Plectopterus gambensis	W	
53	KNOB-BILLED DUCK Sarkidiornis melanotos	W	0
54	AFRICAN PYGMY GOOSE Nettapus auritus	W	0
57	YELLOW-BILLED DUCK Anas undulata	W	
61	HOTTENTOT TEAL Anas hottentota	W	
64	SOUTHERN POCHARD Netta erythrophthalma	AW	
69	OSPREY Pandion haliaetus	PW	0
73	BLACK-SHOULDERED KITE Elanus caeruleus	G	0
75	BLACK KITE Milvus migrans	pA	0
76	AFRICAN FISH EAGLE Haliaeetus vocifer	W	0

84	WHITE-HEADED VULTURE Trigonoceps occipitalis	0	G-VU, R-VU
85	SHORT-TOED SNAKE-EAGLE Circaetus gallicus	0	0
86	BROWN SNAKE-EAGLE Circaetus cinereus	0	R-NT
88	BATELEUR Terathopius ecaudatus	G	G-NT
90	AFRICAN HARRIER-HAWK Polyboroides typus	f	0
91	PALLID HARRIER Circus macrourus	PG	G-NT, R-NT
92	MONTAGU'S HARRIER Circus pygargus	P	R-NT
93	AFRICAN MARSH HARRIER Circus ranivorus	W	R-NT
94	EURASIAN MARSH HARRIER Circus aeruginosus	Pw	0
Atlas No.	**SPECIES NAME Scientific Name**	**Habitat**	**Threat**
116	TAWNY EAGLE (including STEPPE EAGLE) Aquila rapax	PG	0
120	BOOTED EAGLE Hieraaetus pennatus	P	0
122	LONG-CRESTED EAGLE Lophaetus occipitalis	F	0
128	LESSER KESTREL Falco naumanni	P	G-VU, R-VU
129	COMMON KESTREL Falco tinnunculus	P	0
131	FOX KESTREL Falco alopex	0	0
133	RED-NECKED FALCON Falco chicquera	0	R-NT
136	EURASIAN HOBBY Falco subbuteo	P	0
138	LANNER FALCON Falco biarmicus	0	0
173	AFRICAN WATER RAIL Rallus caerulescens	W	
177	STRIPED CRAKE Aenigmatolimnas marginalis	AW	R-NT
178	BLACK CRAKE Amaurornis flavirostris	W	0
179	ALLEN'S GALLINULE Porphyrio alleni	W	
180	PURPLE SWAMPHEN [=PURPLE GALLINULE] Porphyrio porphyrio	W	0
181	COMMON MOORHEN Gallinula chloropus	W	0
182	LESSER MOORHEN Gallinula angulata	AW	
183	RED-KNOBBED COOT Fulica cristata	W	0
185	GREY CROWNED CRANE Balearica regulorum	WG	G-VU, R-NT
191	BLACK-BELLIED BUSTARD Eupodotis melanogaster	0	0
193	JACANA Actophilornis africana	W	0
194	LESSER JACANA Microparra capensis	W	R-NT
195	PAINTED SNIPE Rostratula benghalensis	W	
197	BLACK-WINGED STILT Himantopus himantopus	pW	
201	WATER THICK-KNEE Burhinus vermiculatus	W	
207	COLLARED [=COMMON] PRATINCOLE Glareola pratincola	W	
211	COMMON RINGED PLOVER Charadrius hiaticula	PW	0
212	KITTLITZ'S SANDPLOVER Charadrius pecuarius	W	
213	THREE-BANDED PLOVER Charadrius tricollaris	W	
221	AFRICAN WATTLED LAPWING [=PLOVER] Vanellus senegallus	W	0
221	AFRICAN WATTLED LAPWING [=PLOVER] Vanellus senegallus	W	
223	SPUR-WINGED LAPWING [=PLOVER] Vanellus spinosus	WG	
225	SENEGAL LAPWING [=PLOVER] Vanellus lugubris	AG	
227	LONG-TOED LAPWING [=PLOVER] Vanellus crassirostris	W	0
230	TEMMINCK'S STINT Calidris temminckii	PW	0
231	CURLEW SANDPIPER Calidris ferruginea	PW	
234	RUFF Philomachus pugnax	PW	
236	COMMON SNIPE Gallinago gallinago	PW	0
245	MARSH SANDPIPER Tringa stagnatilis	PW	
246	COMMON GREENSHANK Tringa nebularia	PW	

247	GREEN SANDPIPER Tringa ochropus	PW	0
248	WOOD SANDPIPER Tringa glareola	PW	0
254	GREY-HEADED GULL Larus cirrocephalus	W	
255	COMMON BLACK-HEADED GULL Larus ridibundus	PW	
256	SLENDER-BILLED GULL Larus genei	PW	
257	LESSER BLACK-BACKED GULL Larus fuscus	PW	
259	GULL-BILLED TERN Sterna nilotica	PW	0
263	WHISKERED TERN Chlidonias hybridus	W	0
264	WHITE-WINGED [=BLACK] TERN Chlidonias leucopterus	PW	0
268	AFRICAN GREEN-PIGEON Treron calva	F	0
271	BLUE-SPOTTED WOOD-DOVE Turtur afer	F	0
274	NAMAQUA DOVE Oena capensis	0	0
281	SPECKLED PIGEON Columba guinea	0	0
283	RED-EYED DOVE Streptopelia semitorquata	f	0
284	AFRICAN MOURNING DOVE Streptopelia decipiens	0	0
285	VINACEOUS DOVE Streptopelia vinacea	0	0
286	RING-NECKED DOVE Streptopelia capicola	f	0
289	LAUGHING DOVE Streptopelia senegalensis	0	0
Atlas No.	**SPECIES NAME Scientific Name**	**Habitat**	**Threat**
305	EASTERN GREY PLANTAIN-EATER Crinifer zonurus	0	0
309	RED-CHESTED CUCKOO Cuculus solitarius	AF	0
310	BLACK CUCKOO Cuculus clamosus	A/FF	0
311	COMMON [=EURASIAN] CUCKOO Cuculus canorus	P	0
323	WHITE-BROWED COUCAL Centropus superciliosus	0	0
324	BLACK COUCAL Centropus grillii	W	R-NT
325	SENEGAL COUCAL Centropus senegalensis	f	0
326	BLUE-HEADED COUCAL Centropus monachus	W	0
331	SPOTTED EAGLE-OWL Bubo africanus	0	0
341	SWAMP [=WHITE-TAILED] NIGHTJAR Caprimulgus natalensis	Wg	0
358	AFRICAN PALM SWIFT Cypsiurus parvus	0	0
359	AFRICAN BLACK SWIFT Apus barbatus	0	0
362	EURASIAN SWIFT Apus apus	P	0
363	WHITE-RUMPED SWIFT Apus caffer	0	0
365	LITTLE SWIFT Apus affinis	0	0
368	BLUE-NAPED MOUSEBIRD Urocolius macrourus	0	0
369	SPECKLED MOUSEBIRD Colius striatus	0	0
373	GREY-HEADED [=CHESTNUT-BELLIED] KINGFISHER Halcyon leucocepha	Afw	0
375	WOODLAND KINGFISHER Halcyon senegalensis	A	0
376	STRIPED KINGFISHER Halcyon chelicuti	0	0
380	MALACHITE KINGFISHER Alcedo cristata	W	0
383	PIED KINGFISHER Ceryle rudis	W	0
392	BLUE-CHEEKED BEE-EATER Merops persicus	P	0
404	GREEN WOOD-HOOPOE Phoeniculus purpureus	0	0
431	YELLOW-RUMPED TINKERBIRD Pogoniulus bilineatus	F	0
433	YELLOW-FRONTED TINKERBIRD Pogoniulus chrysoconus	f	0
437	SPOT-FLANKED BARBET Tricholaema lachrymose	0	R-RR
439	WHITE-HEADED BARBET Lybius leucocephalus	0	0
441	BLACK-BILLED BARBET Lybius guifsobalito	0	0
443	DOUBLE-TOOTHED BARBET Lybius bidentatus	f	0
473	CARDINAL WOODPECKER Dendropicos fuscescens	0	0
487	RUFOUS-NAPED LARK Mirafra africana	0	0
489	FLAPPET LARK Mirafra rufocinnamomea	G	0

498	WHITE-HEADED SAW-WING [=ROUGHWING] Psalidoprocne albiceps	f	R-RR
500	SAND MARTIN Riparia riparia	PW	0
500	SAND MARTIN Riparia riparia	PW	
501	BANDED MARTIN Riparia cincta	AG	0
502	GREY-RUMPED SWALLOW Pseudhirundo griseopyga	G	0
503	RUFOUS-CHESTED SWALLOW Hirundo semirufa	0	0
505	LESSER STRIPED SWALLOW Hirundo abyssinica	0	0
509	WIRE-TAILED SWALLOW Hirundo smithii	w	0
512	ANGOLA SWALLOW Hirundo angolensis	w	0
513	BARN [=EURASIAN] SWALLOW Hirundo rustica	Pw	0
515	YELLOW WAGTAIL Motacilla flava	PwG	0
520	AFRICAN PIED WAGTAIL Motacilla aguimp	w	0
529	YELLOW-THROATED LONGCLAW Macronyx croceus	G	0
547	YELLOW-THROATED GREENBUL [=LEAFLOVE] Chlorocichla flavicollis	f	0
562	COMMON BULBUL Pycnonotus barbatus	f	0
576	WHITE-BROWED ROBIN-CHAT Cossypha heuglini	f	0
593	WHINCHAT Saxicola rubetra	P	0
594	NORTHERN WHEATEAR Oenanthe oenanthe	P	0
612	AFRICAN THRUSH Turdus pelios	f	0
615	WHITE-WINGED WARBLER Bradypterus carpalis	W	0
621	AFRICAN MOUSTACHED WARBLER Melocichla mentalis	0	0
622	BROAD [=FAN] -TAILED WARBLER Schoenicola brevirostris	fw	0
624	SEDGE WARBLER Acrocephalus schoenobaenus	Pw	0
630	GREATER SWAMP WARBLER Acrocephalus rufescens	W	0
Atlas No.	**SPECIES NAME Scientific Name**	**Habitat**	**Threat**
631	LESSER SWAMP WARBLER Acrocephalus gracilirostris	w	0
635	OLIVACEOUS WARBLER Hippolais pallida	P	0
638	RED-FACED CISTICOLA Cisticola erythrops	w	0
640	WHISTLING CISTICOLA Cisticola lateralis	0	0
641	TRILLING CISTICOLA Cisticola woosnami	0	0
642	CHUBB'S CISTICOLA Cisticola chubbi	Fw	0
647	WINDING CISTICOLA Cisticola galactotes	w	0
648	CARRUTHERS'S CISTICOLA Cisticola carruthersi	W	R-RR
650	CROAKING CISTICOLA Cisticola natalensis	G	0
655	ZITTING CISTICOLA Cisticola juncidis	wG	0
658	TAWNY-FLANKED PRINIA Prinia subflava	fw	0
677	GREY-BACKED CAMAROPTERA Camaroptera brachyura	f	0
691	RED-FACED CROMBEC Sylvietta whytii	F	0
695	WILLOW WARBLER Phylloscopus trochilus	Pf	0
716	SILVERBIRD Empidornis semipartitus	0	0
717	SPOTTED FLYCATCHER Muscicapa striata	P	0
720	SWAMP FLYCATCHER Muscicapa aquatica	W	0
739	AFRICAN PARADISE-FLYCATCHER Terpsiphone viridis	f	0
751	BLACK-HEADED BATIS Batis minor	f	0
781	GREEN-HEADED SUNBIRD Cyanomitra verticalis	F	0
787	SCARLET-CHESTED SUNBIRD Chalcomitra senegalensis	f	0
790	BRONZE SUNBIRD Nectarinia kilimensis	f	0
802	MARICO [=MARIQUA] SUNBIRD Cinnyris mariquensis	0	0
803	RED-CHESTED SUNBIRD Cinnyris erythrocerca	W	R-RR
810	COPPER SUNBIRD Cinnyris cuprea	fw	0
811	YELLOW WHITE-EYE Zosterops senegalensis	f	0

812	COMMON FISCAL Lanius collaris	G	0
815	GREY-BACKED FISCAL Lanius excubitoroides	Afw	0
817	ISABELLINE [=RED-TAILED] SHRIKE Lanius isabellinus	P	0
820	WOODCHAT SHRIKE Lanius senator	P	0
830	MARSH TCHAGRA Tchagra minutus	w	0
831	BROWN-CROWNED [=HEADED] TCHAGRA Tchagra australi	0	0
833	BLACK-HEADED TCHAGRA Tchagra senegala	0	0
842	PAPYRUS GONOLEK Laniarius mufumbiri	w	G-NT
843	BLACK-HEADED GONOLEK Laniarius erythrogaster	f	0
853	FORK-TAILED DRONGO Dicrurus adsimilis	f	0
855	PIED CROW Corvus albus	0	0
858	PIAPIAC Ptilostomus afer	0	0
869	GREATER BLUE-EARED GLOSSY STARLING Lamprotornis chalybaeus	0	0
872	RÜPPELL'S LONG-TAILED [=GLOSSY] STARLINGLamprotornispurpuropterus	0	0
873	SUPERB STARLING Lamprotornis superbus	0	0
881	GREY-HEADED SPARROW Passer griseus	0	0
890	WHITE-BROWED SPARROW-WEAVER Plocepasser mahali	0	0
894	SLENDER-BILLED WEAVER Ploceus pelzelni	fW	0
902	NORTHERN BROWN-THROATED WEAVER Ploceus castanops	fW	R-RR
904	VITELLINE MASKED WEAVER Ploceus velatus	0	0
906	FOX'S WEAVER Ploceus spekeoides	w	G-NT/RR, R-NT/RR
907	VIEILLOT'S BLACK WEAVER Ploceus nigerrimus	f	0
908	BLACK-HEADED WEAVER Ploceus cucullatus	0	0
910	YELLOW-BACKED WEAVER Ploceus melanocephalus	W	0
925	RED-BILLED QUELEA Quelea quelea	A	0
930	NORTHERN RED BISHOP Euplectes franciscanus	G	0
932	FAN-TAILED WIDOWBIRD Euplectes axillaris	w	0
936	HARTLAUB'S MARSH WIDOWBIRD Euplectes hartlaubi	w	R-VU
959	RED-BILLED FIREFINCH Lagonosticta senegala	0	0
966	FAWN-BREASTED WAXBILL Estrilda paludicola	0	0
969	COMMON WAXBILL Estrilda astrild	wG	0
Atlas No.	**SPECIES NAME Scientific Name**	**Habitat**	**Threat**
974	RED-CHEEKED CORDON-BLEU Uraeginthus bengalus	0	0
980	BRONZE MANNIKIN Lonchura cucullata	0	0
985	PIN-TAILED WHYDAH Vidua macroura	G	0
991	AFRICAN CITRIL Serinus citrinelloides	f	0
992	PAPYRUS CANARY Serinus koliensis	W	R-RR
995	YELLOW-FRONTED CANARY Serinus mozambicus	0	0
266a	[BLACK-FACED SANDGROUSE Pterocles decoratus]	0	0
787a	[HUNTER'S SUNBIRD Chalcomitra hunteri	0	0

NB: Hunter's Sunbird *(Chalcomitra hunteri)* and Black-faced Sandgrouse *(Pterocles decoratus)* should be further followed.

CHAPTER 3: Insects

BUTTERFLY FAUNA OF LAKE BISINA - OPETA WETLAND SYSTEMS AND LAKE MBURO - NAKIVALI WETLAND SYSTEMS

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3 Background

There has been increased awareness and promotion of wetland conservation in Uganda since 1987. Uganda is a signatory to the Ramsar Convention that addresses the issues of wetland degradation through designating sites of international importance. Invertebrates serve an extremely important role in the community. Studies indicate that insects, as a whole, have a large influence on plant diversity and particular species of insect serve keystone functions in the community. Butterflies satisfy most selection criteria for use as bioindicators.

3.1 Why Butterflies?

Butterflies respond quickly to environmental changes and there is now considerable data on how particular species contend with alterations in land-use, and thus may play a valuable role in ecological monitoring (Daily and Ehrlich, 1995). The influence of seasonality on the presence or absence of adults of certain species, and on their morphology, as well as knowledge of species ecology must always be considered. However, the compilation of species lists may be used both qualitatively and quantitatively, to comment on a habitat (its condition and vegetation) and to identify conservation and monitoring needs. Increasingly, therefore, butterflies are being used as tools in ecological monitoring strategies (Pollard and Yates, 1993; Sparrow *et al.,* 1994).

3.2 Why monitor?

Uganda is one of the countries that has ratified the Convention on Biological Diversity and as such is required to inventory and monitor its own biodiversity. This is an onerous task, given that only a small fraction of the organisms living within the boundaries of most countries have so far been discovered, identified, scientifically named and classified (Groombridge, 1992).

Regular monitoring of species' occurrences in a given habitat/site is a necessary component of biodiversity monitoring. The database increases in value with each subsequent monitoring event, and repeated censusing will ensure that any change in biodiversity can be detected.

According to Sparrow *et al.* (1994), no matter how well documented population trends in a single taxonomic group such as butterflies are, they are likely to provide only a partial picture of overall biological diversity. Long-term monitoring is most effective when they include diverse taxa and accompanied by research into abiotic factors such as macro and microclimate and habitat condition. A focused, multidisciplinary approach to monitoring offers the best opportunity for obtaining biological information that is truly useful in making informed management decisions for example gazetting an ecosystem as a result of well noted declines in populations due to certain human activities like logging in forests, wetland drainage or unregulated clearing.

3.3 Study sites and Methods

3.3.1 Study sites

Three different sites were the focus of these surveys. These included Lake Bisina Ramsar site, Lake Opeta and LakeMburo-Nakivali wetland systems.

3.3.1.1 Lake Bisina

The Lake Bisina Ramsar Site is located in eastern Uganda near between Lakes Kyoga and Opeta on the south-western margin of the arid grasslands of Karamoja. The system lies in Kumi district, 15km north from Kumi town and 20km east of Soroti. The lake, which covers an area of 192 km^2, lies 1,050 m above sea level. The Ramsar site contains Lake Bisina and its wetland margins as well as the broad floodplain of the Apedura River which drains the northerly region of Karamoja. The floodplain is up to 6.5km wide and contains a number of lesser lakes. Lake Bisina is one of the 30 Important Bird Areas identified by ***Nature*** Uganda.

3.3.1.2 Lake Opeta

Lake Opeta and its surrounding swamps are located in eastern Uganda, 25km north-east of Kumi town. The Ramsar site stands 1,050 m above sea level and covers an area of 68,913 hectares. The wetland system represents the easternmost part of the Lake Kyoga basin. It occupies an extensive floodplain between the Lake Bisina Ramsar Site (which it drains towards Lake Kyoga) to the west and the base of Mount Elgon, a massive extinct volcanic massif, to the south-east. The Lake Opeta wetlands marks the southern limits of the vast, arid region of Karamoja which extends along Uganda's eastern flank between Mount Elgon and the distant Sudan border, nearly 300km to the north. The grassland plain area immediately east of the wetland is protected within of the Pian-Upe Wildlife Reserve.

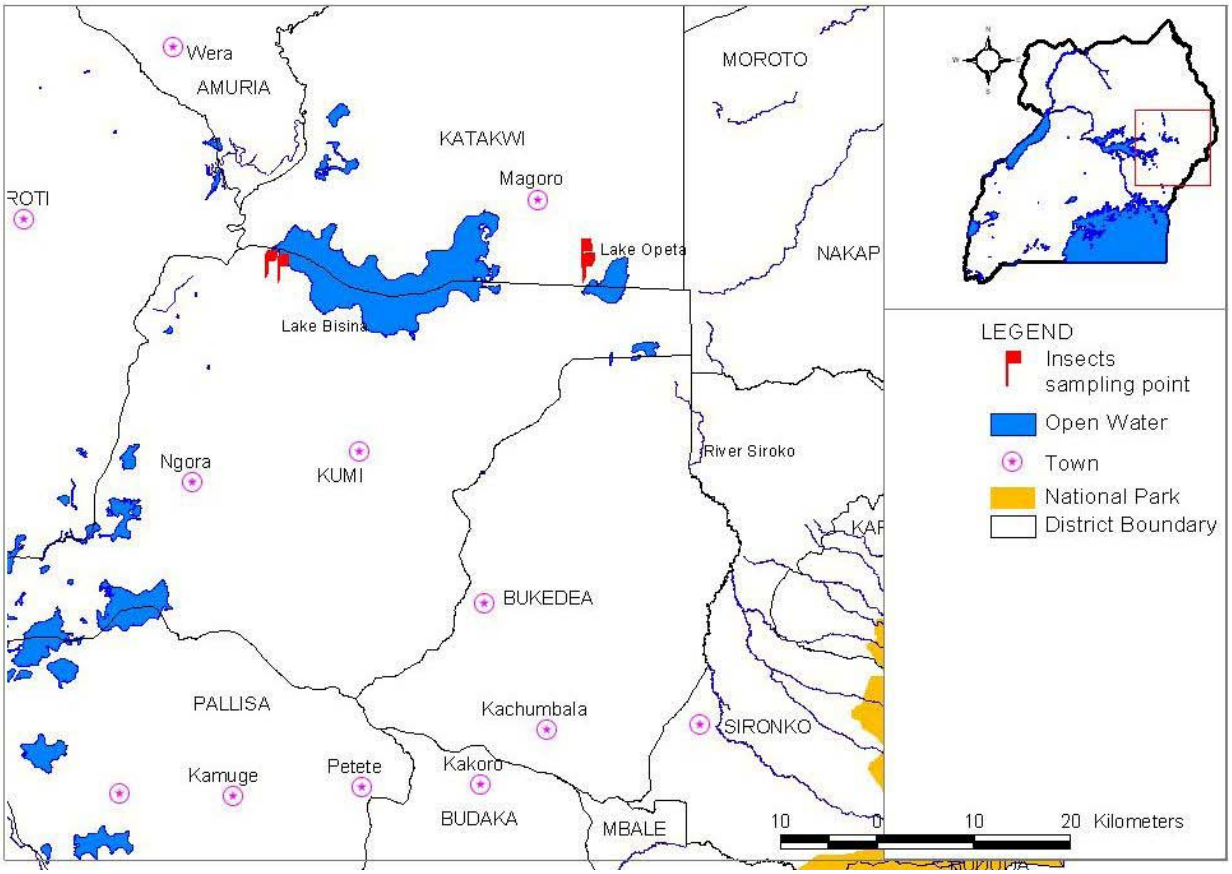

Fig. 3 Insect survey sites in Opeta – Bisina wetland system

3.3.1.3 Lake Mburo-Nakivali

The Lake Mburo - Nakivali Ramsar site occupies some 25,500 hectares in south central Uganda, 60km from the town of Mbarara and some 30km north of the borders with Tanzania and Rwanda. The wetland contains several lakes, of which Lakes Nakivali and Mburo are the largest. The catchment also contains two additional, larger lakes – Kachera and Kijanebalolo – which lie outside the Ramsar site to the east. The system is set in a regional landscape characterized by open savanna and acacia woodland at an altitude of 1,280 – 1,520m a.s.l and in which undulating hills enclose broad flat valleys. These valleys, which are tributaries of the Kagera River, contain seasonal floodplains which drain through papyrus swamps into the various lakes.

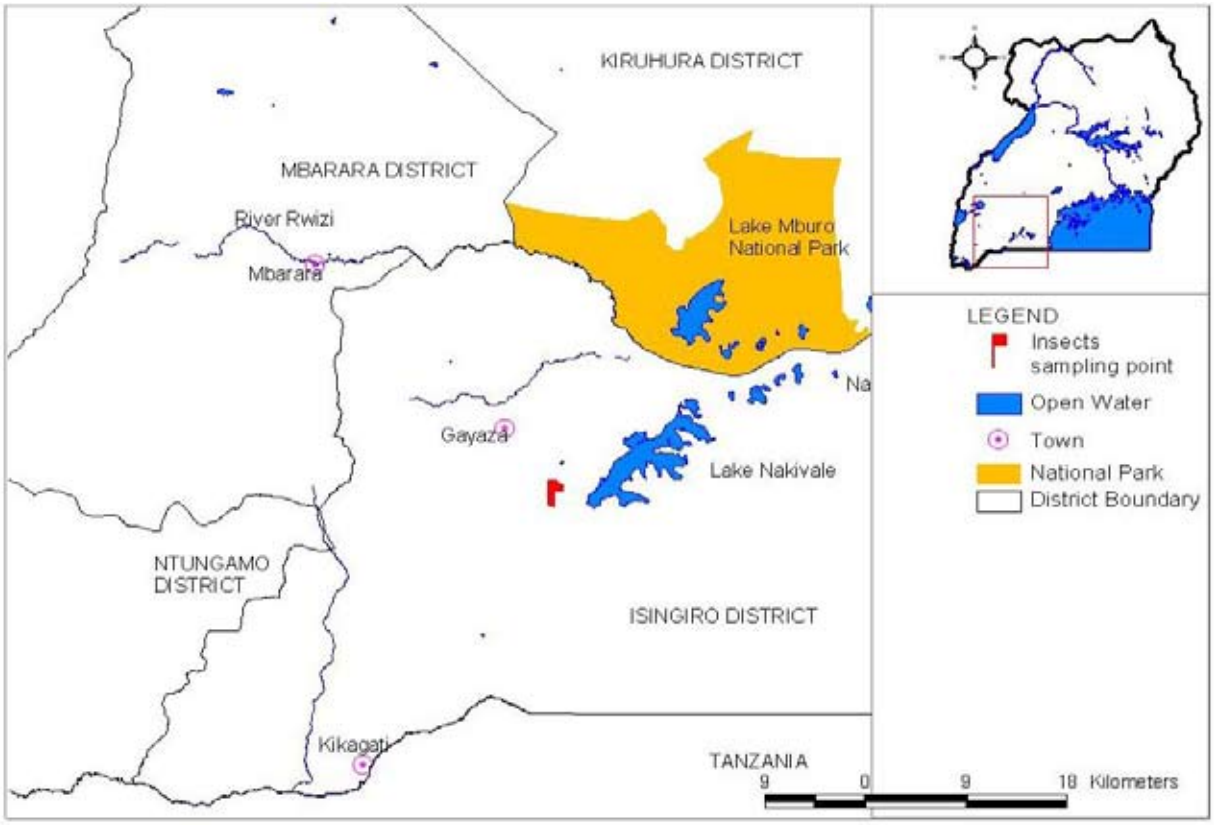

Fig. 4 Insect survey sites in Lake Mburo – Nakivali wetland system

3.3.2 Methods

The butterfly fauna of the survey areas was sampled through the systematic use of sweep nets and baited traps throughout the study period. Sweep netting was done both along an established 0.5km transect line as well as random sweeping within the entire areas (Rapid Biodiversity Assessment) that involves combing through the entire area, and catching every species encountered. Opportunistic observations were included to help build the species list.

Fermenting banana was used as bait for the traps. The baited traps were hanged between 1-10m above the ground within the study sites. Traps were checked twice every day (in the morning and once in the afternoon). The traps were regularly moved to cover most of the study area. Preliminary identifications of common and familiar butterfly species were done in the field. A number of standard field guides, as well as the extensive collections at the Zoology Museum, Makerere University were used for specimen identifications.

Each of the butterfly species was assigned to one of the ecological categories as described by Davenport (1996). The major categories considered in this study are forest dependent species (F), forest edge/woodland species (f), open habitat species (O), widespread species (W), migratory species (M), and wetland species (S).

3.4 Results

A total of 68 species were recorded from the three wetland systems. These included species from all the five super families of butterflies. The list included 34 Nymphalids, 14 Pierids, 13 Lycaenids, 6 Hesperiids and only one Papilionidae.

3.4.1 Species Richness

There were at least four forest edge/woodland species recorded from the two Nakivale sites and Bisina 2 transects. These were *Bicyclus jefferyi*, *Precis pelarga, Ypthima albida* and *Ypthimomorpha itonia*. There was one FL species recorded from Nakivale 2 (*B. smithi*). There were four swamp/ wetland species recorded during this study. These included *Acraea rahira* (Opeta 1), *Mylothris rubricosta* (Nakivale 2), *Borbo micans* (Bisina 3) and *Metisella midas* (Nakivale 2).

Table 1. Summary of Ecotypes for the three Ramsar sites

Ecotype	Lake Nakivale	Lake Bisina	Lake Opeta
FL	1	0	0
f.	2	1	0
S	2	1	1
O	3	11	5
W	11	16	9
O/m	2	8	4
W/m	2	5	4
U	0	1	0
Total	**23**	**43**	**23**

From table 1, it can be noted that the majority of the species recorded at all the three sites fall in the widespread and open habitat categories. Lake Bisina registered the highest number of species with Lake Nakivale and Lake Opeta with 23 species of butterflies respectively.

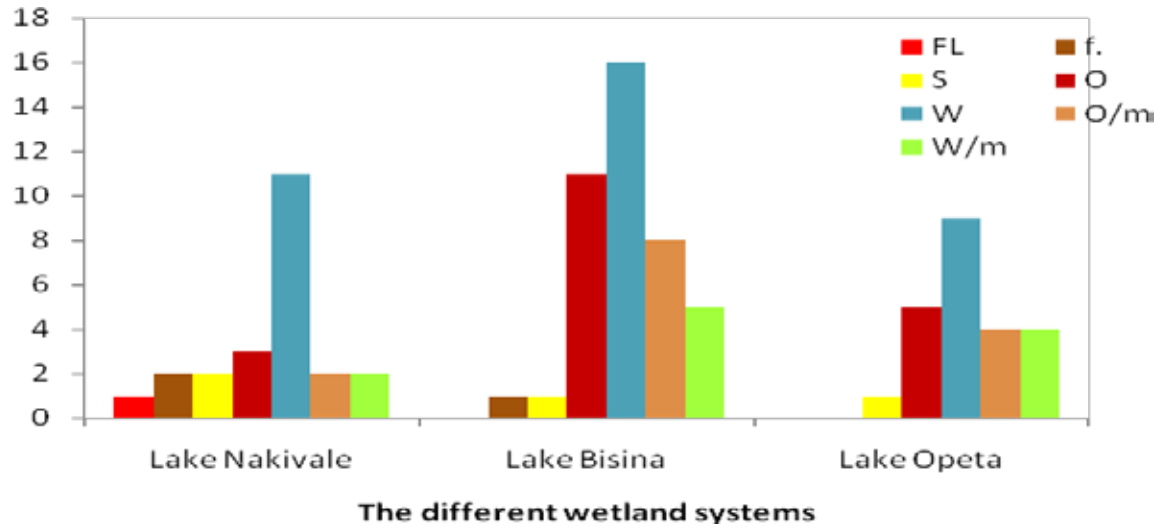

Figure 1. Distribution of butterfly species in the three study sites

Different butterfly species have varied ecological preferences within the habitats. For the wetland systems, the swamp/wetland species (S) is an indicator of the quality of the habitat. From figure 1, the majority of species recorded were open habitat species and the widespread species. The Nakivale area surveyed was dominated by the Acacia woodland and reason enough to justify the presence of a forest species.

In comparison with previous studies (Asasira, 2003), a number of species which were recorded then were visibly absent from current study. For Lake Bisina; Asasira (2003) recorded a total of 61 species compared with 43 species from this study. Like for Lake Opeta, there was a reduction in species numbers from 73 species to only 23 species.

3.4.2 Wetland restricted species

In total four swamp/wetland species were recorded by this study. These included *Acraea rahira*, *Mylothris rubricosta*, *Borbo micans* and *Metisella midas*. According the Davenport, these species have restricted range and therefore very susceptible to habitat loss and degradation.

Some observations:

- From this study, there are no species of conservation concern recorded by this study. Most of the species are common open country or widespread species.
- Because of the mixed nature of the habitats along the wetland areas, variable effects may be experienced in the different parts. Vegetation cutting/ trampling especially through the thicketed areas that are preferred feeding and breeding areas for the butterflies.
- The thicketed areas are some of the preferred foraging areas for adult nectar feeders and food sources for larval stages. Poor quality vegetation supports a lower density of species. Loss of vegetation cover reduces the suitability of any habitat to support species peculiar to them.

3.5 Discussions

3.5.1 Link to ecosystems and Future monitoring

Studying butterflies tells us about the habitats on which we all depend. Long term studies on temperate-zone butterflies that focused on species' population dynamics and responses to habitat fragmentation have successfully contributed to conservation efforts (Sparrow *et al.,* 1994).

Declining butterfly numbers or distributions reflect overall loss of biological diversity and strongly indicate unsustainable practices (Lewinsohn *et al.*, 2005). All butterfly species are valuable in their own right and act as powerful symbols of the state of our environment. Loss or deterioration of habitats, like forests, wetlands and savannas has a negative effect on butterflies, biodiversity and people. Some human practices (for example agriculture, forestry, fisheries, grazing) change habitats and action to conserve butterflies at the habitat level is therefore most effective.

3.5.2 Future monitoring

Regular monitoring of species' occurrences in a given habitat/site is a necessary component of biodiversity monitoring. The database increases in value with each subsequent monitoring event, and repeated censusing will ensure that any change in biodiversity can be detected.

Seasonal factors, such as species turnover and changing weather patterns render once weekly sampling unrepresentative and susceptible to increased sampling error. This preliminary study provided results that can be used as a technical baseline for establishing a butterfly-monitoring programme in the wetland systems.

Sampling frequency should be determined by monitoring needs, logistic constraints and seasonal changes in the butterfly fauna. The detection of differences in the abundance of common species may be accomplished with a moderate field effort, even when an inventory of all the species is far from complete. Concentration of monitoring effort during the season of peak abundance of adult butterflies will maximize efficiency in the field and thus permit standardized comparisons of first monthly and then yearly shifts in the abundance of butterfly fauna. This is because wetter months are known to have highest species turnover.

As per the sampling methods to be used for future butterfly monitoring, results from this study revealed that netting yielded more species than trapping but its success depended heavily on good

weather conditions. On the other hand, trapping, although yielding fewer species of butterflies consistently caught species that were rarely observed in flight, and also trapping was productive even under weather conditions that rendered netting ineffective. For the more open sites, trapping data was negligible compared to the species turnover from the netting efforts. Therefore for such areas, only netting would be productive provided the weather conditions are good. This will also help maximize sampling effort.

In summary, a butterfly-monitoring programme for the wetland areas should constitute

- Regularly revisiting these sites;
- Other similar sites including protected areas should be included to enhance comparisons on rates of land-use change and how this may be affecting butterfly and other fauna;
- Sites should be surveyed at least every 3-5 years depending on logistics;
- Sampling should use a combination of netting and trapping (with at least 20 hours of netting at each site.

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Appendices

Appendix 1. Species lists of butterfly fauna recorded from the three wetland systems and their respective ecological preferences.

	Sites							
Species	**Nakivali 1**	**Nakivali 2**	**Bisina 1**	**Bisina 2**	**Bisina 3**	**Opeta 1**	**Opeta 2**	**Ecological type**
Nymphalidae								
Acraea acerata					>20		1	W
Acraea encedon						1		W
Acraea eponina					3		>10	W
Acraea neobule						2	2	W
Acraea rahira						2		S
Bicyclus jefferyi								f
Bicyclus safitza		1						W
Bicyclus smithi		1						FL
Bicyclus vulgaris			1					W
Byblia ilithyia						1	3	O
Catacroptera cloanthe			1				1	O
Charaxes jasius			1		1			O
Charaxes sp			1					*
Charaxes varanes			1		1			W
Danaus chrysippus	1		4	>50	3	>20	7	O/m
Hypolimnas misippus			3		2			W/m
Junonia chorimene					1			O
Junonia hierta			1					O/m
Junonia oenone	1							W
Junonia orithya			3	2	2	1	2	O/m
Junonia sophia		2						W
Junonia terea		1						W
Mallika jacksoni			1		2			O
Melanitis leda		1						W
Neocoenyra gregorii		2						O
Neptis saclava		3						W
Neptis serena	2	2						W
Pardopsis punctatissima			2	2		3	2	W
Phalanta phalanta					2			O/m
Precis octavia			1					W
Precis pelarga	1							f
Ypthima albida		2						f
Ypthima asterope		1						O
Ypthimomorpha itonia				1				f

Lycaenidae								
Anthene amarah	3	1						O
Azanus natalensis		2	2	2	3			W
Cupidopsis jobates							1	W
Euchrysops malathana					1		1	O
Freyeria trochylus			1		1	1	1	W
Lepidochrysops elgonae			2					O
Leptotes pirithous		1					4	W/m
Tarucus theophrastus			1					O
Tarucus ungemachi						1		O
Tuxentius cretosus			1					O
Zizeeria knysna		2	2	2				W
Zizina antanossa	1		2	4	3	3	3	W
Zizula hylax				1	1			W
Pieridae								
Belenois aurota		3		1	3	1	1	O/m
Belenois creona			1		1			O/m
Belenois gidica							1	W/m
Catopsilia florella			2	2	2			O/m
Colotis antivippe				1		1		O
Colotis auxo					3			W
Colotis eucharis			2		1	1	1	W
Colotis evagore			1	1	1		1	O/m
Dixeia orbona			1		1			W
Eronia leda					2			W
Eurema brigitta			7	4	3	3	3	W/m
Eurema hecabe		2	2	2	2			W/m
Eurema regularis			1					W
Mylothris rubricosta	2							S
Papilionidae								
Papilio demodocus			1		1			W/m
Hesperiidae								
Borbo borbonica						1		W/m
Borbo micans					1			S
Eretis lugens		3						W
Gegenes hottentota				2				O
Metisella midas		2						S
Spialia spio					1			O

Appendix 2. Comparison of butterfly fauna of Lake Bisina and Lake Opeta with Asasira (2003)

(+) = Present and (-) = Absent

Species	Bisina 2003	Opeta 2003	Bisina 2009	Opeta 2009
Hesperiidae				
Borbo borbonica	-	-	-	+
Borbo micans	+	+	+	-
Borbo perobscura	+	-	-	-
Gegenes hottentota	+	+	+	-
Gegenes niso	-	+	-	-
Gomelia elma	-	+	-	-
Kedestes wallengreni	+	-	-	-
Parnara naso	+	-	-	-
Pelopidas mathias	-	+	-	-
Spialia diomus	+	+	-	-
Spialia dromus	+	+	-	-
Spialia spio	-	-	+	-
Lycaenidae				
Actizera lucida	+	-	-	-
Anthene amarah	+	+	-	-
Anthene kersteni	-	+	-	-
Anthene principes	+	-	-	-
Azanus mirza	-	+	-	-
Azanus natalensis	+	+	+	-
Azanus ubaldus	+	-	-	-
Cacyreus lingeus	-	+	-	-
Cupidopsis jobates	+	-	-	+
Eicochrysops hippocrates	+	+	-	-
Euchrysops malathana	+	-	+	+
Euchrysops osiris	+	+	-	-
Freyeria trochylus	+	+	+	+
Lachnonema brimo	+	-	-	-
Lampides boeticus	+	+	-	-
Lepidochrysops elgonae	-	-	+	-
Lepidochrysops neonegus	+	-	-	-
Leptotes pirithous	-	-	-	+
Leptotes sp	-	+	-	-
Pentila pauli	-	+	-	-
Tarucus theophrastus	+	+	+	-
Tarucus ungemachi	+	-	-	+
Tuxentius cretosus	+	+	+	-
Zizeeria knysna	+	+	+	+
Zizina antanossa	+	+	+	+
Zizula hylax	+	+	+	+
Nymphalidae				
Acraea acerata	-	-	+	+
Acraea encedon	-	-	-	+
Acraea eponina	+	+	+	+
Acraea neobule	-	-	-	+
Acraea rahira	+	-	-	+
Bicyclus angulosus	+	-	-	-
Bicyclus jefferyi	-	+	-	-
Bicyclus safitza	-	+	-	-
Bicyclus sp	-	+	-	-

Bicyclus vulgaris	-	-	+	-
Byblia anvatara	+	-	-	-
Byblia ilithya	+	+	-	+
Catacroptera cloanthe	+	+	+	+
Charaxes jahlusa	-	+	-	-
Charaxes jasius	-	+	+	-
Charaxes numenes	-	+	-	-
Charaxes sp	-	+	+	-
Charaxes tiridates	-	+	-	-
Charaxes varanes	-	+	+	-
Charaxes viola	-	+	-	-
Charaxes zoolina	+	+	-	-
Danaus chrysippus	+	+	+	+
Hamanumida daedalus	+	+	-	-
Henotesia phaea	-	+	-	-
Hypolimnas misippus	+	-	+	-
Junonia chorimene	-	+	+	-
Junonia hierta	-	-	+	-
Junonia orithya	+	+	-	-
Mallika jacksoni	+	+	+	-
Melanitis leda	-	+	-	-
Neptis kiriakoffi	+	-	-	-
Neptis morosa	+	-	-	-
Neptis serena	+	+	-	-
Pardopsis punctatissima	+	+	+	+
Phalanta phalanta	-	-	+	-
Precis ceryne	+	+	+	-
Precis pelarga	-	+	-	-
Ypthima sp	+	-	-	-
Ypthimomorpha itonia	+	+	+	-
Papilionidae				
Papilio demodocus	+	+	+	-
Pieridae				
Appias epaphia	+	+	-	-
Belenois aurota	+	+	+	+
Belenois creona	+	+	+	-
Belenois gidica	+	+	-	+
Belenois subeida	+	+	-	-
Catopsilia florella	+	+	+	-
Colotis antevippe	+	+	+	+
Colotis aurigeneus	-	+	-	-
Colotis auxo	-	+	+	-
Colotis danae	-	+	-	-
Colotis eucharis	-	+	+	+
Colotis euippe	+	+	-	-
Colotis evagore	+	+	+	+
Colotis hetaera	-	+	-	-
Colotis vesta	+	+	-	-
Dixeia orbona	-	-	+	-
Dixeia pigea	-	+	-	-
Eronia cleodora	-	+	-	-
Eronia leda	-	-	+	-
Eurema brigitta	+	+	+	+
Eurema hapale	-	+	-	-
Eurema hecabe	+	+	+	-
Eurema regularis	+	+	+	-
Mylothris rubricosta	+	+	-	-

CHAPTER 4: Plants

RAPID ASSESSMENT OF LAKE MBURO - NAKIVALI AND LAKE BISINA - OPETA WETLAND SYSTEMS VEGETATION

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4.1 Introduction

4.1.1 Location of Lake Mburo-Nakivali wetland system

The Lake Mburo-Nakivali wetland system lies between 30º 55'E and 00º 40'S at an altitude of 1280-1520 m.a.s.l. It is surrounded by seasonal and permanent swamps. Much of this system lies within the 260 km^2 of L. Mburo National Park at the convergence of two biological zones, which provides it with a wide range of habitats and a high diversity than might be expected given its relatively small size. The Mburo-Nakivali wetland system contains several lakes, of which Lakes Nakivali and Mburo are the largest. The study was carried out at Lake Nakivali in Isingiro district.

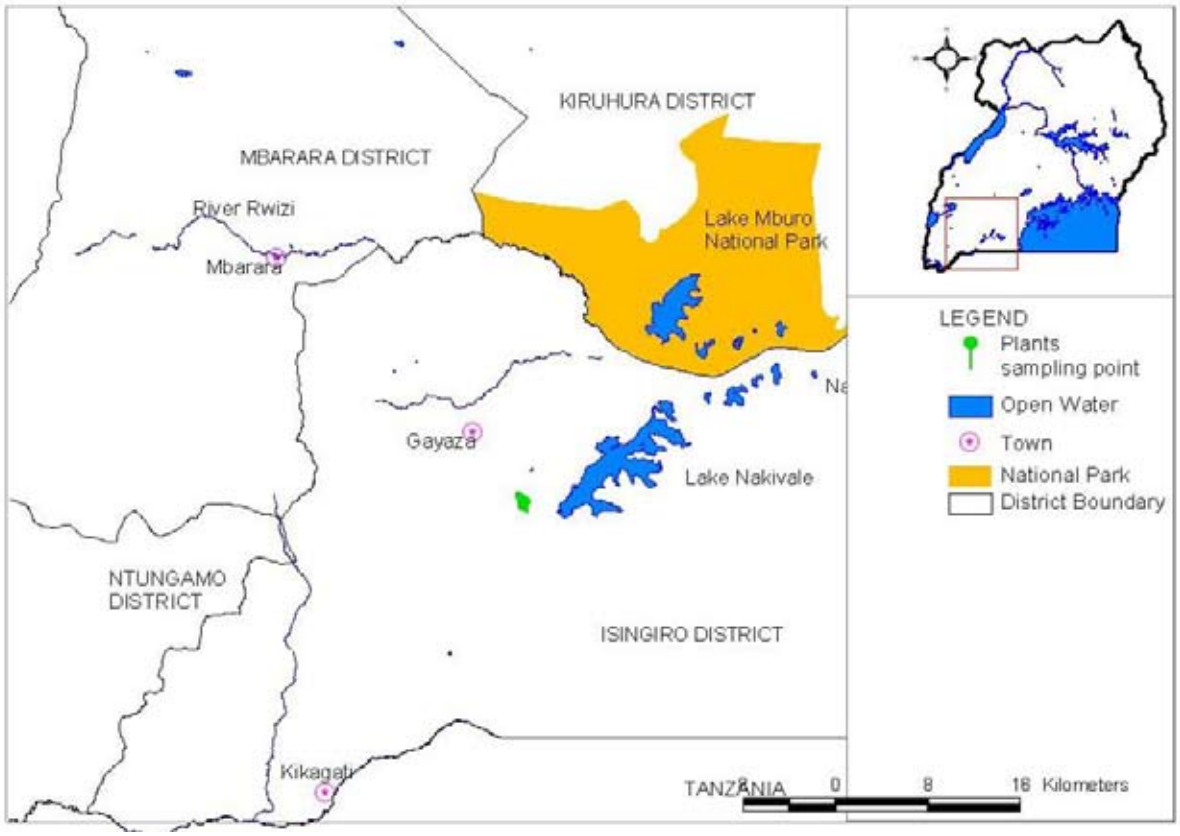

Fig. 5 Plants survey Lake Mburo-Nakivali wetland system

4.1.2 Vegetation

The system is set in a regional landscape characterised by *Acacia* woodland and with undulating hills covered with grasses which enclose the broad flat valleys. These valleys are tributaries of the Kagera River and contain seasonal flood plains which drain through papyrus swamps into the various lakes. This wetland system was described by Langdale-Brown (1964) as *Echinochloa* grassland and permanent swamp (*Cyperus papyrus* swamp). On the ground we found four outstanding vegetation types namely; *Echinochloa* grassland, Cyperus *papyrus* swamp, Seasonal swamp forest and bushes.

***Echinochloa* grassland**: The Echinochloa grassland is dominated by *Echinochloa pyramidalis* with *Cyperus dives*, *C. latifolius* and *Leersia hexandra* as sub dominant.

Permanent swamp *(Cyperus papyrus* swamp): The permanent wetland is dominated by *Cyperus papyrus* and the common associates include *Cissampelos mucronata*, *Dissotis rotundifolia*, *Dryopteris* sp., *Leersia hexandra* and *Polygonum salicifolium*. The tree layer is dominated by *Acacia polyacantha*.

Seasonal wetlands: Characterised by Seasonal swamp forest which was found to be colonised with some species known to be montane like *Podocarpus milanjianus*, lowland species include *Baikiaea insignis* and *Spondianthus preusii*. Also found were bushes of natural thickets on free draining sandy loam or sandy clay loams. In Nakivali, *Allophylus africana*, *Pluchea ovalifolia*, *Croton* sp., *Euphorbia candelabrum*, *Grewia mollis* are the most common.

4.1.3 Plant diversity
Plants offer potential advantages over other taxa as biodiversity indicators because they are the primary producers. Their abundance and diversity is likely to influence the species richness belonging to higher trophic levels (Kent *et al*. 1996). An inventory of all plant species was carried out in the study site.

4.1.4 Physical and ecological features
This wetland system is an *Acacia-Echinochloa-Cyperus* wetland associated with grasses and scattered thickets of *Allophylus abyssinica* and other forest colonisers. It has been highly modified by human activities through farming and cutting of the natural vegetation.

4.1.5 Land tenure and status
The site lies partly within a gazetted National Park and communal land. The main activities are subsistance farming and fishing.

4.1.6 Study objectives and methods.

4.1.6.1 The specific objectives of this vegetation survey were to:
i. Produce guiding methods of wetland vegetation assessment for the two systems.
ii. Establish baseline information on wetland vegetation richness or diversity.
iii. Identify indicator species that may be used as eco-system vegetation monitoring.
iv. Take appropriate GPS coordinates of surveyed areas (including for secondary data)
v. Make field observations and descriptions as supportive information to the report.
vi. Explore existing surveys report and use as supporting data where appropriate.
vii. Produce a comprehensive report on the wetland vegetation diversity (Checklist).

4.1.6.2 Methods
The following general approaches were adopted as a basis for assessing the flora.

Sampling: Sampling points were selected in such a way that a maximum number of strata were represented at a given site as a way of minimising time spent on movement to sample different strata. Vegetation strata (layers) were identified and for each layer the percentage cover for the species was estimated visually and recorded. Opportunistic sampling was also applied especially for the micro habitats registered in the study area.

Layer code: The layer codes were by height not habitat. Tree layers were ranging between 3 - >5 m high. In this class for example, papyrus which is a sedge, if it was >3m, was recorded here and likewise, a tree seedling that was <1m high was recorded in the herb layer. The Shrub layers ranged from 1 - 3 m, whereas the herb layer was from 0-1m.

Field data collection: A pre-designed field data sheet was used to standardize data collection. A GPS was used to mark sampled quadrat points.

Transects: Two transects each 500 m long were laid along the study area running parallel at a distance of 20 m apart, in order to establish baseline information on wetland vegetation richness and identify indicator species for vegetation monitoring. The sample area was small due to limited time allocated for the study. These two transects were placed in different vegetation types to capture the various habitats.

Quadrats: Nested quadrats of standard sizes (trees 30 x 30 m, shrubs 15 x 15 m and herbs 2 x 2 m) were laid along these transects at an interval of 20m. Opportunistic sampling (visual estimates with out plotting) was applied on micro habitats that lay outside the quadrats in order to capture as much data as possible. The checklist generated will be used to set the ecological standards that shall be used as the bench mark for future references.

Percentage cover: Percentage cover estimations were visual characterized under three strata (layers) levels (trees, shrubs and herbs). All species encountered were recorded. The unidentified species in the field were collected, given a unique reference number and taken to Makerere University Herbarium (MHU) for identification.

4.1.7 Results

A total of 123 species from 94 genera and 43 families were recorded. Of these, 16 were trees, 21 shrubs and 86 herbaceous species. Poaceae was the most represented family with 16 species, followed by Asteraceae with 14 (Appendix 1).

4.1.7.1 Species abundance

Species abundances were visually estimated as percentage cover values per quadrat following the scale of 80-100 =5, 60- 79 =4, 40- 59 =3, 20- 39 =2, 1- 19 = 1 and below 1 =+.

The herbal layer consists mainly of tall *Cyperus papyrus*, *Echinochloa pyramidalis*, and several woody seedlings constituting to about 80 % of the plant cover while the shrub and tree layers both constitute about 10 % and bare ground about 10 %. For all sampled quadrats, species' average cover values were calculated and are presented in Table 1 (Please note that a species may occur in more than one stratum or layer).

Table 1: Species abundance

Layer	Family	*Species*	% cover	Life form
Tree				
	Anacardiaceae	*Rhus natalensis*	1	P
	Asteraceae	*Pluchea ovalifolia*	5	P
	Asteraceae	*Vernonia amygdalina*	1	P
	Caesalpiniaceae	*Sesbania sesban*	1	P
	Capparaceae	*Capparis tomentosa*	2	P
	Convolvulaceae	*Ipomoea wightii*	1	P
	Cyperaceae	*Cyperus dives*	1	P
	Cyperaceae	*Cyperus papyrus*	5	P
	Ebenaceae	*Euclea tridens*	1	P
	Euphorbiaceae	*Flueggea virosa*	1	P
	Euphorbiaceae	*Spondianthus preusii*	2	P
	Lauraceae	*Beilschmiedia ugandensis*	1	P
	Menispermaceae	*Cissampelos mucronata*	1	P
	Mimosaceae	*Acacia kirkii*	1	P
	Mimosaceae	*Acacia polyacantha*	4	P
	Mimosaceae	*Acacia sieberiana*	2	P

Layer	Family	*Species*	% cover	Life form
	Myrtaceae	*Grevelea robusta*	2	P
	Palmae	*Phoenix reclinata*	1	P
	Phytolaccaceae	*Phytolacca dodecandra*	1	P
	Poaceae	*Echinochloa pyramidalis*	1	P
	Poaceae	*Typha latifolia*	2	P
	Podocarpaceae	*Podocarpus milanjianus*	1	P
	Rhamnaceae	*Maesopsis eminii*	1	P
	Rutaceae	*Teclea nobilis*	1	P
	Sapindaceae	*Allophylus Africana*	4	P
	Tiliaceae	*Grewia bicolour*	1	P
	Vitaceae	*Cissus rotundifolia*	1	P
Shrub				
	Acanthaceae	*Asystasia gangetica*	+	P
	Amaranthaceae	*Achyranthes aspera*	2	P
	Anacardiaceae	*Rhus natalensis*	3	P
	Apocynaceae	*Carissa edulis*	1	P
	Asteraceae	*Conyza sumatrensis*	1	A
	Asteraceae	*Erlangea cordifolia*	1	P
	Asteraceae	*Gyanura scandens*	1	A
	Asteraceae	*Melanthera scandens*	1	P
	Asteraceae	*Pluchea ovalifolia*	5	P
	Asteraceae	*Vernonia amygdalina*	2	P
	Caesalpinaceae	*Sesbania sesban*	+	P
	Capparaceae	*Capparis tomentosa*	1	P
	Celastraceae	*Maytenus heterophylla*	+	P
	Convolvulaceae	*Hewettia sublobata*	1	P
	Convolvulaceae	*Ipomoea acuminata*	1	A
	Convolvulaceae	*Ipomoea cairica*	2	P
	Convolvulaceae	*Ipomoea sp.*	1	P
	Cyperaceae	*Cyperus articulata*	1	P
	Cyperaceae	*Cyperus denudatus*	1	A
	Cyperaceae	*Cyperus distans*	1	P
	Cyperaceae	*Cyperus dives*	1	P
	Cyperaceae	*Cyperus papyrus*	5	P
	Ebenaceae	*Euclea divinorum*	+	P
	Euphorbiaceae	*Acalypha neptunica*	3	P
	Euphorbiaceae	*Flueggea virosa*	1	P
	Euphorbiaceae	*Ricinus communis*	5	A
	Euphorbiaceae	*Spondianthus preusii*	1	P
	Flacourtiaceae	*Flacourtia indica*	1	P
	Lamiaceae	*Leonotis nepetifolia*	4	A
	Malvaceae	*Abutilon mauritianum*	1	P
	Malvaceae	*Pavonia patens*	1	P
	Malvaceae	*Sida ovata*	1	P
	Menispermaceae	*Cissampelos mucronata*	1	P
	Mimosaceae	*Acacia polyacantha*	1	P
	Mimosaceae	*Acacia sieberiana*	1	P
	Mimosaceae	*Albizia grandibracteata*	1	P
	Palmae	*Phoenix reclinata*	1	P
	Papilionaceae	*Baikiaea insignis*	2	P

Layer	Family	*Species*	% cover	Life form
	Poaceae	*Brachiaria jubata*	+	P
	Poaceae	*Echinochloa pyramidalis*	5	P
	Poaceae	*Pennisetum purpureum*	1	P
	Poaceae	*Typha latifolia*	2	P
	Poaceae	*Zea mays*	4	A
	Polygalaceae	*Polygala sphenoptera*	1	A
	Polygonaceae	*Polygonum pulcherum*	3	P
	Sapindaceae	*Allophylus abyssinica*	1	P
	Sapindaceae	*Allophylus Africana*	2	P
	Sapindaceae	*Blighia unijugata*	1	P
	Sapotaceae	*Manilkara sp.*	1	P
	Solanaceae	*Withania somnifera*	1	A
	Tiliaceae	*Grewia bicolor*	1	P
	Ulmaceae	*Chaetacme aristata*	1	P
	Ulmaceae	*Trema orientalis*	1	P
	Urticaceae	*Urera hypselodendron*	+	P
	Vitaceae	*Cissus rotundifolia*	1	P
	Vitaceae	*Cyphostemma adenocaule*	1	P
Herb				
	Acanthaceae	*Asystasia gangetica*	5	P
	Acanthaceae	*Dicliptera laxata*	2	P
	Acanthaceae	*Dyschoriste radicans*	2	P
	Acanthaceae	*Justicia exigua*	+	A
	Aizoaceae	*Zaleya pentandra*	1	A
	Amaranthaceae	*Achyranthes aspera*	5	P
	Amaranthaceae	*Amaranthus (Mbooge)*	3	A
	Amaranthaceae	*Amaranthus hybridus*	1	A
	Amaranthaceae	*Amaranthus spinosa*	1	A
	Amaranthaceae	*Celosia trigyna*	1	A
	Anacardiaceae	*Rhus natalensis*	+	P
	Apocynaceae	*Carissa edulis*	1	P
	Asclepiadaceae	*Pentarrhinum inspidum*	1	P
	Asteraceae	*Ageratum conyzoides*	1	A
	Asteraceae	*Bidens pilosa*	+	A
	Asteraceae	*Enydra fluctuans*	5	P
	Asteraceae	*Erlangea cordifolia*	5	P
	Asteraceae	*Galinsoga parviflora*	1	A
	Asteraceae	*Melanthera scandens*	1	P
	Asteraceae	*Pluchea ovalifolia*	5	P
	Asteraceae	*Siesbeckia orientalis*	1	A
	Asteraceae	*Sphaeranthus sauveolens*	2	A
	Asteraceae	*Spilanthes mauritiana*	1	A
	Asteraceae	*Tagetes minuta*	2	A
	Asteraceae	*Vernonia amygdalina*	1	P
	Capparaceae	*Capparis tomentosa*	+	P
	Celastraceae	*Maytenus heterophylla*	1	P
	Commellinaceae	*Commelina benghalensis*	5	P
	Commellinaceae	*Commelina latifolia*	2	P
	Commellinaceae	*Cyanotis foecunda*	+	P
	Commellinaceae	*Murdania simplex*	1	P

Layer	Family	*Species*	% cover	Life form
	Convolvulaceae	*Hewettia sublobata*	1	P
	Convolvulaceae	*Ipomoea acuminata*	1	P
	Convolvulaceae	*Ipomoea cairica*	1	P
	Convolvulaceae	*Ipomoea purpurea*	1	P
	Cruciferae	*Erucastrum arabicum*	2	A
	Cucurbitaceae	*Cucumis aculeatus*	1	A
	Cyperaceae	*Cyperus alba*	+	A
	Cyperaceae	*Cyperus denudatus*	1	A
	Cyperaceae	*Cyperus distans*	+	A
	Cyperaceae	*Cyperus dives*	3	P
	Cyperaceae	*Cyperus esculenta*	1	P
	Cyperaceae	*Cyperus papyrus*	2	P
	Cyperaceae	*Pycreus mundtii*	1	P
	Euphorbiaceae	*Acalypha neptunica*	5	P
	Euphorbiaceae	*Flueggea virosa*	1	P
	Euphorbiaceae	*Phyllanthus niruri*	+	A
	Euphorbiaceae	*Phyllanthus ovalifolia*	+	P
	Flacourtiaceae	*Flacourtia indica*	+	P
	Hydrocharitaceae	*(like Lemna)*	4	P
	Lamiaceae	*Leucas martinicensis*	1	A
	Malvaceae	*Abutilon mauritianum*	4	P
	Malvaceae	*Hibiscus diversifolia*	1	P
	Malvaceae	*Sida ovata*	1	P
	Malvaceae	*Urena lobata*	1	P
	Menispermaceae	*Cissampelos mucronata*	1	P
	Mimosaceae	*Acacia polycantha*	4	P
	Onagraceae	*Jussiaea sp.*	1	P
	Oxalidaceae	*Oxalis corniculata*	+	A
	Palmae	*Phoenix reclinata*	1	P
	Papilionaceae	*Desmodium salicifolium*	+	P
	Papilionaceae	*Phaseolus vulgaris*	5	A
	Papilionaceae	*Trifolium usambarense*	+	P
	Phytolaccaceae	*Phytolacca dodecandra*	1	P
	Plumbaginaceae	*Plumbago zeylanica*	2	P
	Poaceae	*Brachiaria decumbens*	1	P
	Poaceae	*Brachiaria jubata*	1	P
	Poaceae	*Cynodon dactylon*	5	P
	Poaceae	*Digitaria abyssinica*	5	P
	Poaceae	*Digitaria diagonalis*	1	P
	Poaceae	*Digitaria longiflora*	1	A
	Poaceae	*Echinochloa pyramidalis*	5	P
	Poaceae	*Eleusine corocana*	2	A
	Poaceae	*Eleusine indica*	1	P
	Poaceae	*Eragrostis tenuifolia*	+	A
	Poaceae	*Leersia hexandra*	+	P
	Poaceae	*Setaria homonyma*	2	A
	Poaceae	*Setaria sphacelata*	+	P
	Poaceae	*Zea mays*	4	A
	Polygalaceae	*Polygala sphenoptera*	2	A
	Polygonaceae	*Polygonum pulchrum*	1	P

Layer	Family	*Species*	% cover	Life form
	Polygonaceae	*Polygonum salicifolium*	5	P
	Polygonaceae	*Polygonum setolosum*	1	P
	Rhamnaceae	*Maesopsis eminii*	1	P
	Sapindaceae	*Allophylus Africana*	+	P
	Solanaceae	*Lycopersicon esculenta*	+	A
	Solanaceae	*Solanum nigrum*	1	A
	Solanaceae	*Solanum sessilistellatum*	1	P
	Solanaceae	*Solanum tuberosum*	2	A
	Solanaceae	*Withania somnifera*	+	A
	Tiliaceae	*Grewia bicolor*	2	P
	Tiliaceae	*Grewia similis*	1	P
	Tiliaceae	*Triumfetta macrophylla*	1	P
	Typhaceae	*Typha latifolia*	1	P
	Ulmaceae	*Chaetacme aristata*	+	P
	Vitaceae	*Cissus rotundifolia*	1	P
	Vitaceae	*Cyphostemma adenocaule*	1	P
		Bare bround	3	

Note: P = Perennial and **A** = Annual

4.1.7.2 Ecosystems challenges

This ecosystem has been highly modified through:-clearing vegetation and reclaiming seasonally flooded valleys for farming leading to biodiversity loss and soil erosion starting at the bare patches slopes after clearing. This is expected to completely change the species dynamics. The anticipated adverse impacts include: Species loss, soil fragility, introduction of invasive species, siltation of the wetland and flash flooding.

4.1.7.3 Environment and vegetation management

Plant cover is effective in preventing erosion to the extent that it absorbs the kinetic energy of raindrops, covers a large proportion of the soil during periods of the year when rainfall is heavy, slows down runoff, and keeps the soil surface porous (Zhang et al., 2005). Whatever the slope, extent of soil fragility or climatic conditions, complete plant cover ensures a high level of soil and water conservation. Plant cover may have a priority in any effort to improve on water management, infiltration, biomass production and soil conservation. Some researchers have used plant cover as an indicator to assess ecosystem functional status in restoration projects (Maestre *et al*., 2006). Plant cover can be used to compare the abundance (dominance) of species of widely different growth forms, because it is not biased by the size and distribution of individuals. Only 3 % of the land was found to be bare, without plant cover. However, this is a high percentage that exposes the ecosystem to the effects of erosion if not monitored and maintained well. This being a fragile ecosystem, much of it should not be exposed. It was observed that diversity of herbs was higher than that of shrubs and trees. Fortunately, most of the dominating herbs are perennial species. For monitoring purposes, if the annual herbs dominate over the perennial ones, chances of getting larger bare patches will increase hence putting the ecosystem at an even greater risk of erosion. Dominance of annual species is expected if more land is cleared for agriculture. This being a wetland, the indicator species include all those recorded for family Cyperaceae as well as the following associated species: *Echinochloa pyramidalis*, *Enydra fluctuans*; families Nymphaceae, Typhaceae and Alismataceae (see Table 1). Significant changes in the estimated cover for the indicator species will directly imply that the negative effects of human disturbance are acting on the ecosystem.

4.1.7.4 Monitoring indicators and regimes

The indicators and regimes will be monitored indirectly through, water quality changes, soil erosion levels and plant species diversity change. Any environmental changes must be observed and reacted upon.

4.1.8 Discussions

Lake Nakivali wetland as a representation of Lake Mburo-Nakivali system is highly degraded due to human activities. Natural vegetation has been cleared for farming. This might be partly due to overpopulation, poverty and lack of enforceable policies and reasonable management measures. According to Sisk *et al.* (1994); McCracken and Abaza (2001); and Reynolds and Smith (2002) ecosystem degradation phenomena are a worldwide environmental problem limiting the ecosystems sustainability. Seriously damaged lands not only lose control over resources, but also lose the capacity for self-repair and are unable to prevent additional degradation. As these degrading processes continue, a threshold can be crossed exceeding the ability for the ecosystem to recover and desertification results, a dynamic and self-perpetuating process. There is need therefore to restore this ecosystem. This restoration will bring back native species and their habitats. Seedlings of many species are expected to emerge, survive and establish reproducing populations, and then populations are expected to assemble into a community similar to the original system. Species composition can reflect the process of vegetation succession and be used as one of the objectives of vegetation restoration and improvement.

4.1.9 Conclusions and recomendations

The different degradation treatments had significant effects on species composition, plant cover and species diversity, and thus affect the ecological function of plant communities. Therefore, decisions and regulations related to strategies, such as re-vegetation planning, species selection, seedling management should be carefully considered. Reforestation with native dominant plant species or natural restoration is a reasonable choice for reforestation. A landscape approach should be condidered for community mobilization, awareness programmes and restoration of various zones.

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Appendix 1; Checklist of plants in Lake Mburo - Nakivali system

Family	*Species*	HABIT
Acanthaceae	*Asystasia gangetica (L.) T.Anders.*	H
Acanthaceae	*Dicliptera laxata C.Blake*	H
Acanthaceae	*Dyschoriste radicans Nees*	H
Acanthaceae	*Justicia exigua*	H
Aizoaceae	*Zaleya pentandra*	H
Amaranthaceae	*Achyranthes aspera L.*	H
Amaranthaceae	*Amaranthus graecizans L.*	H
Amaranthaceae	*Amaranthus hybridus*	H
Amaranthaceae	*Amaranthus spinosus L.*	H
Amaranthaceae	*Celosia trigyna L*	H
Anacardiaceae	*Rhus natalensis Krauss*	S
Apocynaceae	*Carissa edulis (Forssk.) Vahl*	S
Asclepiadaceae	*Pentarrhinum inspidum*	L
Asteraceae	*Ageratum conyzoides L.*	H
Asteraceae	*Bidens pilosa L.*	H
Asteraceae	*Conyza sumatrensis H.B.K.*	H
Asteraceae	*Enydra fluctuans*	H
Asteraceae	*Erlangea cordifolia (Oliv.) S.Moore*	H
Asteraceae	*Galinsoga parviflora Cav*	H
Asteraceae	*Gyanura scandens O.Hoffm.*	H
Asteraceae	*Melanthera scandens (Schum. & Thonn.) Roberty*	H
Asteraceae	*Pluchea ovalifolia*	H
Asteraceae	*Siesbeckia orientalis L.*	H
Asteraceae	*Sphaeranthus sauveolens*	H
Asteraceae	*Spilanthes mauritiana (Pers.)DC*	H
Asteraceae	*Tagetes minuta L.*	H
Asteraceae	*Vernonia amygdalina Del.*	S
Caesalpiniaceae	*Sesbania sesban (L.) Merr.*	S
Capparaceae	*Capparis tomentosa Lam.*	S
Celastraceae	*Maytenus heterophylla*	S
Commellinaceae	*Commelina benghalensis Wall.*	C
Commellinaceae	*Commelina latifolia L.*	H
Commellinaceae	*Cyanotis foecunda*	H
Commellinaceae	*Murdania simplex (Vahl.) Brenan.*	H
Convolvulaceae	*Hewettia sublobata (L.) Kunze*	L
Convolvulaceae	*Ipomoea acuminata (Vahl) Roem. & Schult.*	H
Convolvulaceae	*Ipomoea cairica (L.) Sweet*	C
Convolvulaceae	*Ipomoea purpurea (L.) Roth*	C
Convolvulaceae	*Ipomoea wightii (Wall.) Choisy*	C
Cruciferae	*Erucastrum arabicum Fisch. & May.*	H

Family	*Species*	HABIT
Cucurbitaceae	*Coccinia barteri (Hook.f.)Keay*	C
Cyperaceae	*Cyperus alba Nees*	H
Cyperaceae	*Cyperus articulatus L.*	H
Cyperaceae	*Cyperus denudatus L.f.*	H
Cyperaceae	*Cyperus distans*	
Cyperaceae	*Cyperus dives*	
Cyperaceae	*Cyperus esculentus L.*	H
Cyperaceae	*Cyperus papyrus L.*	H
Cyperaceae	*Pycreus mundtii*	
Ebenaceae	*Euclea latidens Stapf*	T
Ebenaceae	*Euclea divinorum*	T
Euphorbiaceae	*Acalypha neptunica Müll.Arg.*	H
Euphorbiaceae	*Flueggea virosa (Willd.) Voigt*	S
Euphorbiaceae	*Phyllanthus niruri*	H
Euphorbiaceae	*Phyllanthus ovalifolius Forssk.*	H
Euphorbiaceae	*Ricinus communis L.*	H
Euphorbiaceae	*Spondianthus preusii Engl.*	T
Flacourtiaceae	*Flacourtia indica (Burm.f.) Merr.*	S
Hydrocharitaceae	*(like Lemna)*	H
Lamiaceae	*Leonotis nepetifolia (L.) Ait.*	H
Lamiaceae	*Leucas martinicensis (Jacq.) Ait.f.*	H
Lauraceae	*Beilschmiedia ugandensis*	T
Malvaceae	*Abutilon mauritianum (Jacq.) Sweet*	H
Malvaceae	*Hibiscus diversifolia*	H
Malvaceae	*Pavonia patens*	H
Malvaceae	*Sida ovata Forssk.*	H
Malvaceae	*Urena lobata L.*	H
Menispermaceae	*Cissampelos mucronata A.Rich.*	C
Mimosaceae	*Acacia kirkii*	
Mimosaceae	*Acacia polycantha*	
Mimosaceae	*Acacia sieberiana DC*	T
Mimosaceae	*Albizia grandibracteata Taub.*	T
Myrtaceae	*Grevillea robusta Cunn.ex R.Br.*	T
Onagraceae	*Jussiaea sp.*	H
Oxalidaceae	*Oxalis corniculata L.*	H
Palmae	*Phoenix reclinata*	
Papilionaceae	*Baikiaea insignis*	
Papilionaceae	*Desmodium salicifolium*	
Papilionaceae	*Phaseolus vulgaris*	
Papilionaceae	*Trifolium usambarense*	
Phytolaccaceae	*Phytolacca dodecandra L'Herit*	S
Plumbaginaceae	*Plumbago zeylanica L.*	H

Family	*Species*	HABIT
Poaceae	*Brachiaria decumbens*	
Poaceae	*Brachiaria jubata*	
Poaceae	*Cynodon dactylon (L.) Pers.*	H
Poaceae	*Digitaria abyssinica (A.Rich.) Stapf*	H
Poaceae	*Digitaria diagonalis (Nees) Stapf*	H
Poaceae	*Digitaria longiflora (Retz.) Pers.*	H
Poaceae	*Echinochloa pyramidalis*	
Poaceae	*Eleusine corocana*	
Poaceae	*Eleusine indica (L.) Gaertn.*	H
Poaceae	*Eragrostis tenuifolia*	
Poaceae	*Leersia hexandra Sw.*	H
Poaceae	*Pennisetum purpureum*	
Poaceae	*Setaria homonyma (Steud.) Chiov.*	C
Poaceae	*Setaria sphacelata (Schum.)Moss*	C
Poaceae	*Zea mays*	
Podocarpaceae	*Podocarpus milanjianus*	
Polygalaceae	*Polygala sphenoptera Fresen.*	H
Polygonaceae	*Polygonum pulcherum*	
Polygonaceae	*Polygonum salicifolium*	
Polygonaceae	*Polygonum setolosum A.Rich.*	H
Rhamnaceae	*Maesopsis eminii*	
Rutaceae	*Teclea nobilis*	
Sapindaceae	*Allophylus abyssinica*	
Sapindaceae	*Allophylus africana P.Beauv.*	T
Sapindaceae	*Blighia unijugata*	
Sapotaceae	*Manilkara sp.*	
Solanaceae	*Lycopersicon esculentum Miller*	H
Solanaceae	*Solanum nigrum L.*	H
Solanaceae	*Solanum sessilistellatum*	
Solanaceae	*Solanum tuberosum L.*	H
Solanaceae	*Withania somnifera*	
Tiliaceae	*Grewia bicolor Juss.*	S
Tiliaceae	*Grewia similis K.Schum.*	S
Tiliaceae	*Triumfetta macrophylla K.Schum.*	S
Typhaceae	*Typha latifolia L.*	H
Ulmaceae	*Chaetacme aristata Plunch*	T
Ulmaceae	*Trema orientalis (L.) Blume*	T
Urticaceae	*Urera hypselodendron (Hochst.) Wedd.*	L
Vitaceae	*Cissus rotundifolia (Forsk.) Vahl*	L
Vitaceae	*Cyphostemma adenocaule Wild & R.B.Drumm.*	L

4.2 Rapid plant survey of Lake Bisina-Opeta wetland sysyems

4.2.1 Introduction

Lake Bisina-Opeta wetland system is located in North-Eastern Uganda in the Teso and Karamoja regions. The Bisina wetland system lies in the Eastern end of the Lake Kyoga basin and it covers an area of 54,229 ha while the Opeta wetland covers an area of 68,913 ha. Lake Bisina is a shallow freshwater lake, 32 km long and 6 km wide surrounded by a papyrus swamp. Historically, the system has been valuable for flood prevention. However this function is becoming less effective with growing settlement on marginal lands and silting within Bisina and the neighbouring Opeta wetlands caused by degradation of the Mount Elgon water catchment.

The Lake Bisina-Opeta wetland system lies between 33°51'- 34° E and 01°35' - 01°'N, at an elevation of 1,050 m a.s.l. in the Eastern end of the Lake Kyoga basin. The dominant open water species for both lakes are *Nymphea nouchali*, *Najas pectinata* and *Ceratophyllum dumersum*. The marshy margins are fringed by a leafless sedge *Cyperus articulatus* and *Echinochloa pyramidalis,* which dominate parts of the shorelines. In the deeper waters off the shore, the vegetation is dominated by *Vossia cuspidata* and some patches with *Cyperus papyrus*. The main vegetation type of this area is *Acacia - Hyparrhenia - Themeda* grass savannah (Langdale-Brown 1964).Plants offer potential advantages over other taxa as biodiversity indicators because they are the primary producers. Their abundance and diversity is likely to influence the species richness belonging to higher trophic levels (Kent *et al*. 1996). An inventory of all plant species was carried out in the study site.

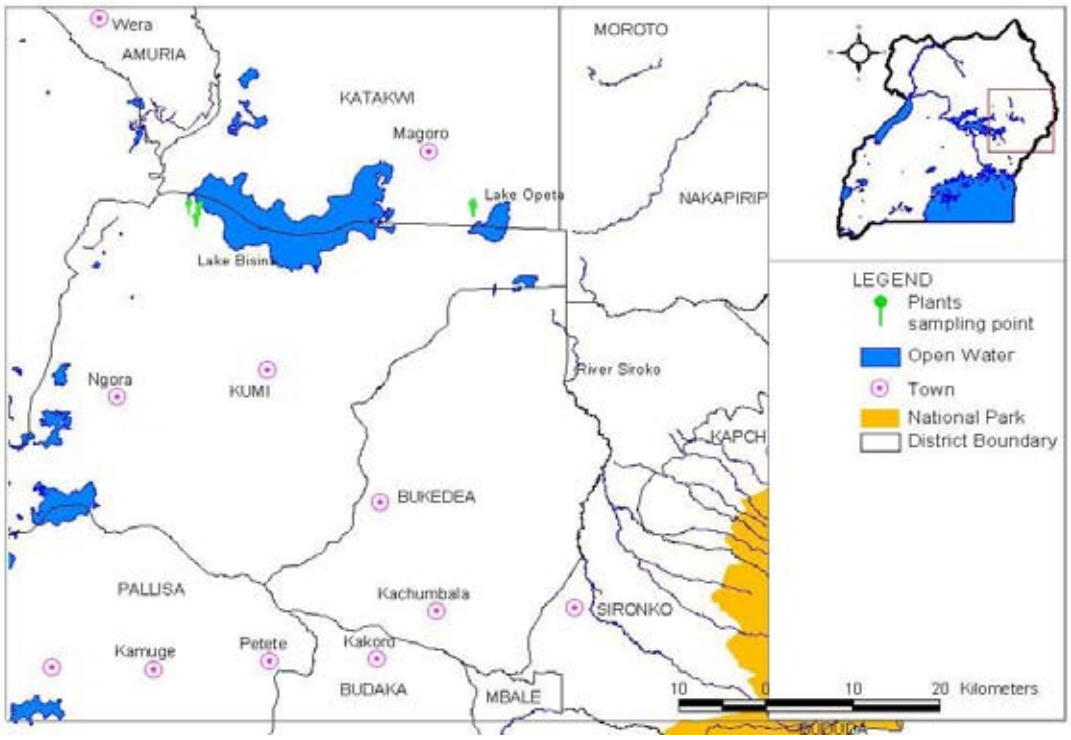

Fig. 6 Plant survey of Lake Bisina - Opeta wetland sysyems

4.2.2 Physical and ecological features

This wetland system consists of perennial grasses, sedges, Acacias, thickets of *Harissonia abyssinica* in the drier areas, and has been modified by human activities like grazing, fishing and farming. In terms of land tenure and status, the sites are designated Ramsar sites and are Important Bird Areas.

4.3.3 Results

4.3.3.1 Lake Bisina

A total of 70 species were recorded around Lake Bisina (Table 1) and among these was the localised rare *Ottelia fischeri*. The dominant species in the herbal layer were *Echinochloa pyramidalis*, *Cyperus articulatus*, *Hyparrhenia filipendula* and *Paspalidium geminatum* while the shrub and tree layers mainly had *Acacia drepanolobium* and *Harissonia abyssinica*. Only five tree species were recorded; 11 shrub species; the majority being herbs with 54 species (Table 1).

4.3.3.2 Lake Opeta

Lake Opeta was richer than L. Bisina with 84 species from 63 genera and 23 families (Table 2). The dominant species in the herbal layer were *Echinochloa pyramidalis*, *Cyperus articulatus*, and *Hyparrhenia filipendula* while the shrub and tree layers mainly had *Acacia* spp*., Crateva adensonii* and *Harissonia abyssinica*. The tree strata had 10 species while the shrub strata had 24 species and the majority were herbs with 60 species (Table 2).

Table 1: Plant species in the different strata recorded at Lake Bisina

Layer	Family	Species	% cover	Life form
Herb				
	Alismataceae	*Caldesia reniformis*	2	P
	Alismataceae	*Wisneria filifolia*	+	P
	Amaranthaceae	*Achyranthes aspera*	+	P
	Asteraceae	*Conyza sumatrensis*	+	A
	Asteraceae	*Crassocephalum picridifolia*	+	A
	Cucurbitaceae	*Coccinea grandis*	+	P
	Cyperaceae	*Abildgaardia ovata*	1	P
	Cyperaceae	*Cyperus articulatus*	3	P
	Cyperaceae	*Cyperus denudatus*	2	A
	Cyperaceae	*Cyperus difformis*	1	P
	Cyperaceae	*Cyperus latifolius*	1	P
	Cyperaceae	*Fimbristylis umbellata*	2	P
	Cyperaceae	*Kyllinga alba*	+	A
	Cyperaceae	*Pycreus mundtii*	+	P
	Cyperaceae	*Scleria hirtella*	2	P
	Hydrocharitaceae	*Ottelia fischeri*	+	P
	Malvaceae	*Abutilon mauritianum*	2	P
	Malvaceae	*Hibiscus cannabinus*	1	P
	Malvaceae	*Pavonia sp.*	+	P
	Malvaceae	*Sida acuta*	2	P
	Menispermaceae	*Cissampelos mucronata*	1	P
	Menispermaceae	*Stephania abyssinica*	2	P
	Najadaceae	*Najas pectinatus*	1	A
	Nymphaeaceae	*Nymphaea nouchali*	3	P
	Onagraceae	*Jassiaea*	+	A
	Papilionaceae	*Alysicarpus glumaceous*	1	P
	Papilionaceae	*Alysicarpus setosa*	1	P
	Papilionaceae	*Colutea*	+	P
	Papilionaceae	*Desmodium salicifolium*	2	P
	Papilionaceae	*Tephrosia pumila*	1	P
	Papilionaceae	*Vigna luteola*	1	P
	Papilionaceae	*Zornia pratensis*	1	P

Layer	Family	Species	% cover	Life form
	Papilionaceae	*Zornia setosa*	1	P
	Plumbaginaceae	*Plumbago zaylenica*	1	A
	Poaceae	*Andropogon canaliculatus*	1	P
	Poaceae	*Bothriochloa insculpta*	2	P
	Poaceae	*Brachiaria jubata*	2	P
	Poaceae	*Cynodon dactylon*	2	P
	Poaceae	*Digitaria abyssinica*	1	P
	Poaceae	*Digitaria diagonalis*	2	A
	Poaceae	*Echinochloa haploclada*	2	P
	Poaceae	*Echinochloa pyramidalis*	4	P
	Poaceae	*Eragrostis tenuifolia*	2	A
	Poaceae	*Hyparrhenia filipendula*	3	P
	Poaceae	*Hyparrhenia rufa*	2	P
	Poaceae	*Microchloa kunthii*	1	P
	Poaceae	*Panicum (small)*	+	P
	Poaceae	*Panicum repens*	1	P
	Poaceae	*Paspalidium geminatum*	3	P
	Poaceae	*Setaria sphacelata*	2	P
	Poaceae	*Sporobolus pyramidalis*	1	P
	Potamogetonaceae	*Potamogeton pectinatus*	1	P
	Rubiaceae	*Oldenlandia corymbosa*	1	A
	Rubiaceae	*Pentas* sp.	+	A
Shrub				
	Anacardiaceae	*Lannea humilis*	1	P
	Caesalpiniaceae	*Cassia bicapsularis*	1	P
	Caesalpiniaceae	*Piliostigma thonningii*	+	P
	Mimosaceae	*Acacia drepanolobium*	3	P
	Mimosaceae	*Acacia hockii*	2	P
	Mimosaceae	*Albizia coriaria*	1	P
	Balanitaceae	*Balanites aegyptica*	1	P
	Rubiaceae	*Pavetta crassipes*	+	P
	Simaroubaceae	*Harrisonia abyssinica*	2	P
	Tiliaceae	*Grewia similis*	1	P
	Verbenaceae	*Vitex doniana*	+	P
Tree				
	Anacardiaceae	*Lannea humilis*	1	P
	Balanitaceae	*Balanites aegyptica*	1	P
	Combretaceae	*Combretum collinum*	1	P
	Mimosaceae	*Acacia seyal*	2	P
	Mimosaceae	*Albizia coriaria*	1	P

Table 2: Plant species in the different strata recorded at Lake Opeta

Layer	Family	Species	% cover	Life form
Herb				
	Alismataceae	*Caldesia reniformis*	2	P
	Alismataceae	*Limnophytum angolense*	1	P
	Alismataceae	*Wisneria filifolia*	1	P
	Amaranthaceae	*Achyranthes aspera*	2	P
	Amaranthaceae	*Celosia trigyna*	+	A
	Commelinaceae	*Commelina africana*	+	A
	Cyperaceae	*Abildgaardia ovata*	+	P

Layer	Family	Species	% cover	Life form
	Cyperaceae	*Cyperus articulatus*	3	P
	Cyperaceae	*Cyperus denudatus*	1	A
	Cyperaceae	*Cyperus difformis*	+	A
	Cyperaceae	*Cyperus latifolius*	+	P
	Cyperaceae	*Cyperus like articulata*	+	P
	Cyperaceae	*Fimbristylis umbellata*	1	P
	Cyperaceae	*Fuirena umbellata*	1	P
	Cyperaceae	*Kyllinga alba*	1	A
	Cyperaceae	*Pycreus mundtii*	+	P
	Euphorbiaceae	*Phyllanthus niruri*	+	A
	Euphorbiaceae	*Euphorbia hirta*	+	A
	Lamiaceae	*Leucas martinicensis*	+	A
	Malvaceae	*Sida acuta*	+	P
	Nymphaeaceae	*Nymphaea nouchali*	2	P
	Papilionaceae	*Alysicarpus glumaceous*	+	P
	Papilionaceae	*Crotalaria cephalotes*	+	P
	Papilionaceae	*Desmodium salicifolium*	+	P
	Papilionaceae	*Eriosema psoraleoides*	1	A
	Papilionaceae	*Indigofera spicata*	1	P
	Papilionaceae	*Tephrosia pumila*	1	P
	Papilionaceae	*Vigna luteola*	1	P
	Papilionaceae	*Zornia pratensis*	1	P
	Papilionaceae	*Zornia setosa*	1	P
	Plumbaginaceae	*Plumbago zaylenica*	1	A
	Poaceae	*Andropogon canaliculatus*	2	P
	Poaceae	*Bothriochloa insculpta*	2	P
	Poaceae	*Brachiaria jubata*	1	P
	Poaceae	*Chloris gayana*	2	A
	Poaceae	*Chloris pychnothrix*	1	A
	Poaceae	*Ctenium somalense*	1	A
	Poaceae	*Cynodon dactylon*	3	P
	Poaceae	*Digitaria abyssinica*	1	P
	Poaceae	*Digitaria diagonalis*	+	A
	Poaceae	*Echinochloa haploclada*	+	P
	Poaceae	*Echinochloa pyramidalis*	3	P
	Poaceae	*Eragrostis exasperata*	1	A
	Poaceae	*Eragrostis olivacea*	1	A
	Poaceae	*Eragrostis tenuifolia*	+	A
	Poaceae	*Hyparrhenia filipendula*	3	P
	Poaceae	*Hyparrhenia rufa*	1	P
	Poaceae	*Leersia hexandra*	4	P
	Poaceae	*Panicum maximum*	+	P
	Poaceae	*Panicum repens*	1	P
	Poaceae	*Paspalidium geminatum*	2	P
	Poaceae	*Paspalum scrobiculatum*	1	P

Layer	Family	Species	% cover	Life form
	Poaceae	*Setaria sphacelata*	1	P
	Poaceae	*Sporobolus festivus*	+	P
	Poaceae	*Sporobolus pyramidalis*	+	P
	Polygonaceae	*Polygonum pulcherum*	+	A
	Portulacaceae	*Talinum portulacca*	+	P
	Potamogetonaceae	*Potamogeton pectinatus*	+	P
	Proteaceae	*Protea sp.*	+	P
	Rubiaceae	*Oldenlandia corymbosa*	+	A
	Tiliaceae	*Corchoorus tridens*	+	A
Shrub				
	Capparaceae	*Capparis erythrocarpos*	1	P
	Capparaceae	*Capparis tomentosa*	1	P
	Capparaceae	*Crateva adansonii*	2	P
	Cyperaceae	*Cyperus articulatus*	2	P
	Euphorbiaceae	*Flueggea virosa*	1	P
	Euphorbiaceae	*Clutia sp.*	+	P
	Menispermaceae	*Chasmanthera dependens*	+	P
	Mimosaceae	*Acacia drepanolobium*	2	P
	Mimosaceae	*Acacia hockii*	1	P
	Mimosaceae	*Acacia senegalensis*	1	P
	Mimosaceae	*Acacia seyal*	1	P
	Mimosaceae	*Acacia sieberiana*	+	P
	Mimosaceae	*Albizia coriaria*	1	P
	Mimosaceae	*Dicrostachys cinerea*	+	P
	Papilionaceae	*Tamarindus indica*	1	P
	Papilionaceae	*Tephrosia nana*	+	P
	Proteaceae	*Protea sp.*	+	P
	Rhamnaceae	*Scutia myrtina*	2	P
	Rubiaceae	*Pavetta crassipes*	1	P
	Simaroubaceae	*Harrisonia abyssinica*	3	P
	Tiliaceae	*Grewia similis*	2	P
	Tiliaceae	*Triumfetta rhomboidea*	+	P
	Tiliaceae	*Grewia mollis*	+	P
	Vitaceae	*Cissus rotundifolia*	2	P
Tree				
	Capparaceae	*Crateva adansonii*	2	P
	Euphorbiaceae	*Euphorbia candelabrum*	+	P
	Mimosaceae	*Acacia drepanolobium*	3	P
	Mimosaceae	*Acacia seyal*	2	P
	Mimosaceae	*Acacia sieberiana*	+	P
	Mimosaceae	*Albizia coriaria*	1	P
	Papilionaceae	*Tamarindus indica*	1	P
	Proteaceae	*Protea sp.*	+	P
	Rhamnaceae	*Scutia myrtina*	2	P
	Tiliaceae	*Grewia mollis*	+	P

4.3.4 Ecosystems challenges

This ecosystem has been modified through:- Over grazing; siltation and poor farming methods and fishing. This is expected to change the ecosystem and the anticipated adverse impacts include: wetland loss, siltation, floods, species loss, and soil fragility.

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4.3.5 Environmental and vegetation management

The massive collection of silt affect the seed bank in the soil and most annuals will die. To control siltation along the plains, there is need to make contours along the slopes to reduce on the amount of silt from the slopes that drain into the plains. Plant cover may have a priority in any effort to improve on water management, infiltration, biomass production and soil conservation. Many herbs tend to be annuals and this means that during the unfavourable or dry seasons, many species will die leaving a lot of exposed patches which at the beginning of the dry season suffer a lot of erosion. Also due to trampling by animals grazing and access to watering points, too much exposure to the scorching sun of the dry season, the exposed soil may degrade in quality through too much water loss and hardening. This could affect the soil seed bank, leaving these exposed patches permanently bare or with scanty vegetation during the wet season.

4.3.6 Monitoring indicators and regimes

The monitoring indicators and regimes will be indirectly through, water quality changes, soil erosion levels, plant species diversity change and any environmental changes must be observed and reacted upon. The indicator species that should be used include; *Cyperus papyrus, C. articulatus, Leersia hexandra, Limnophytum angolense, Caldesia reniformis, Wisneria filifolia* (these will die with less water and silting). If the water levels increase, marsh or seasonally flooded species like *Echinochloa pyramidalis* will die. The seed bank will be washed away into the lake and these will all die.

4.3.7 Discussion

Lake Bisina and Lake Opeta have rich diversity of species and with some localised rare plant species like *Ottellia fischeri* and *Suddia sagittifolia*. The *Suddia sagitifolia* though not sighted during the study is confirmed to be present at the site based on Herbarium material. The *Suddia sagitifolia* was until recently believed to be limited to southern Sudan but it has now been established that this plant also occurs in Uganda in the Lake Kyoga Basin.

The threats here include: over-fishing, poor farming methods like overgrazing, and low levels of environmental awareness may all be contributing to the deterioration of the ecological system of Lake Bisina-Opeta wetland system. Increased flood risk within the catchment due to erosion from the mountains and siltation within the systems has reduced the ability to absorb flood waters. This might be partly due to overpopulation, weak enforcement of existing regulations and lack of enforceable policies and reasonable management measures.

4.3.8 Conclusions and recommendations

The different degradation treatments had significant effects on species composition, plant cover and species diversity, and thus affect the ecological function of plant communities. Therefore, decisions and strategies such as flood control, re-vegetation planning, species selection and seedling management should be carefully considered. Replanting with native dominant plant species or natural restoration is a reasonable choice for re-vegetation. Other interventions such as boundary marking, wetlands restoration, wise use of resources and promotion of some income generating activies (eco-tourism) should be considered for the whole landscape.

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Appendix 1: Species Checklist

Family	Name	Habit
Alismataceae	*Caldesia reniformis* (D.Don.) Makino	H
Alismataceae	*Wisneria filifolia* Hook.f.	H
Amaranthaceae	*Achyranthes aspera*	H
Anacardiaceae	*Lannea humilis*	T
Asteraceae	*Conyza sumatrensis*	H
Asteraceae	*Crassocephalum picrifolia*	H
Balanitaceae	*Balanites aegyptica*	T
Caesalpiniaceae	*Cassia bicapsularis*	S
Caesalpiniaceae	*Piliostigma thonningii*	S
Combretaceae	*Combretum collinum*	T
Cucurbitaceae	*Coccinea grandis*	H
Cyperaceae	*Abildgaardia ovata*	H
Cyperaceae	*Cyperus articulatus*	H
Cyperaceae	*Cyperus denudatus*	H
Cyperaceae	*Cyperus difformis*	H
Cyperaceae	*Cyperus latifolius*	H
Cyperaceae	*Fimbristylis umbellate*	H
Cyperaceae	*Kyllinga alba*	H
Cyperaceae	*Pycreus mundtii*	H
Cyperaceae	*Scleria hirtella*	H
Hydrocharitaceae	*Ottelia fischeri*	H
Malvaceae	*Abutilon mauritianum*	S
Malvaceae	*Hibiscus cannabinus*	S
Malvaceae	*Pavonia sp.*	S
Malvaceae	*Sida acuta*	H
Menispermaceae	*Cissampelos mucronata*	H
Menispermaceae	*Stephania abyssinica*	H
Mimosaceae	*Acacia (red stout hooked short spine)*	T
Mimosaceae	*Acacia drepanolobium*	S
Mimosaceae	*Acacia hockii*	S
Mimosaceae	*Albizia coriaria*	T
Najadaceae	*Najas pectinatus*	H
Nymphaeaceae	*Nymphaea nouchali*	H
Onagraceae	*Jassiaea*	H
Papilionaceae	*Alysicarpus glumaceous*	H
Papilionaceae	*Alysicarpus setosa*	H
Papilionaceae	*Colutea*	H
Papilionaceae	*Desmodium salicifolium*	H
Papilionaceae	*Tephrosia pumila*	H

Family	Name	Habit
Papilionaceae	*Vigna luteola*	H
Papilionaceae	*Zornia pratensis*	H
Papilionaceae	*Zornia setosa*	H
Papilionaceae	*Zornia setosa*	H
Plumbaginaceae	*Plumbago zaylenica*	H
Poaceae	*Andropogon canaliculatus*	H
Poaceae	*Bothriochloa insculpta*	H
Poaceae	*Brachiaria jubata*	H
Poaceae	*Cynodon dactylon*	H
Poaceae	*Digitaria abyssinica*	H
Poaceae	*Digitaria diagonalis*	H
Poaceae	*Echinochloa haploclada*	H
Poaceae	*Echinochloa pyramidalis*	H
Poaceae	*Eragrostis exasperata*	H
Poaceae	*Hyparrhenia filipendula*	H
Poaceae	*Hyparrhenia rufa*	H
Poaceae	*Microchloa kunthii*	H
Poaceae	*Panicum (small)*	H
Poaceae	*Panicum repens*	H
Poaceae	*Paspalidium geminatum*	H
Poaceae	*Setaria sphacelata*	H
Poaceae	*Sporobolus pyramidalis*	H
Potamogetonaceae	*Potamogeton pectinatus*	H
Rubiaceae	*Oldenlandia corymbosa*	H
Rubiaceae	*Pavetta crassipes*	S
Rubiaceae	*Pentas sp.*	H
Simaroubaceae	*Harrisonia abyssinica*	S
Tiliaceae	*Grewia similis*	S
Verbenaceae	Vitex doniana	S

CHAPTER 5: FISH

RAPID ASSESSMENT OF THE FISH BIODIVERSITY OF THE MBURO-NAKIVALI WETLAND SYSTEMS AND OPETA-BISINA WETLAND SYSTEMS, UGANDA

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5.1 Introduction

Lakes Bisina and Lake Opeta are *"finger lakes"*, extensions of Lake Kyoga, surrounded by swamp land during rainy seasons. These lakes are shallow, usually reaching a depth of a maximum of 6 meters and Lake Opeta usually forms a separate lake during dry seasons.

The lakes have three different environmental zones: the open clear water deeper than 3 m; the water less than 3 m, which is covered completely with water lilies and other submerged water plants like ceratophylum; and the swamps mainly papyrus, which fringe the shoreline. The lakes have a rich biodiversity that include flora and fauna such as *Cyperus Papyrus*, Hippo Grass (*Vossia Cuspidata*), Cattail (*Typha spp*.), Water lily (*Nymphea spp*.), and Water Lettuce (*Pistia stratiodes*). Large crocodile populations and other wild life.

There are 46 different fish species in the Lake Kyoga basin with some of them endemic. The Nile Perch (*Lates niloticus*) was introduced into the main Lake Kyoga, Nakuwa and Bisina in the late 1950s to increase the fish production. The Nile Perch profileration in lakes Kyoga and Nakuwa led to the almost complete elimination of many native fish species such as *Orechromis esculentus* and *variabilis*, *Mormyrus kanumme*, *Schilbe mystus* and several Haplochromines species.

Lakes Mburo, Kachera, Nakivali and Kijjanebalora are part of the complex system of lakes separated from Lake Victoria by extended swamps known as the Koki lakes, some of the satellite lakes in the Lake Victoria basin. The fisheries of these lakes are important as they contribute to government efforts of increasing food security, poverty reduction and conservation of natural resource base.

These lakes are important biodiversity areas because some of these lakes have been found to contain the native tilapiine *Oreochromis esculentus* (Ngege), absent or threatened with extinction in the main Lakes Victoria and Kyoga. It's also important to note that this species is only unique to the Victoria and Kyoga lake basins (Graham, 1929, Worthington, 1929). The values of some of these lake fisheries are however, threatened by human activities such as over exploitation, introduction of exotics especially water hyacinth that is already present in River Rwizi and habitat degradation among others.

The main human activities in the two wetland systems are fishing, cultivation, settlement and livestock keeping. There are no industrial enterprises in the area, due to lack of grid or any other power connectivity.

5.2 Why monitor fish diversity?

Fish diversity, species richness, species pollutant tolerance, disease prevalence and other metrics are used to evaluate the aquatic health of water bodies as with reference to generally agreed conditions. Fish as an indicator is widely regarded as one of the more reliable methods for assessing human-induced ecological impacts. Fish are always captured by a variety of methods but what is important is that collection should be representative of all the possible habitat types available in a water body.

5.3 Why use fish in monitoring?

a) The longer life span (3 to 4 years), exposes fish to years of impacts and provide a good assessment of long-term impacts
b) Fish represent a broad range of trophic levels.They may be strongly influenced by lower trophic levels (i.e. algae, macro-invertebrates etc.). Therefore fish assemblage provides an integrated view of the entire environmental system.
c) Fish are relatively easy to catch and identify; the environmental requirements and life history of fish are also well documented.
d) The general public is familiar with fishing for income, food and sport.
e) Water body aquatic life uses are depicted in terms of fish

5.4 Objectives

The overall objective of this assessment was to make an inventory of the fish status to guide the future biodiversity monitoring efforts aimed at suitable management. This was achieved specifically through:

a) Making an inventory of the fish species present in the two wetland systems and identify those that are endangered
b) Identifying how human activities threaten fish species diversity in the two wetlands systems

5.5 Materials and Methods

5.5.1 Study area

The assessment focused on two satellite lakes in each of the two wetland systems namely lakes Mburo and Kachera in the Mburo-Nakivali system, Lake Victoria basin; Opeta and Bisina in the Opeta-Bisina wetland system Lake Kyoga basin.

The Mburo-Nakivali weland system covers a surface area of about 570 Km^2. Lake Kachera is part of a complex of lakes (Mburo, Nakivali and Kiijanebalora) and extensive papyrus swamp (Burgis *et al.*, 1987) located at 00^0 35'S; 31^0 07' E, with a total surface area of 36.3 km^2, and a maximum depth of 4.1 m (Worthington, 1932). Lake Kachera has a maximum length of 20.0 km and width of 3.5 km (Atlas of Uganda, 1967; Welcomme, 1972;). The lake has one river out flow Kibali discharging through River Kagera into Lake Victoria. The size and shape of the lake varies from time to time due to floating islands. The shoreline vegetation is fringed with papyrus (C*yperus papyrus)*, reeds (*Phragmites mauritianus)*, forest, and scattered banana plantations. Lake Kachera is borderd by Rakai district and Lake Mburo National Park and is exposed to very many anthropogenic factors. The communities around Lake Kachera have for long depended on fishing as a major economic activity. The non fishing communities around the lake are either traditional cattle keepers or cultivators, but most of the communities around the lake now practice mixed farming combining both livestock management and crop cultivation to varying degrees (Marquardt *et al*., 1994; Kamugisha *et al*., 1997; Namara and Infield, 1998; Emerton, 1999).

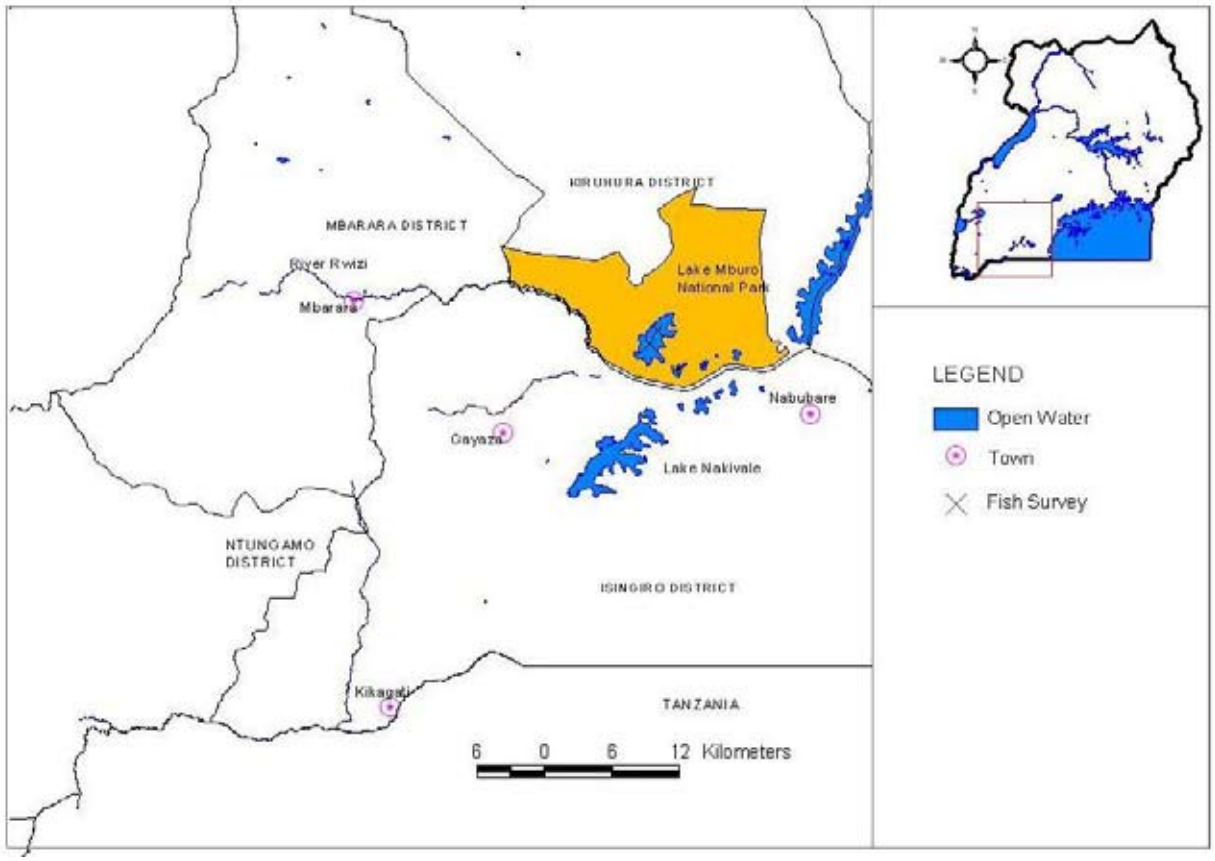

Fig. 7 Fish survey sites in Mburo – Nakivali wetland system

Lake Mburo is part of a complex of lakes (Mburo, Nakivali and Kiijanebalora) and extensive papyrus swamp (Burgis *et al.*, 1987) located at 00 40'S; 30^0 56' E in Kiruhura District in an area owned in precolonial days by the traditional King, the Omugabe of Nkore (Mugisha, 2003), it has a total surface area of 10.4 km^2, a maximum length of 6.0 km and width of 3 km (Atlas of Uganda, 1967). However, the size and shape vary from time to time due to floating islands. The inhabitants (Bahima) around the lake primarily use the riparian land for pastoralism. Until the intervention of colonial government, fishing was not an important economic activity in the lake (Mugisha, 2003). In 1983 Lake Mburo was gazetted as a national park (Burgis *et al*., 1987) and therefore fishing was restricted. Following the eviction of the last residents in 1997 there is no permanent human settlement in the 260 km^2 Lake Mburo National Park, apart from approximately 50 Uganda Wildlife Authority (UWA) staff and 100 or so workers and fisherfolk who temporarily reside at Lubale Landing site (Emerton, 1999). The economic benefits accruing from fisheries activities were valued at Ush 108.1 million in 1997, 7.6 million of which went to the national park as house maintenance fees, boat fees, and fuel wood fees for processors, and the rest to the Department of Fisheries Resources (Emerton, 1997). The National Park is characterised by high densities of animals most of which are native and the lake harbours large populations of hippopotamuses most of the daylight hours, spending the night out of the water.

Lake Bisina, is another large lake, located 272 km north east of the town of Jinja, in the shadow of Mt. Elgon at 01^0 38^1 N 33^0 58^1E it has an elevation of 1048 m and has tiny crater lakes high in the mountains. Lake Bisina has a surface area of 308 km^2 (Atlas of Uganda, 1967) and a maximum depth of 3.5 m. Districts of Kumi (south) and Katakwi (North) border Lake Bisina. Lake Bisina like the main lakes Victoria and Kyoga was stocked with Nile perch and the tilapiines (*O. niloticus, O. leucostictus* and *T. zilli*) in the early 1970's. Lake Bisina is known by local inhabitants to have supported a Nile perch fishery however; this study did not record any Nile perch throughout the survey. Lake Bisina is one of the lakes internationally recognized as a biodiversity cradle, because they still contain remnants of native species flocks of cichlids that occurred in lakes Victoria and Kyoga before the Nile perch boom and demise of cichlid species (Mbabazi *et al.*, 2004; Schwartz *et al*., 2006).The lake is characterized by a variety of habitat types ranging from submerged aquatic macrophytes dominated by *Najas horrida* and *Ceratophyllum spp.* some floating water lilies (*Nymphaea* spp). Most of the lake's shoreline is fringed with hippo grass (*Vossia cuspidata*) and a very small portion of cattail (*Typha domingensis*). The human populations surrounding the lake are mainly pastoralist comunities keeping cattle and goats but they also do some crop cultivation.

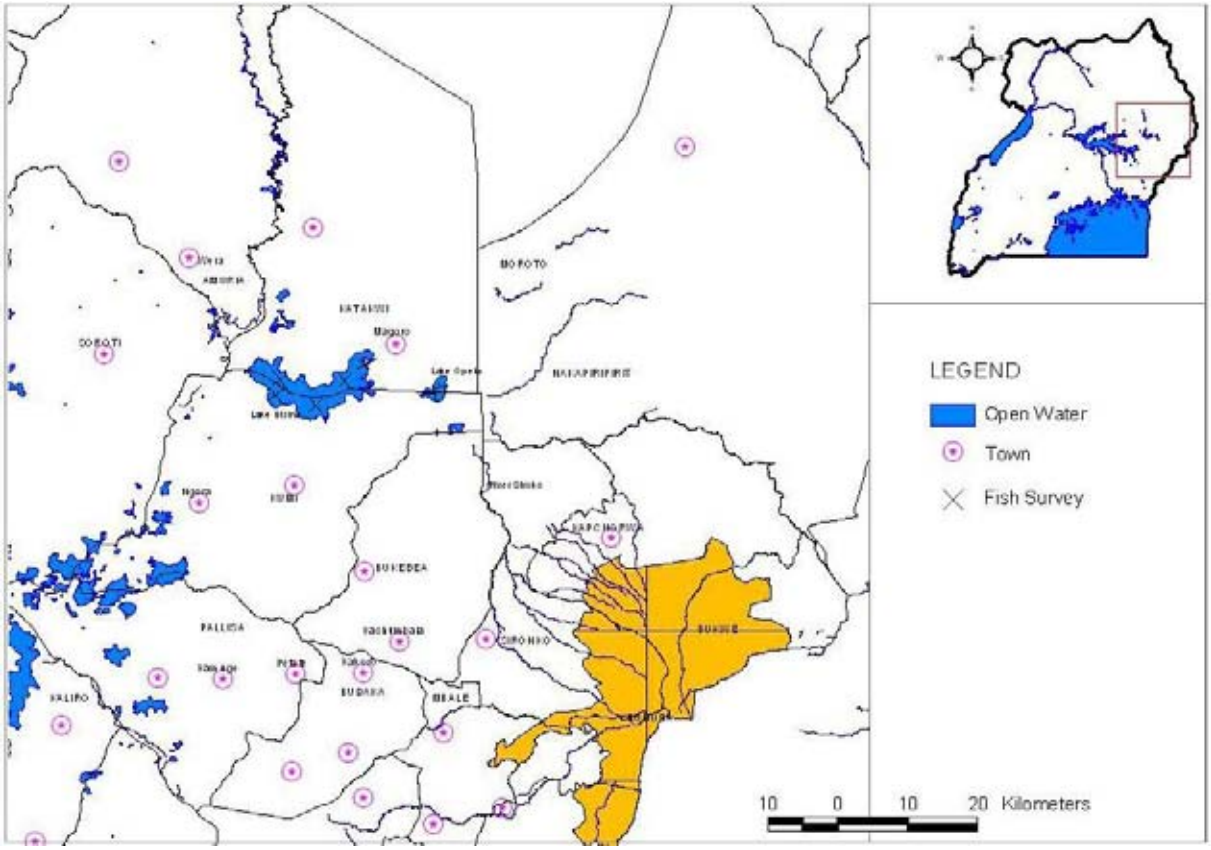

Fig. 8 Mammal survey sites in Opeta – Bisina wetland system

5.5.2 Data Capture and analysis

This assessment was based on data based on a single visit trip to one of the lakes Opeta and at a three months interval through a PhD study by Mbabazi between 2001 and 2003.

In all the above situations fish samples were obtained using multifilament experimental gill nets with stretch mesh sizes (25.4 to 203.2 mm) in increments of 12.7 mm intervals from 25.4 to 139.7 mm, and 25.4 mm intervals for nets ranging in mesh size 52.4 to 203.2 mm in a fleet of 90m long. The nets were set at dusk and retrieved the following morning. The fishes were sorted and identified to the lowest taxonomic level possible, number and weight of each taxon were recorded. The fishes that could not be identified especially haplochromine cichlids were preserved in 10% formaldehyde solution.

In the laboratory, the fishes were sorted into taxonomic groups (genera or species) based on morphometric and meritic procedures described by Greenwood (1981). Where a fish specimen was not exactly defined, it was assigned a “chieronym” (working name). (e.g. *Prognathochromis “shovel mouth”).*

Species composition and relative abundance of haplochromines were estimated from percentage contribution by number of each species.

5.5.3 Results

A total of 36 fish species belonging to 22 genera and 7 families. Of the fish species, 36 were from the Opeta-Bisina and 10 Mburo Nakivali wetland systems respectively (Table 1).

Table 1. The fish fauna of the Mburo-Nakivali and Opeta-Bisina wetland systems in Uganda

		Wetland System			
		Mburo-Nakivali		Opeta-Bisina	
Family	**Fish species**	**Kachera**	**Mburo**	**Opeta**	**Bisina**
Cichlidae	*Astatoreochromis sp.*	1	1	1	1
	Astatotilapia sp	1	1	4	3
	Haplochromis lividus			1	1
	Haragachromis spp.	1	1	1	3
	Lipochromis spp.			1	4
	Marcusenius spp.			2	
	Oreochromis spp.	3	3	3	3
	Pedicel				1
	Prognathochromis spp.			2	3
	Psammochromis spp.			1	1
	Pyxichromis spp.				1
	Tilapia sp.	1		1	1
	Xystichromis sp.			1	1
Mormyridae	*Gnathonemus spp.*			2	1
	Mormyrus sp			1	
	Petrocephalus spp.			1	1
Ciprynidae	*Bagrus spp.*			2	2
Characidae	*Brycinus sp.*			1	1
Claridae	*Clarias spp.*	2	2	2	2
Lepidosirenidae	*Protopterus sp.*	1	1		1
Schibeidae	*Schilbe sp.*				1
Machokidae	*Synodontis spp.*			1	2
= 8	= 22	= 10	= 9	= 28	= 34

The species richness was higher in the Opeta-Bisina wetland system (28 and 34) compared to the Mburo-Nakivali system (9 and 10). Subsequently, the Opeta-Bisina system had species richness of haplochromines (20) than the Mburo-Nakivali system (only 3). In both systems the native tilapiine *Oreochromis esculentus* co-existed with the introduced *Oreochromis niloticus* while the former was eliminated in the main lakes where Nile perch was introduced.

Table 2. The Mburo-Nakivali and Opeta – Bisina wetland systems and their species of biodiversity importance.

Wetland System	Lake	Species of Biodiversity importance
Mburo-Nakivali	Nakivali	*O. esculentus*
	Mburo	*O. esculentus*
	Kachera	*O. esculentus*
	Kijanebalola	*O. esculentus*
Opeta-Bisina	Bisina	Haplochromines, *O. variabilis*
	Opeta	*O. variabilis*, Haplochromines

5.6 Threats to Fish Biodiversity

The threats to fish species can be grouped into five interacting categories. Over-exploitation; introduction or invasion of exotic species; pollution and eutrophication; flow modification; destruction or degradation of habitat; and climate change.

Over exploitation is the result of harvesting or killing animals or plants, for food, materials or medicine, over and above the reproductive capacity of the population to replace itself. Overfishing has been the dominant threat to fish biodiversity and has devastated many commercial fish stocks. Overfishing reduces the size and genetic diversity of affected fish population. This decline has been found to reduce reproductive success and increase susceptibility of stocks to disease and environmental stresses. The problem of by catch of non-target species and under-sized juveniles of target species caught sometimes exceeds the saleable sizes. Overfishing can also lead to complete collapse of the target species and an ecosystem as a whole, termed as a trophic cascade. Collection of ornamental fish had also threatened fish diversity in Lake Bisina and Nawampasa in the late 1990s. Over harvesting of papyrus for art crafts, building and construction is another threat because it exposes the lakes to possibility of invasion of species e.g. Nile perch

Pollution problems arising from land based activities contaminate the lake with heavy metals and pesticide residues. Pollution also comes from, agriculture as well as households, either by direct disposal of harmful substances into the water bodies or indirect discharges that reach the lakes via rivers. Persistent organic pollutants consumed by organisms at the bottom of the food chain get concentrated as predators eat contaminated prey. The threat of excessive nutrient enrichment is a reality. Despite the growing pollution threat there are currently no targeted efforts to reduce water pollution.

Habitat degradation is brought about by an array of interacting factors. It may involve direct effects on the fish habitat such as cultivation up to the Lake margin or indirect impacts which are already evident, e.g. the high human population density in the basin leads to accelerated conversion of forests to agricultural land. The consequences of these include increased surface runoff and river sediment loads that can lead to habitat alterations such as shoreline erosion, smothering of littoral habitats, clogging of river bottoms or wetland aggradations besides destruction of refugia.

Reduction in water levels in water bodies is another threat to fish diversity in the form of habitat reduction. For example historical natural water level fluctuations, due to changes of climate and river discharge may lead to a reduction of levels. The level on the coastline reduces thus reducing fish habitats in the littoral areas and posing potential negative impact on fish diversity.

Flow modifications are very common in running waters and this is not an exception to the lakes in the wetland systems. Regulation of rivers that flow into the lakes could be one of the most significant anthropogenic impacts on the biodiversity of the lake e.g. River Ruizi that enters Lake Mburo through Kachera, Kijanebalola into Lake Victoria. Changes in the hydrological regimes, reducing spring run-off, can lead to increased shoaling of river delta and reduction in the area of delta vegetation (reeds, cat-tail, and bushes). This loss of vegetation can result in a loss of aquatic fauna especially the migratory and semi-migratory fish species that are deprived of their natural spawning grounds. As spring flows are reduced, fish migration upriver for spawning is impeded and essential nursery areas are limited.

Wide spread invasion and deliberate introduction of non-indigenous species adds to the physical and chemical impacts of humans to fish species diversity, in part because exotics usually successively invade native species already modified or degraded by humans e.g. the introduction of Nile perch and four tilapiine species in the basin provides a classic example. Escape of farmed fish into the wild is also associated with the floods that are common in these wetland systems.

Climate change has started manifesting itself recently and its impacts can easily be depicted e.g. the current water fluctuation levels in water bodies. Climate change is associated with the continuous global increase in temperature and green house gas emissions. The global extent of climate change will mean that no ecosystem on earth will be immune from rising air or sea temperatures or changing weather patterns. The impact of climate changes on fish diversity in the basin is not yet well understood, but a general increase in ultraviolet radiation due to ozone depletion harms microscopic, photosynthetic algae and zooplankton at the base of the aquatic food web, potentially affecting the food supply of the entire water body community. Climate change may not only result in water level rise and severe storm damage but also temperature, salinity and other parameters causing a wide range of effects from species mortality, modifying species composition and migratory patterns to shifts in the entire aquatic system. However, the impact of climate change on biodiversity may be gradual compared to other threats.

5.7 Discussion

The first fishery survey of lakes Mburo and Kachira by Worthington (1929) up to early 1950s the most important commercial fish species in the lakes were *Clarias spp*, the lung fish *Protopterus eathiopicus* and haplochromines (Worthington, 1932). In lakes Opeta and Bisina like in the other Kyoga lakes the most important commercial species in order of importance were native tilapiines (*O. esculentus* and *variabilis*), the lung fish and catfishes *Bagrus docmak*, *C. gariepinus*, *Schilbe intermedius*, *Barbus spp*, Haplochromines and momyrids. The present surveys indicate that the fish communities of most of the assessed lakes in the wetland systems are composed of native species however in the Mburo-Nakivali systems new species were recorded namely *O. esculentus* and *O. niloticus* and these species were introduced in these lakes and dams in the early 1950s when the general introductions took place. Among the tilapiines cichlids, significant populations of the two native tilapiines remain in these lakes although they have been displaced from the main lakes Victoria, Kyoga, Nabugabo and Nakuwa where Nile perch has established (Ogutu-Ohwayo, 1990; Mbabazi et al., 2004; Chapman *et al.*, 2008). The native tilapiines, which have disappeared from the main lakes, survive as both native and introduced populations in satellite lakes within the Victoria

and Kyoga lake basins. The lakes in the two wetland systems still house remnants of the native species especially haplochromines which were thought to be eliminated in the main lakes Victoria and Kyoga. Because of their structural heterogeneity of macrophyte cover separating these lakes from the main lakes that make it difficult for the predatory Nile perch to access the lakes (Chapman *et al.*, 1999; Mbabazi *et al.*, 2004).

5.8 Conclusions

a) The native tilapiines, which have disappeared from the main lakes, survive as both native and introduced populations in satellite lakes in wetland systems within the Victoria and Kyoga lake basins.
b) The native haplochromine that existed in Lake Victoria and Kyoga prior to the Nile perch boom are still present in the Opeta-Bisina wetland system.
c) The two wetland systems therefore contribute to conservation of fish species diversity threatened by introduction of exotics and other anthropogenic factors in the Victoria and Kyoga basin lakes.

5.9 Recommendations

a) It is therefore recommended that some of the Lakes in the wetland systems around Lakes Victoria and Kyoga be designated as conservation areas of haplochromines and other species threatened by introductions of exotics in the main Lakes.
b) There is need to prevent clearing of vetetation that separate these lakes from the main Lakes to avoid colonization by the Nile perch
c) Discourage harvesting of ornamental fish from these Lakes and instead introduce them in aquaculture.
d) There is need to initiate the development of management plans that will guide the implimentation of all conservation interventions.

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CHAPTER 6: MAMMALS

INFORMATION ON MAMMAL DIVERSITY FOR THE OPETA – BISINA AND MBURO – NAKIVALE WETLAND SYSTEMS, EASTERN AND WESTERN UGANDA

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6.1 Background

Mammals represent a usually quite conspicuous component of the biota of many places especially when they comprise of larger more conspicuous species such as antelopes, elephants, hippos and diurnal primates. Although the larger species usually form the major basis of attractions to tourist areas, in many biomes the larger proportion of the mammalian biodiversity is comprised of the medium to small sized mammals.

The Ugandan mammalian diversity of 340 species for example, is comprised of only 30% larger mammals while the rest are all medium to small sized mammals. In human impacted habitats, the large mammals are lost out quicker than the medium to small sized species. The latter are capable of surviving in even small fragments of natural habitats while the larger species may not be able to.

6.1.1 Bisina system

The Bisina Wetland system located in Kumi district is described by Byaruhanga *et al* (2001) as having a water body occupying an area of 192 km^2 with a thin strip of fringing papyrus swamp. The general area in which the Bisina system is located was mapped by Langdale-Brown *et al.* (1964) as sitting in surrounding vegetation characterized by grass savanna mostly dominated by *Hyparrhenia* grass savannas, *Acacia-Albzia-Dichrostachys* bushland and communities on sites with impeded drainage. Together the said vegetation communities would have provided suitable habitats for ranging of open environment mammals.

6.1.2 Opeta system

The Opeta system on the other hand was described by Byaruhanga *et al* (2001) as one of the few remaining intact marshes in Uganda. The main land use pattern they recorded at the time was grazing of livestock by mainly two communities of the Karamajong people. Langdale-Brown *et al* (1964) mapped the general area in which Lake Opeta sits to be dominated by communities on sites with impeded drainage mainly dominated by *Combretum-Acacia-Hyparrhenia* savanna but also with stands of *Acacia-Setaria* savanna.

Byaruhanga *et al* (2001) however described the area of Lake Opeta as an extensive swamp of *Miscanthus* merging into dry *Hyparrhenia* grass with Lake Opeta as a small lake in the middle of the swamp. The Opeta system would have been an important ranging area not only for livestock as mentioned already but also as a dry season watering area for wildlife. This supposition is strengthened by its close proximity to Pian-Upe wildlife reserve.

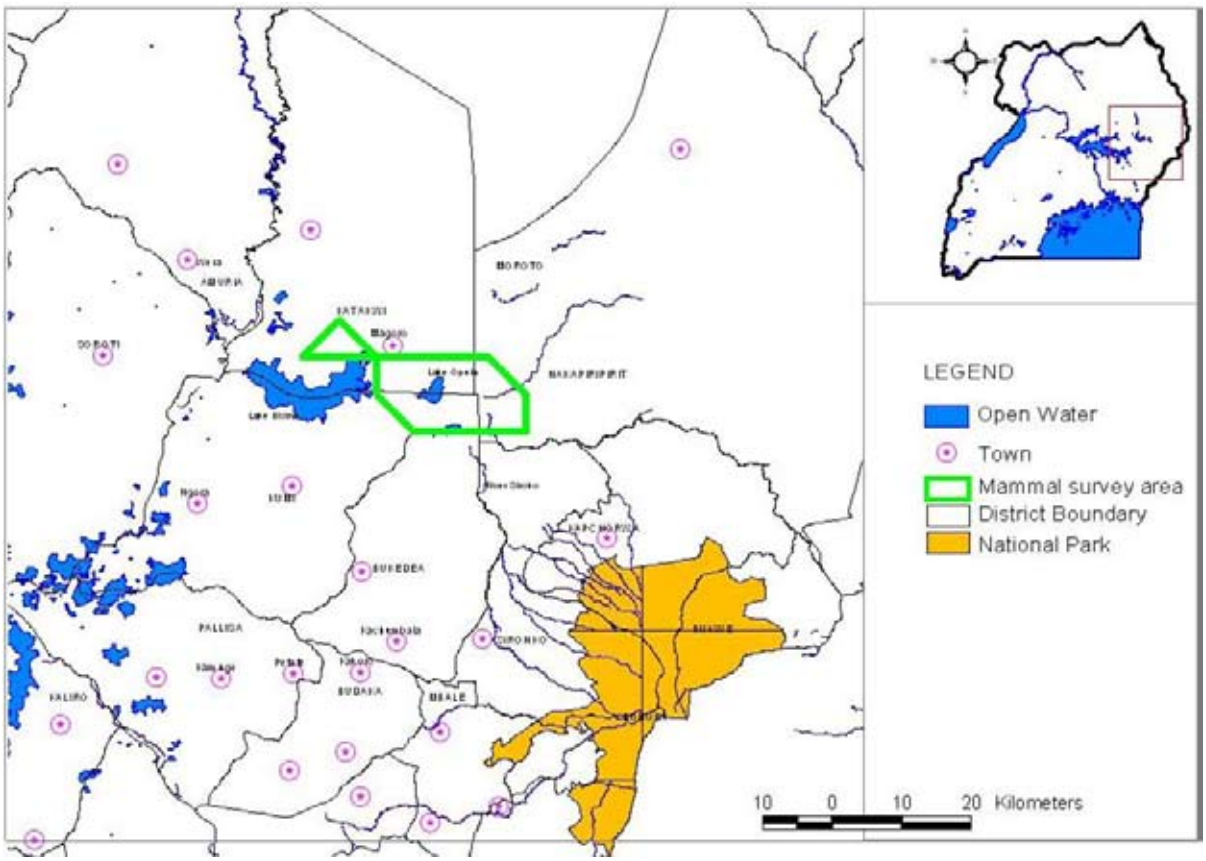

Fig. 9 Mammal survey sites in Opeta – Bisina wetland system

6.1.3 Lake Mburo-Nakivali wetland system

The Mburo-Nakivali system is continuous with the Lake Mburo National Park. The general area was mapped by Langdale-Brown *et al* (1964) to comprise of a rather extensive *Cyperus papyrus* swamp mixed with *Echinocloa* grassland on sites with impeded drainage. These two vegetation formations form the central section of this system. Elsewhere on the other hand the system is largely a dry *Acacia* savannah dominated by *Acacia-Cymbopogon/Themeda* complex with a scattering of other dry type communities including dry *Hyparrhenia* and *Themeda-Luodetia* grass savannas.

Occurring in the same ecosystem as the Lake Mburo National Park, this system would also have been an important range area for several species of mammals that are unique to this area in Uganda.

The Mburo-Nakivali system lies within the general area of the cattle corridor, implying that it is liable to facing heavy pressures from livestock. Byaruhanga *et al* (2001) pointed out that the Lake Mburo National Park which is a key future of this area receives erratic and unreliable rainfall that causes shortage of pastures and affecting the behavior of the animal life in the area. Since Lake Mburo, Nakivali and the other associated water bodies would carry water throughout the year, they should provide the only sources of water in the dry seasons.

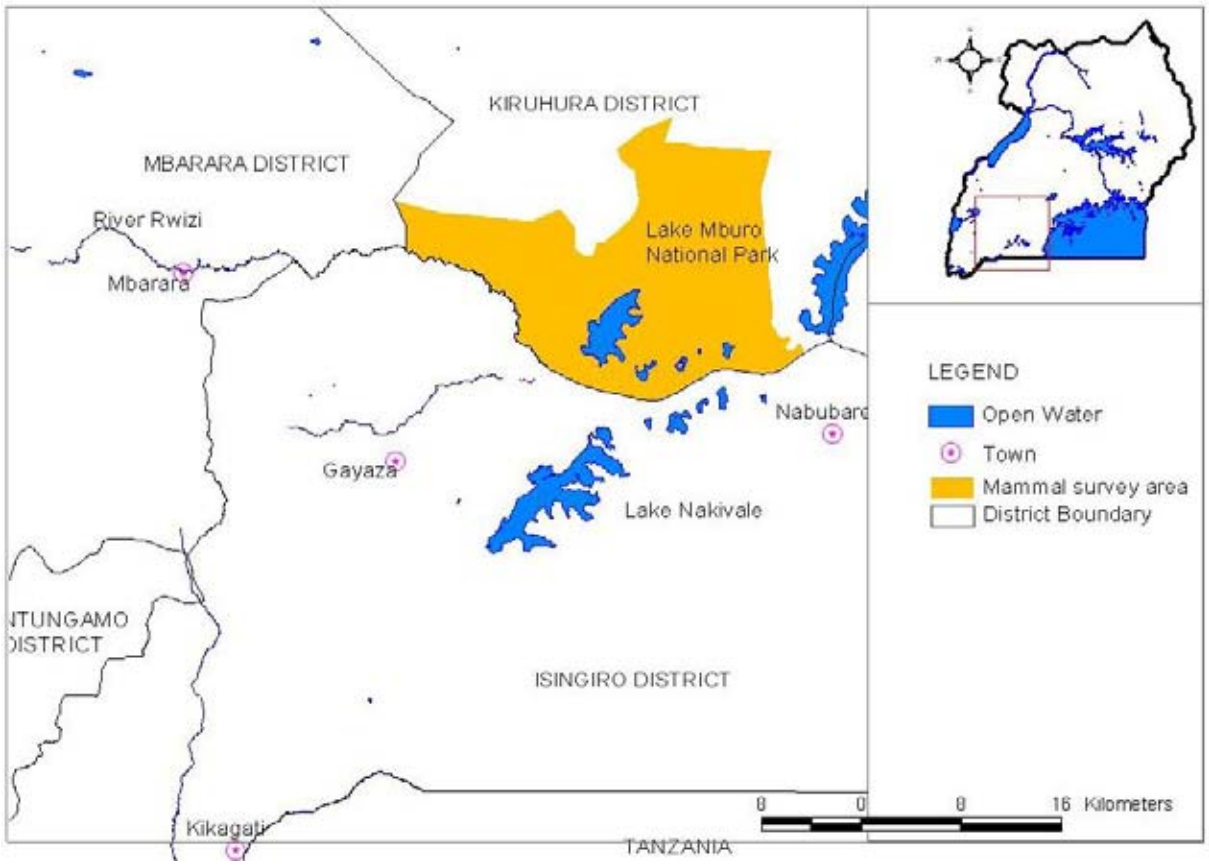

Fig. 10 Mammal survey area Lake Mburo-Nakivali wetland system

6.2 Methods

The information for producing this report is strictly based on a search and collation of the available literature. In most cases the direct mammal information for the target areas was only anecdotal. In some instances such as those sourced from Kingdon (1971, 1974, 1977, 1979, 1982a and 1982b) and Kityo *et al* (2009) the information represents actual point records of occurrence in the vicinity of the wetland systems.

6.3 Results

As mentioned elsewhere in this report, the list of mammals presented here represents species that are at this point assumed to range or occur in the two wetland systems. Field verification exercises will need to be conducted to show which if any of the listed mammals still survive in the two systems.

There is every possibility that the larger species will have been locally extirpated from these areas but there are also small chances that some larger species may still occur at very low abundances.

The total number of mammals that we consider might occur or previously occurred in the Lake Mburo –Nakivale and Opeta – Bisina wetland systems number to 138 species (Appendix 1). We reiterate however, that outside the protected areas including Lake Mburo NP and Pian Upe wildlife reserve in the vicinity of the wetland systems in question the larger species may well have been extirpated out.

6.3.1 Lake Mburo-Nakivali wetland system

Table 1 summarizes the mammalian diversity in the Lake Mburo – Nakivali wetland systems. Altogether these comprise of 110 species in 13 orders the largest of which are the Artiodactyla, Carnivora and Rodentia.

Table 1 Summary of possible mammalian diversity in the Lake Mburo-Nakivali wetland system

Order	**Family**	**Total**
Artiodactyla	Bovidae	13
	Hippopotamidae	1
	Suidae	3
Artiodactyla Total		17
Carnivora	Canidae	1
	Felidae	5
	Herpestidae	8
	Hyaenidae	1
	Mustelidae	6
	Viverridae	7
Carnivora Total		28
Hyracoidea	Procaviidae	2
Hyracoidea Total		2
Insectivora	Chrysochloridae	1
	Erinaceidae	1
	Soricidae	4
Insectivora Total		6
Lagomorpha	Leporidae	3
Lagomorpha Total		3
Macroscelidea	Macroscelididae	2
Macroscelidea Total		2
Megachiroptera	Pteropodidae	8
Megachiroptera Total		8
Microchiroptera	Emballonuridae	1
	Nycteridae	2
	Rhinolophidae	1
	Vespertilionidae	3
	Megadermatidae	1
	Molosidae	1
Microchiroptera Total		9
Perisodactyla	Equidae	1
Perisodactyla Total		1

Order	Family	Total
Pholidota	Manidae	3
Pholidota Total		3
Primates	Cercopithecidae	2
	Galagonidae	3
	Loridae	1
Primates Total		6
Rodentia	Cricetidae	2
	Hystricidae	2
	Muridae	12
	Myoxidae	1
	Sciuridae	4
	Thryonomyidae	2
	Anomaluridae	1
Rodentia Total		24
Tubulidentata	Orycteropodidae	1
Tubulidentata Total		1
Grand Total		110

Of the mammal species compiled for the Nakivali wetland system, it is likely that several species of the orders Artiodactyla, the larger Carnivora, Perisodactyla and Primates are locally extirpated or if they still exist, that they occur at very low densities. Species such as the Lions will certainly already be locally extinct in areas outside the protected areas. These would reduce the diversity by up to 30 species, therefore leaving a still fairly rich mammalian biota of 80 species of small to medium sized species. Because no specific mammalian studies have been conducted in the area, there may well be many more species of small sized mammals that range into this area but that are not recorded yet.

6.3.2 Bisina and Opeta wetland systems

Table 2 summarizes the possible mammalian diversity in the Bisina-Opeta wetland systems. Altogether these comprise of 100 species in 13 orders the largest of which like is the case for the Nakivali system are the Artiodactyla, Carnivora and Rodentia.

Table 2: Summary of possible mammalian diversity in the Bisina-Opeta wetland system

Order	Family	Total
Artiodactyla total		**20**
	Bovidae	17
	Hippopotamidae	1
	Suidae	2
Carnivora total		**29**
	Canidae	4

	Felidae	5
	Herpestidae	6
	Herpestidae	2
	Hyaenidae	3
	Mustelidae	5
	Viverridae	4
Hyracoidea total		**3**
	Procaviidae	3
Insectivora total		**4**
	Erinaceidae	1
	Soricidae	3
Largomorpha total		**3**
	Leporidae	3
Macroscelidea total		**2**
	Macroscelididae	2
Megachiroptera total	**6**	**6**
	Pteropodidae	6
Microchiroptera total		**7**
	Nycteridae	2
	Rhinolophidae	1
	Vespertilionidae	4
Perissodactyla total		**1**
	Equidae	1
Pholidota total		**3**
	Manidae	3
Primates total		**5**
	Cercopithecidae	3
	Galagonidae	1
	Loridae	1
Rodentia total		**16**
	Hystricidae	2
	Muridae	8
	Rhizomyidae	1
	Scuiridae	3
	Thryonomyidae	2
Tubulidentata total		**1**
	Orycteropodidae	1
Grand Total		**100**

In this system too it is quite likely that the larger species in the orders Artiodactyla, the larger Carnivora, Perisodactyla may well be locally hunted or squeezed out accounting for up to 30 species. Again the small species (rodents, insectivores and bats) may well be underrepresented in the list for Bisina-Opeta systems as well because no directed surveys have been conducted in these areas for mammals.

6.4 Indicator species for biodiversity monitoring

At the moment it may turn out to be a rushed decision to point to any of the species in the list as potential indicator species. A more useful list would benefit from actual field surveys to establish the condition of the wetland systems, including among other:-

i. Current nature of the vegetation
ii. Land use schemes in the areas
iii. Pressures and their sources onto the wetland systems

In addition, such a survey would generate actual baseline data on occurrence of species, the distribution of the species and relative abundance of some common species. On the basis of these surveys, meaningful indicators would then be identified.

In the meantime a simple monitoring scheme could involve: -

i. Monitoring activity and diversity of insectivorous bats using a bat detector. This approach would quickly and cheaply yield baseline data through a passive monitoring scheme. These such data could be used to quickly gain impressions in communities dynamics of insect eating bats in the different areas
ii. Transect runs to document large mammals or their signs to give insight into which species still range in the different areas
iii. Trapping along the transects to document species and their relative abundance of the small mammals in the areas.

These approaches will then help to collect data on the basis of which suitable indicator species can be selected. A detailed monitoring protocol would then be developed for these species. At the very minimum however the protocols will involve collecting data on among others:-

i. Species presence or absence
ii. Community composition trends
iii. Seasonal variations in i and ii above
iv. Trends in relative abundance and or dominance
v. Total populations for such species for which this will be possible

6.5 Next steps

To verify the accuracy of the lists presented here, it will be essential to conduct detailed field surveys cognizant of the fact that mammal surveys for most of the orders are much slower and more time intensive exercises than vegetation and avian surveys. The surveys should target to acquiring primary field data but also secondary data from interviews with local communities.

Appendix 1: Potential list of mammals for the Bisina-Opeta and Mburo-Nakivali wetland system

Order	Family	Common Name	*Species Name*	Bisina - Opeta	Nakivali Mburo
Artiodactyla	Bovidae	Impala	*Aepyceros melampus*		√
Artiodactyla	Bovidae	Blue Duiker	*Cephalophus monticola*	√	√
Artiodactyla	Bovidae	Topi	*Damaliscus lunatus*	√	√
Artiodactyla	Bovidae	Roan Antelope	*Hippotragus equinus*	√	√
Artiodactyla	Bovidae	(Defassa) Waterbuck	*Kobus ellipsiprymnus*	√	√
Artiodactyla	Bovidae	Sitatunga	*Tragelaphus spekii*	√	√
Artiodactyla	Bovidae	Hartebeest	*Alcelaphus buselaphus*	√	
Artiodactyla	Bovidae	Grant's Gazelle	*Gazella granti*	√	
Artiodactyla	Bovidae	Uganda Kob	*Kobus kob*	√	
Artiodactyla	Bovidae	Klipspringer	*Oreotragus oreotragus*	√	√
Artiodactyla	Bovidae	Onbi	*Ourebia ourebia*	√	√
Artiodactyla	Bovidae	Bohor Reedbuck	*Redunca redunca*	√	√
Artiodactyla	Bovidae	Common Duiker	*Sylvicapra grimmia*	√	√
Artiodactyla	Bovidae	African Buffalo	*Syncerus caffer*	√	√
Artiodactyla	Bovidae	Common Eland	*Taurotragus oryx*	√	√
Artiodactyla	Bovidae	Lesser Kudu	*Tragelaphus imberbis*	√	
Artiodactyla	Bovidae	Bush Buck	*Tragelaphus scriptus*	√	√
Artiodactyla	Bovidae	Yellow-backed Duiker	*Cephalophus weynsii*	√	
Artiodactyla	Hippopotamidae	Hippopotamus	*Hippopotamus amphibius*	√	√
Artiodactyla	Suidae	Giant Forest Hog	*Hylochoerus meinertzhageni*		√
Artiodactyla	Suidae	Woodland Warthog	*Phacochoerus africanus*	√	√
Artiodactyla	Suidae	Bush Pig	*Potamochoerus porcus*	√	√
Carnivora	Canidae	Side-striped Jackal	*Canis adustus*	√	√
Carnivora	Canidae	Golden Jackal	*Canis aureus*	√	
Carnivora	Canidae	Black-Backed Jackal	*Canis mesomelas*	√	
Carnivora	Canidae	Bat-eared Fox	*Otocyon megalotis*	√	
Carnivora	Felidae	Caracal	*Caracal caracal*	√	
Carnivora	Felidae	Serval	*Felis serval*		√
Carnivora	Felidae	African Wild Cat	*Felis silvestris*		√
Carnivora	Felidae	Serval Cat	*Leptailurus serval*	√	
Carnivora	Felidae	Lion	*Panthera leo*	√	√
Carnivora	Felidae	Leopard	*Panthera pardus*	√	√
Carnivora	Felidae	Golden cat	*Profelis aurata*		√
Carnivora	Herpestidae	Marsh Mongoose	*Atilax paludinosus*	√	√
Carnivora	Herpestidae	Alexandar's cusimanse	*Crossarchus alexandri*	√	√

Order	Family	Common Name	*Species Name*	Bisina - Opeta	Nakivali Mburo
Carnivora	Herpestidae	Savanna Mongoose	*Dologale dybowskii*	√	√
Carnivora	Herpestidae	Dwarf Mongoose	*Helogale parvula*	√	√
Carnivora	Herpestidae	Egyptian Mongoose	*Herpestes ichneumon*	√	√
Carnivora	Herpestidae	Slender Mongoose	*Herpestes sanguineus*		√
Carnivora	Herpestidae	White-tailed Mongoose	*Ichneumia albicauda*	√	√
Carnivora	Herpestidae	Banded Mangoose	*Mungos mungo*	√	√
Carnivora	Herpestidae	Jackson's mongoose	*Bdeogale jacksoni*	√	
Carnivora	Hyaenidae	Spotted Hyaena	*Crocuta crocuta*	√	√
Carnivora	Hyaenidae	Striped hyaena	*Hyaena hyaena*	√	
Carnivora	Hyaenidae	Aardwolf	*Proteles cristatus*	√	
Carnivora	Mustelidae	African Clawless Otter	*Aonyx capensis*	√	√
Carnivora	Mustelidae	Swamp (Congo Clawless) Otter	*Aonyx congica*	√	√
Carnivora	Mustelidae	Zorilla (Striped Polecat)	*Ictonyx striatus*	√	√
Carnivora	Mustelidae	(African) Spot-necked Otter	*Lutra maculicollis*	√	√
Carnivora	Mustelidae	Honey Badger	*Mellirora capensis*	√	√
Carnivora	Mustelidae	Striped (White-naped) Weasel	*Poecilogale albinucha*	√	√
Carnivora	Viverridae	East African Civet	*Civettictis civetta*	√	√
Carnivora	Viverridae	Small-spotted Genet	*Genetta genetta*	√	√
Carnivora	Viverridae	Servaline Genet	*Genetta servalina*	√	√
Carnivora	Viverridae	Blotched (Rusty Spotted) Genet	*Genetta tigrina*		√
Carnivora	Viverridae	Servaline Genet	*Genetta victoriae*		√
Carnivora	Viverridae	Africam Palm Civet	*Nandinia binotata*	√	√
Hyracoidea	Procaviidae	Yellow-spotted rock procaviidae	*Heterohyrax brucei*	√	
Hyracoidea	Procaviidae	Rock Hyrax	*Procavia capensis*	√	
Hyracoidea	Procaviidae	Western Tree hyrax	*Dendrohyrax dorsalis*		√
Hyracoidea	Procaviidae	Southern Tree Hyrax	*Dendrohyrax arboreus*	√	√
Insectivora	Chrysochloridae	Stuhlmann's Golden Mole	*Chrysochloris stuhlmanni*		√
Insectivora	Erinaceidae	Four-toed Hedgehog	*Atelerix albiventris*	√	√
Insectivora	Soricidae	Mt Elgon musk shrew	*Crocidura elgonius*	√	
Insectivora	Soricidae	Dwarf musk shrew	*Crocidura nanilla*	√	
Insectivora	Soricidae	Lesser Red Musk Shrew	*Crocidura hirta*		√

Order	Family	Common Name	*Species Name*	Bisina - Opeta	Nakivali Mburo
Insectivora	Soricidae	Northern Giant Musk Shrew	*Crocidura olivieri*	√	√
Insectivora	Soricidae	Hero shrew	*Scutisorex somereni*		√
Insectivora	Soricidae	Climbing Forest shrew	*Sylvisorex megalura*		√
Lagomorpha	Leporidae	Central African Grass Rabbit	*Poelogus marjorita*	√	√
Lagomorpha	Leporidae	Cape (Brown) Hare	*Lepus capensis*	√	√
Lagomorpha	Leporidae	Savanna (Crawshay's) Hare	*Lepus victoriae*	√	√
Macroscelidea	Macroscelididae	Rufous Elephant shrew	*Elephantulus rufescens*	√	√
Macroscelidea	Macroscelididae	Short-snouted Elephant shrew	*Elephantulus brachyrhynchus*	√	√
Megachiroptera	Pteropodidae	Bocage's Fruit Bat	*Rousettus angolensis*	√	
Megachiroptera	Pteropodidae	Sraw-colured fruit bat	*Eidolon helrum*	√	√
Megachiroptera	Pteropodidae	Gambian Epauletted Fruit Bat	*Epomophorus gambianus*		√
Megachiroptera	Pteropodidae	Little Epaluletted fruit Bat	*Epomophorus labiatus*	√	√
Megachiroptera	Pteropodidae	Franquet's fruit Bat	*Epomops franqueti*		√
Megachiroptera	Pteropodidae	Hammer-headed fruit Bat	*Hypsignathus monstrosus*	√	√
Megachiroptera	Pteropodidae	Dwarf epauletted Fruit bat	*Micropteropus pusillus*		√
Megachiroptera	Pteropodidae	Egyptian Fruit Bat	*Rousettus aegyptiacus*	√	√
Megachiroptera	Pteropodidae	Pygmy Epauletted Fruit Bat	*Epomophorus minimus*	√	√
Microchiroptera	Emballonuridae	Mauritian Tomb Bat	*Taphozous mauritianus*		√
Microchiroptera	Megadermatidae	Yellow-winged Bat	*Lavia frons*		√
Microchiroptera	Molosidae	Little-free-tailed Bat	*Chaenephon pumilus*		√
Microchiroptera	Nycteridae	Egyptian slit-faced bat	*Nycteris thebaica*	√	
Microchiroptera	Nycteridae	Hairy slit-faced bat	*Nycteris hispida*	√	√
Microchiroptera	Nycteridae	Large-eared slit faced Bat	*Nycteris macrotis*		√
Microchiroptera	Rhinolophidae	East African Horseshoe Bat	*Rhinolophus eloquens*	√	√
Microchiroptera	Vespertilionidae	Common long-fingered Bat	*Miniopterus schreibersi*	√	
Microchiroptera	Vespertilionidae		*Pipistrellus hesperidus*	√	
Microchiroptera	Vespertilionidae	Banana Bat	*Pipistrellus nanus*	√	
Microchiroptera	Vespertilionidae	Moleney's Flat-headed Bat	*Mimetillus moloneyi*		√

Order	Family	Common Name	*Species Name*	Bisina - Opeta	Nakivali Mburo
Microchiroptera	Vespertilionidae	African Giant House Bat	*Scotophilus nigrita*	√	√
Microchiroptera	Vespertilionidae	Rufous mouse-eared bat	*Myotis bacogii*		√
Perisodactyla	Equidae	Plains (Burchell's) Zebra	*Equus burchelli*	√	√
Pholidota	Manidae	Ground Pangolin	*Manis temminki*	√	√
Pholidota	Manidae	Tree Pangolin	*Manis tricuspis*	√	√
Pholidota	Manidae	Giant Pangolin	*Smutsia gigantea*	√	√
Primates	Cercopithecidae	Olive Baboon	*Papio Anubis*	√	√
Primates	Cercopithecidae	Vervet Monkey	*Cercopithecus aethiops*	√	√
Primates	Cercopithecidae	Patas monkey	*Erythrocebus patas*	√	
Primates	Galagonidae	Thomas Galago	*Galagoides thomasi*		√
Primates	Galagonidae	Senegal Galago	*Galago senegalensis*	√	√
Primates	Galagonidae	Demidoff's (Dwarf) Galago	*Galago demidovii*		√
Primates	Loridae	Potto	*Perodicticus potto*	√	√
Rodentia	Anomaluridae	Beecroft's flying squirrel	*Anomalurus derbianus*		√
Rodentia	Cricetidae	Forest Pouched Rat	*Cricetomys gambianus*		√
Rodentia	Cricetidae	Tropical Groove-toothed Rat	*Otomys tropicalis*		√
Rodentia	Hystricidae	African Bush-tailed porcupine	*Atherurus africanus*	√	√
Rodentia	Hystricidae	Crested Porcupine	*Hystrix cristata*	√	√
Rodentia	Muridae		*Acomys cahirinus*	√	
Rodentia	Muridae		*Acomys subspinosus*	√	
Rodentia	Muridae	Nothern Bush Rat	*Aethomy's hindei*	√	
Rodentia	Muridae	Rusty-nosed Rat	*Oenomys hypoxanthus*	√	
Rodentia	Muridae	Eastern Brush-furred Rat	*Lophuromys flavopunctatus*		√
Rodentia	Muridae	Northern Savanna Rat	*Mastomys hildebrandtii*		√
Rodentia	Muridae	Pygmy Mouse	*Mus minutoides*		√
Rodentia	Muridae	Grey-bellied Pygmy Mouse	*Mus triton*		√
Rodentia	Muridae	Common Thicket Rat	*Grammomys dolichurus*		√
Rodentia	Muridae	Kaiser's Bush Rat	*Aethomys kaiseri*		√
Rodentia	Muridae	Common Striped Grass Mouse	*Lemniscomys striatus*		√
Rodentia	Muridae	Nile Grass Rat	*Arvicanthis niloticus*	√	√
Rodentia	Muridae	Mill Rat (Three-toed Grass Rat)	*Mylomys dybowskyii*	√	√

Order	Family	Common Name	*Species Name*	Bisina - Opeta	Nakivali Mburo
Rodentia	Muridae	Common Brush-furred Rat	*Lophuromys sikapusi*	√	√
Rodentia	Muridae	Shaggy Marsh Rat	*Dasmys incomtus*	√	√
Rodentia	Myoxidae	African Common Dormouse	*Graphiurus murinus*		√
Rodentia	Rhizomyidae	Rupell's mole-rat	*Tachyoryctes splendes*	√	
Rodentia	Sciuridae	Boehm's Bush Squirrel	*Funisciurus paraxerus boehmi*		√
Rodentia	Sciuridae	Giant forest squirrel	*Protoxerus strangeri*		√
Rodentia	Sciuridae	Striped Ground Squirrel	*Xerus erythropus*		√
Rodentia	Sciuridae	Red-legged Sun Squirrel	*Heliosciurus rufobrachium*	√	√
Rodentia	Scuiridae	Gambian Sun Squirrel	*Helioscuirus gambianus*	√	
Rodentia	Scuiridae	Geoffrey's Ground Squirrel	*Xerus rutilus*	√	
Rodentia	Thryonomyidae	Savannah (Common) Cane Rat	*Thryonomys swinderianus*	√	√
Rodentia	Thryonomyidae	Marsh (Lesser) Cane Rat	*Thryonomys gregorianus*	√	√
Tubulidentata	Orycteropodidae	Aardvark (Ant Bear)	*Orycteropus afer*	√	√

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CHAPTER 7: WATER QUALITY

WATER QUALITY ASSESSMENTS IN THE OPETA - BISINA WETLAND SYSTEMS AND MBURO-NAKIVALE WETLAND SYSTEMS

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7.1 Introduction

Wetlands are among the most important ecosystems on earth. They have been described as the kidneys of the landscape because they function as the downstream receivers of water and waste from both natural and human sources (Mitsch & Gosselink, 2007). They stabilize water supplies, thus ameliorating both floods and drought. They serve as sources, sinks, and transformers of nutrients; and they are among the most productive ecosystems on the planet when compared to adjacent terrestrial and deep water aquatic systems. A detailed account of wetland functions in Uganda is presented in WMD/MWE (2009) and generally in Keddy (2000).

Factors such as temperature, electrical conductivity, dissolved oxygen; turbidity and pH interact to influence the abundance and distribution of biodiversity in wetland ecosystems. Variation in these parameters is influenced by the underlying geology, climatic factors, and land-use practices within the landscape. For example conductivity may increase in wetlands draining intensively cultivated watersheds and urban areas. An assessment was carried out on the above parameters in order to establish their baseline condition and explore possible human impacts on the wetlands.

7.2 Objectives, study sites and methods

7.2.1 Objectives

- Produce guiding methods for each parameter to be used during and after the exercise.
- Establish baseline information on water physical and chemical parameters identified (PH, electrical conductivity, dissolved oxygen, temperature, turbidity and total dissolved solids)
- Take appropriate GPS coordinates for points from where sampling was done.
- Make field observations and descriptions to support observed values in the field.
- Produce a comprehensive report on the work done.

7.2.2 Study sites:

(a) Opeta-Bisina wetland system

It is located in eastern Uganda. The wetland system is characterized by open water that is clear with some emergent vegetation mainly of sedges and floating vegetation dominated by the day water lily *Nymphaea* sp and submerged water weeds. Some patches of *Cyperus papyrus* exist in areas with minimal agricultural encroachment. The main inflow into the Opeta system is through River Sironko.

Five sites were sampled on both Bisina (3) and Opeta (2). The Bisina sites were:

1. Akide landing site. It is located on the north-eastern end of Lake Bisina and was accessed from Kumi town. 2) Kakor village landing site. Most of the shore to this site is grazing land and it is located where waterfowl counts are undertaken (starting point) and 3) Site is located towards the southern end of Lake Bisina but on the western shore of the Lake overlooking the rocks/hills on Soroti Kumi road. The point is located where the waterfowl crew usually rests. The two points on Opeta were located, one on the northern end of the lake at Agule village landing site in Opeta Parish. The immediate environs of the site are characterized by overgrazing and bush burning seems prevalent in the area. The second site on Opeta was located on River Sironko to get an insight into the quality of water flowing into the wetland.

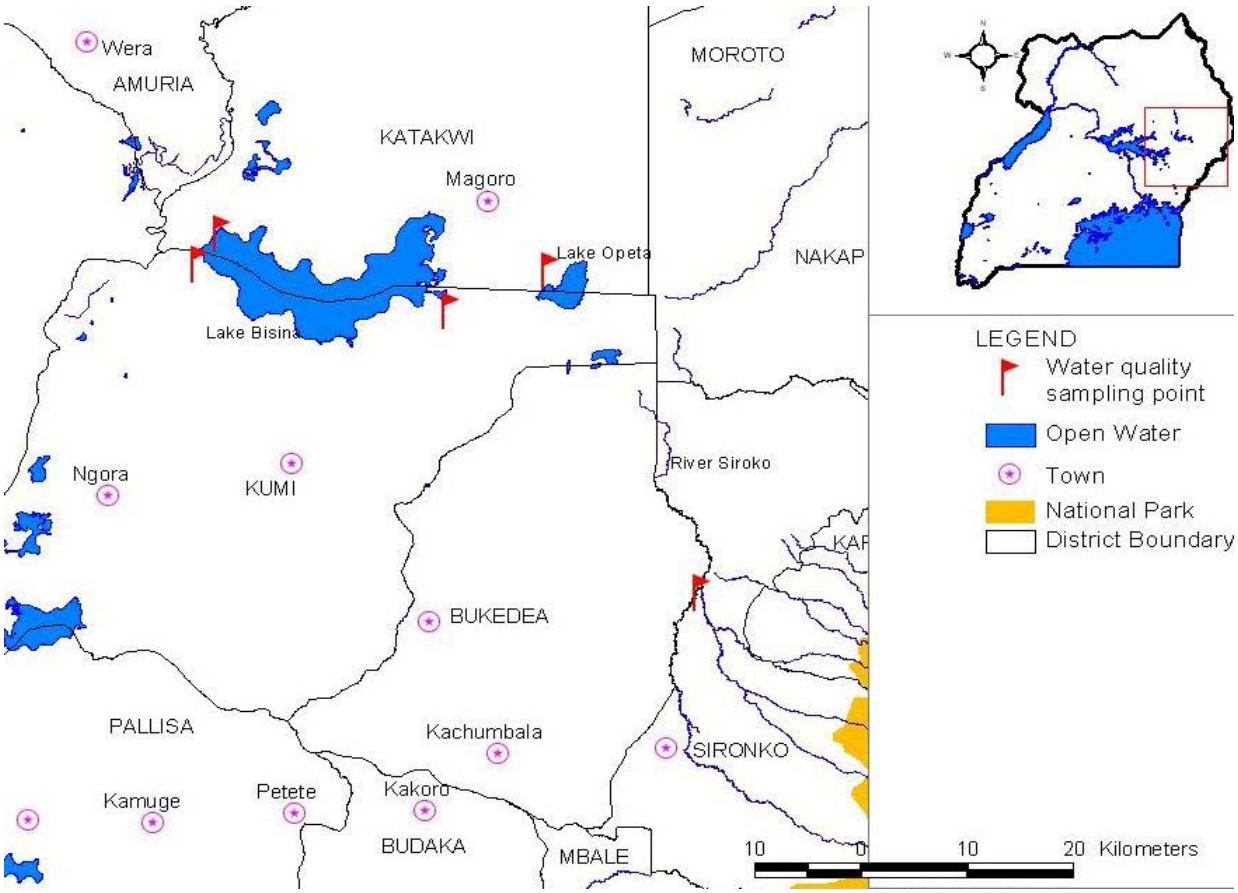

Fig. 11 Water quality survey of Lake Bisina - Opeta wetland sysyems

(b) Nakivale-Mburo wetland complex

The wetland complex is located in western Uganda in the districts of Isingiro and Mbarara. The main inflow into the wetland system is via River Rwizi that divides up downstream supplying water to both Lakes Nakivale and Mburo. The Nakivale water is mainly turbid with a greenish colour probably due to high concentrations of algae. Lake Mburo water is relatively less turbid compared to the Nakivale water. Shores of Lake Mburo and most of its catchments are relatively in pristine condition as opposed to those of Nakivale whose eastern end is mainly agricultural.

Ten sampling sites were located within the Nakivale-Mburo wetland system both on the open water of the lakes and in streams and rivers draining into the wetland system. The sites were 1) River Rwizi just above the bridge on Mbarara-Kabale road, characterized by fast flowing water. 2) Kahirimbi landing site on Lake Nakivale characterized highly turbid waters. The eastern side of the shore is mainly agricultural land settled by refugees while the western end of the site comprises of forested hills with a mixture of grazing fields, and a papyrus swamp close to the lake shore. 3) Rukinga landing site on Lake Nakivale is similar to Kahirimbi in catchment condition but with the eastern side highly impacted by agriculture. 4) Kashojwa landing site directly opposite River Rwizi inflow into Lake Nakivale. 5) Kagogo site, located on the arm of the Rwizi River that flows into Lake Nakivale. Slow flowing water in a mainly papyrus swamp.

6) River Rwizi arm flowing into Lake Mburo. This constitutes the main river Rwizi channel that is fast flowing; site is located approximately 3km from Lake Mburo. The site is located in a pure stand of *Cyperus papyrus.* 7) Kigaaga river- it appears to be the main inlet into Lake Nakivale and

is characterized by slow flowing water in a savannah type of vegetation. Most of the watershed of this river is composed of pastureland. Emergent sedges and the water lily were some of the aquatic plants at the site. 8) A small stream flowing by the roadside approximately a km from Isingiro town on the Mbarara road. It is an inlet into Lake Nakivale. This was sampled to gauge the quality of water flowing into Lake Nakivale and to assess whether water quality in the catchment has an influence on the quality of water in the lake. 9) Lake Mburo at a point where river Rwizi enters the lake. The site is characterized by dark waters at the interface of open water and a papyrus swamp. 10) Lake Mburo in the middle/ open water site. This was located in the middle of lake in order to determine whether the Rwizi waters have an influence on the general water quality of the lake.

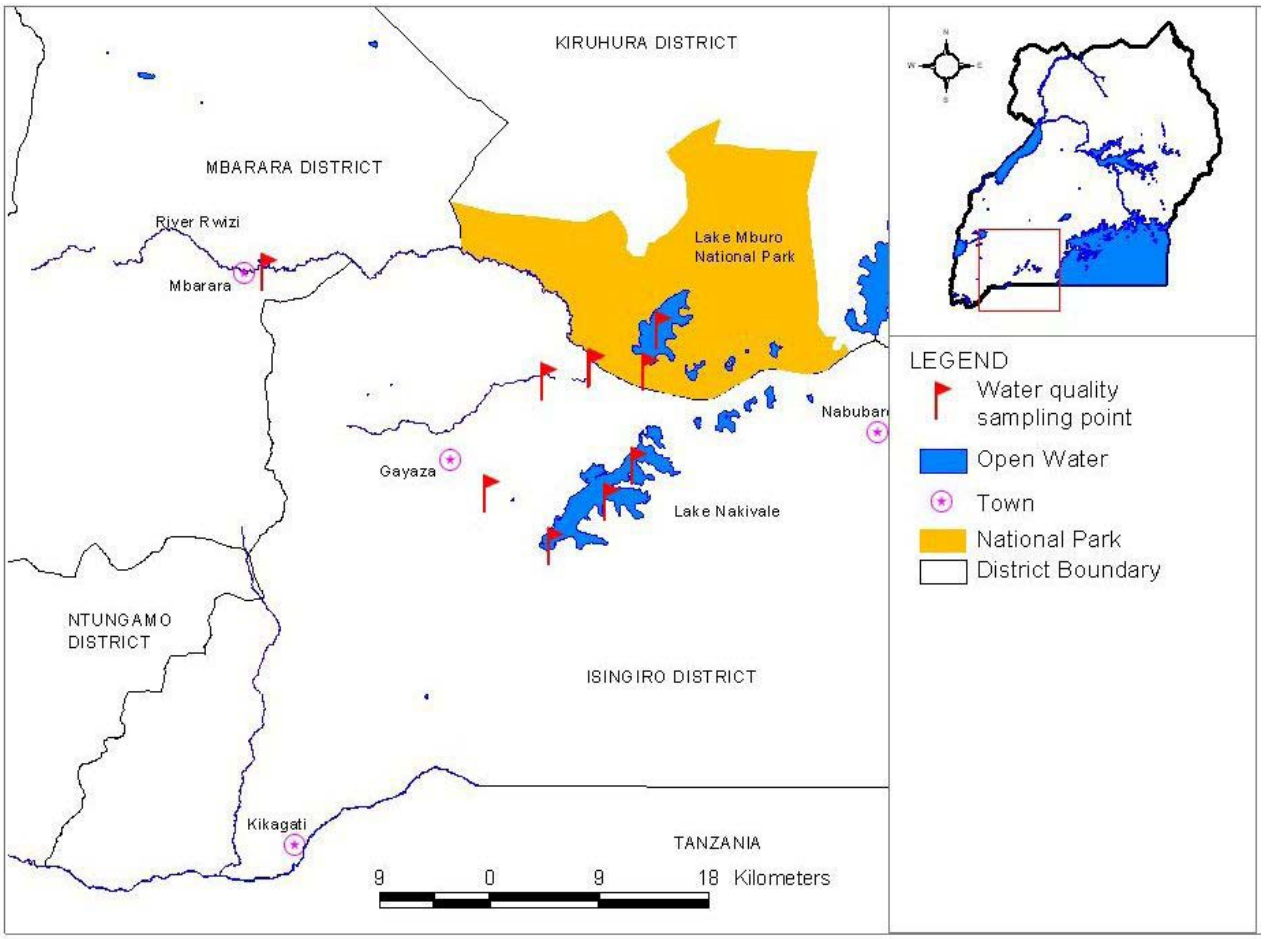

Fig. 12 Water quality survey of Lake Mburo - Nakivali wetland sysyems

7.2.3 Field sampling

Various water quality parameters were measured at each site. They were; dissolved oxygen, surface water temperature, electrical conductivity, pH, total dissolved solids (TDS) and turbidity/water colour. Water depth was measured at sites where it was possible. All sites were geo-referenced with a Global Positioning System (GPS, Model GPSmap 60Cx) and altitude was also read from the GPS.

7.2.3.1 Dissolved oxygen (mg/l)

Dissolved oxygen is a crucial requirement of all life in water. It is normally saturated in fast flowing rivers. It is however expected to drop with a reduction in river discharge and an increase in water temperature. Other human impacts such as pollution may alter the concentration of oxygen.

Dissolved oxygen was measured using an oxygen meter (Model 76390 YSI 95). This was measured both at the surface and the bottom where site depth was greater than 50 cm.

7.2.3.2 Electrical conductivity (μS cm^{-1})

This is a measure of the ability of water to conduct electricity. It varies with the level of human activities in the watershed and the nature of the underlying geology. It also varies with season being lower in the wet season and higher during the dry seasons. Conductivity and temperature were measured using a conductivity, salinity and temperature meter (Model 76244 YSI 30). Surface water temperature is influenced by other covariates such as the time of the day, the time of the year, and the air temperature at the time of measurement. Time of the day was therefore recorded wherever measurements were made.

7.2.3.3 pH

Is a standard measure of the hydrogen ion concentration of the water and is represented using a logarithmic scale. pH was measured using a digital pH meter (Model PHEP 5 TESTR)

7.2.3.4 Turbidity/water colour

This was assessed mainly based on the colour of the water and on whether it was possible to see the bottom of the lake or river. For example a river draining a wetland/papyrus swamp would have dark water that is not necessarily turbid whereas brown water would result in water bodies draining agricultural or urbanized watersheds.

7.2.3.5 Total dissolved solids (ppm)

Total dissolved solids which is a measure of suspended sediment was measured using a TDS Testr Low model, Oakton Instruments.

7.3 Results and discussion

There was variation in water quality parameters between the two wetland systems. The wetlands in the Bisina-Opeta complex were characterized by clearly shallow waters and high surface water temperature compared to the Nakivale Mburo system. Temperature ranged from 22.6 to 30.9 °C in the Bisina Opeta system while it ranged from 19 to 24.9 °C (see table 1). Temperature tended to be lower in sections of the wetlands with flowing water such as in the Sironko river (22.6 °C) draining into the Opeta wetland and in the Rwizi River (19 °C) draining into the Mburo-Nakivale system. Surface water temperature is influenced by other covariates such as the time of the day and the air temperature and accordingly water temperature tended to be lower in the morning than in the late afternoons at all sampled sites.

Electrical conductivity varied from 153.7 to 437.1 μS cm^{-1} in the Bisina Opeta system, the lowest value being recorded in river Sironko that drains into Lake Opeta. Conductivity was much higher in the Opeta system compared to Lake Bisina. Conductivity varied highly in the Mburo-Nakivale system ranging from 117.1 μS cm^{-1} in River Rwizi upstream to 1423.5 μS cm^{-1} at Kigaaga, a major inflow into Lake Nakivale. The Lake Nakivale waters were the most saline of all sampled sites. According to Beadle (1974), for most ecological purposes, except for very saline waters, conductivity reflects sufficiently closely the total concentration of the major ions and thus the salinity. Thus, it appears that Lakes Mburo and Nakivale drain catchments that differ in geology and therefore mineral composition with the result that Lake Mburo is less saline than Nakivale. Total dissolved solids (TDS) varied in a similar pattern as conductivity being highest in saline waters (900 ppm at Kigaaga) and lowest in

freshwater/riverine sites (lowest, 70ppm in River Rwizi Wetland). The progressive drop in TDS from upstream sites as the water flows through papyrus swamps shows that the wetlands are performing an important ecological function of sequestering ions from the water. The differences in conductivity and TDS between Nakivale and Mburo systems probably shows little or no hydrological connection between the two lakes or the dilution effect of the Rwizi waters on Lake Nakivale is negligible.

Dissolved oxygen was much lower in the Bisina- Opeta compared to the Mburo-Nakivale system. It ranged from 3.03 to 7.23 mg/l in the Bisina-Opeta and 6.3 to 9.9 mg/l in the Nakivale - Mburo system. The differences in dissolved oxygen might have important implications for the aquatic biota found in the two wetland systems. Thus productivity could be lower in the Bisina-Opeta system compared to the Nakivale-Mburo system. Casual observations on the fish catches on some landing sites of the two wetland systems showed that fish sizes were larger on the Mburo-Nakivale system than on the Bisina-Opeta.

Turbidity was estimated visually from the color of water. Generally waters of the Bisina-Opeta system were much clearer than that of Mburo-Nakivale which was mostly turbid ranging from dark to greenish colour. The dark colour of the Rwizi water may be attributed to the high concentrations of humic acids as a result of decomposition in the papyrus swamps and the fact that the river drains an agricultural watershed upstream. The greenish colour of Mburo-Nakivale waters is likely a result of high concentration of phytoplankton in the two lakes.

Cluster analysis (Fig 1) shows a clear separation of sites based on their physicochemical characteristics. Three major clusters were evident and they included the Bisina-Opeta complex, The Rwizi Mburo system that also clustered with the River Sironko site were characterized by low conductivity, low water temperatures and low TDS. The last cluster composed of Lake Nakivale sites and its tributary sites characterized by relatively high conductivity. The separation of sites/ wetland types based on the measured physicochemical parameters is proof that the variables can be used as indicators of wetland condition. That is, by measuring water quality, one is able to gauge the conservation status of a wetland as the variables are likely to change with wetland modification or degradation. Apart from anthropogenic impacts, the fundamental controls of background water quality are climate, geology, soils, topography and biota (Petts & Amoros 1996).

7.4 Conservation Implications

The water catchments of the two wetland systems are impacted to different levels by human activities. For example, River Sironko that drains into the Opeta system is highly turbid from agricultural activities implying that if conservation measures aimed at maintaining or improving water quality in the wetlands are to be implemented; these efforts should not be restricted to wetlands systems only but should also take into consideration the upstream sources of the water. The Mburo-Nakivale system catchment appears to be better conserved than the Bisina-Opeta system as the most of the shoreline has been converted to pastureland in the latter. Several fishermen talked to on both wetland systems reported receding water levels in the lakes. Thus, a timely intervention to reverse or slow down this negative trend is recommended especially with the threat of global warming. Further research in the areas of phisiacal and chemical nature of the water in both wetland systems is required such that concrete interventions can be sought.

Wetland	*Site name*	*DO (mg/l)*	*DO temp*	*TDS*	*Cond*	*cond temp*	*pH*	*Depth (cm)*	*Turbidity*	*Time*	*Northings*	*Eastings*	*Altitude*
Bisina	Akidye	3.84	26.9	175	285.5	26.9	7.1	130	Clear	morning	617420	180118	1043
Bisina	Kakor WFC	5.84	27.9	200	316	30	8.1	200	Clear	Noon	593886	184770	1041
Bisina	WFC end	7.17	30.7	205	321.13	30.9	-	167.5	Clear	afternoon	595908	187729	1040
Mburo	Rwizi-bridge	7.83	19	80	117.1	19	7.8	-	Dark	morning	237786	9931640	1391
Mburo	Kagogo	6.25	19.6	75	149.45	19.5	7.3	78	Dark	morning	264621	9923774	1263
Mburo	Rwizi-swamp	6.80	19.7	70	123.2	19.7	6.7	174	Darkbrown	morning	264739	9923837	1261
Mburo	lake edge	6.79	22.5	90	140.95	22.9	8.3	-	Dark	Noon	269182	9923527	1253
Mburo	mid-lake	8.19	22.8	90	144.6	23.05	7.8	-	Clear	afternoon	270304	9926948	1253
Nakivale	Kahirimbi	7.59	24.4	430	727	23.8	12.2	99	Greenish	Noon	261362	9909391	1249
Nakivale	Rukinga	9.9	23.7	420	678.5	24.9	12.5	190	Greenish	afternoon	266040	9912949	1245
Nakivale	Kashojwa	9.85	23.7	390	642	23.8	12.6	63	Greenish	afternoon	268269	9915900	1249
Nakivale	Kigaaga	9.63	20.8	900	1423.5	20.6	8.2	60	Clear	noon	260873	9922806	1266
Nakivale	Stream	8.61	24	360	598	24	7.5	10	Milky	afternoon	256051	9913666	1302
Opeta	Agule	3.03	27.02	285	437.1	27.3	-	67.5	Clear	morning	626815	184042	1046
Opeta	Sironko	7.23	22.6	90	153.7	22.6	-	60	Brown	noon	641104	152134	1063

Table 1 Mean water quality variables at the sampled sites. A – shows that variable was not measured at a site.

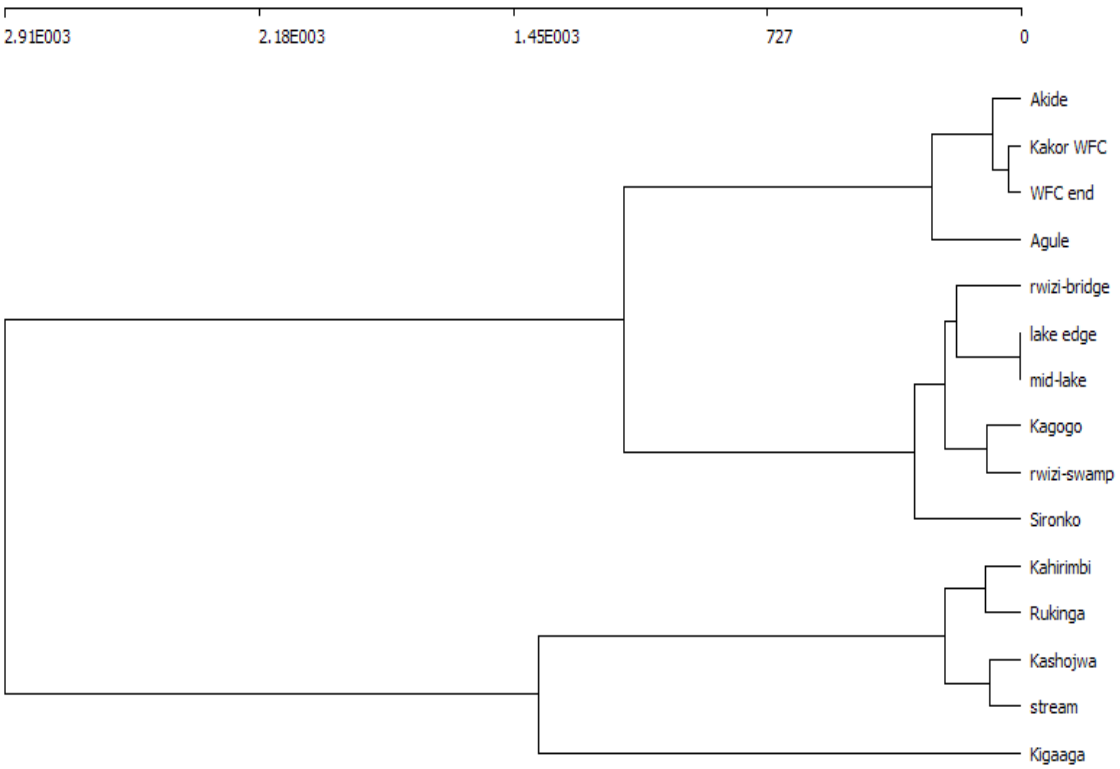

Figure 1 Dendrogram showing clustering of sites based on physicochemical variables. Sites that cluster together are similar in variables measured.

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