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Bujagali Hydropower Project, Uganda
Social and Environmental Assessment
Terms of Reference

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1.0 Introduction

1.1 Preface

Development of the Bujagali Hydropower Project (hereinafter "Project" or "HPP") was first initiated by AES Nile Power Ltd., (AESNP) in the late 1990's. Among other things, AESNP prepared Social and Environmental Assessment (SEA) documentation for the Project that was approved by the Government of Uganda's (GoU) National Environmental Management Authority (NEMA) in 1999/2001, and by the World Bank and African Development Bank Boards in December 2001. However, in 2003 AESNP withdrew from the Project. Subsequent to AESNP pullout, the GoU initiated an international bidding process for the development of the project, which was awarded to Bujagali Energy Ltd. (BEL), a project-specific partnership of Sithe Global Power (USA) and IPS Limited (Kenya).

The Board approvals by the lenders for AESNP's project, and the permits issued by NEMA to AESNP, are both no longer valid. Thus BEL will be required to prepare and submit for approvals new SEA documentation, The SEA documentation shall need to address the requirements of NEMA, the World Bank Group, and other lenders, including the African Development Bank (AfDB), the European Investment Bank (EIB), the Netherlands Development Finance Company (FMO), and others. Many of these entities have their own nomenclature for SEA documentation including "Environmental Impact Assessment", "Environmental Impact Statement" "Environmental and Social Impact assessment", and "Social and Environmental Assessment". For the purposes of this project the term Social and Environmental Assessment is considered to be synonymous with the different terms used by NEMA and the various lenders.

This document provides a draft Terms of Reference (ToR) to conduct the new SEA. The objective of this SEA draft ToR is that, when finalized, will serve as the basis for conducting an SEA process, and producing SEA documentation, for the Bujagali HPP that will comply with all of the GoU and international lender social and environmental legislation, regulations, and policies.

BEL has based its preparation of this draft ToR broadly on the guidance provided in "A Common Framework for Environmental Assessment – A Good Practice Note" (Multilateral Finance Institutions Working Group on Environment, 2005). For this SEA assignment, BEL has appointed a consulting team lead by R.J. Burnside International Limited of Canada (henceforth referred to as the "Consultant") to conduct and oversee, the SEA tasks proposed in this ToR, manage the SEA process on behalf of BEL, and author the SEA documentation to comply with GoU and international lender requirements. An organogram of the Consultant's proposed SEA team is provided in Figure 1.

1.2 Brief Project Description

The Bujagali HPP is a proposed 250 MW hydropower facility located on the Victoria Nile about 8 km downstream (north) of the Town of Jinja, in Uganda. The design for the HPP described herein has been taken from the design developed by Scott Wilson Piesold (2004) and that was used as the design basis for the bidding process completed by the GoU. If variations be required or proposed then these will be assessed accordingly.

The Power Station will include construction and operation of the following:

- A permanent access road from the Jinja/Kayunga state highway to the Power Station on the west bank;
- A 28 m tall dam extending across the Victoria Nile at Dumbbell Island that will create a 388 ha reservoir, approximately 80 ha of which will be newly inundated land and 308 ha of which is area currently inundated by the Victoria Nile. The HPP will utilize the same water that is used by the Kiira and Nalubaale hydropower facilities that are located upstream of the Bujagali HPP at Jinja. Any water that is released by those facilities will in turn be released by the Bujagali HPP;
- A spillway system;
- Intake and powerhouse structures to accommodate five Units comprising five water turbines, five generators, five generator unit transformers, power station auxiliary equipment and associated equipment;
- A substation and associated transmission equipment up to the Boundary;
- A paved two-lane vehicular service way that permits access for service and maintenance over the entirety of the dam works and over the spillway, intake and powerhouse structures and related equipment; and,
- A Control Room, relay rooms, telecommunications facilities, station services, battery room, standby diesel generator, workshop and storage facilities, office accommodation, operators facilities, and other necessary facilities for the operation and maintenance of the Power Station.

The design described in general above is very similar to the design that was proposed by AESNP. The key differences are as follows:

- Construction of the main spillway is now to the left (west) of Dumbbell Island;
- Construction of a siphon spillway is now to the right side (east side) of Dumbbell Island as opposed to over the powerhouse; and,
- Utilisation of earth core for the dam rather than an asphalt core.

Figure 2 provides general location mapping for the Bujagali HPP and Figure 3 illustrates the proposed project layout at the hydropower site.

In addition to the hydropower generation component of the Bujagali HPP, new and/or upgraded electrical transmission facilities will be necessary to evacuate the power from the Bujagali HPP to the Uganda system grid and load centres. The transmission facilities will be constructed, owned, and operated by the Uganda Electrical Transmission Company Limited (UECTL). UETCL has contracted BEL to assist with the development of the transmission facilities, the scope of which includes preparation of an SEA. A complementary ToR for the SEA work associated with the proposed transmission facilities accompanies this ToR for the HPP.

The transmission system as described above constitutes an "associated facility" for the Bujagali HPP based on the definition for a projects "Area of Influence" as defined in IFC's Performance Standard 1 (2006).

For the SEA documentation required for the Bujagali HPP, a detailed description of the project shall be provided so that all interested parties will know exactly what BEL is seeking approval for from NEMA and financing for from international lending institutions. The detailed description will include all project components directly required for, and ancillary to, the project, and this will be done for both the hydropower generation and electrical transmission components of the project. BEL will undertake this project description in consultation with the GoU, and the GoU's consultants, Scott Wilson Piesold of the United Kingdom, so that all relevant project components for the Bujagali HPP are identified in the SEA documentation.

1.3 Project Context

Uganda is currently experiencing a significant electricity shortage. All electricity customers in the country experience regular, rotating blackouts, locally referred to as "load shedding." The need for new sources of electricity to satisfy growing demand is acute. Whilst the demand for electricity in the country is steadily growing, the ability of the country's two major hydropower plants, the Nalubaale and Kiira power stations located on the Victoria Nile at Jinja, to meet the demand is decreasing, given the present low lake levels in Lake Victoria, upon which the Nalubaale and Kiira power stations rely. Uganda is also in discussions with Kenya and Tanzania for the development of an East African Power Pool to be shared and jointly managed by the three nations.

The SEA documentation will include a description of the need for the project, including an evaluation of other potential methods of electricity generation and management in the country to address Uganda's electricity deficit, including conservation measures and the null, or "do nothing," alternative. The SEA will also present information about the nature of the current and forecasted electricity deficit in Uganda. Additionally, the SEA will present information about other candidate hydropower development options for the country, as well as alternative hydropower development configurations at or near the Bujagali site. The intent of this exercise will be to provide the justification for the project's development, as proposed by BEL. Finally, the SEA will summarize published information about the role of the project within the East African Power Pool being considered between Uganda, Kenya and Tanzania.

1.4 Applicable Laws, Regulations and Policies to the Project

There are a number of legislative and regulatory instruments in Uganda dealing with environmental management in Uganda that are relevant to the Bujagali HPP SEA. The most important of these is the Constitution of the Republic of Uganda (1995), which is the supreme law in Uganda, but other relevant instruments are provided below. Those instruments that are new or have been updated and/or revised are asterisked:

- The National Environment Act, CAP. 153, and its Environmental Impact Assessment Regulations (1998), Waste Management Regulations (1999), Standards for Discharge of Effluent into Water or on Land Regulations (1999), Wetlands, Riverbanks, and Lake Shores Management Regulations (1999), Minimum Standards for Management of Soil Quality Regulations (2001)*, Noise Standards and Control Regulations (2003)*, and Conduct and Certification of Environmental Practitioners Regulations (2003)*;
- The Water Act, CAP. 152, and its Waste Discharge Regulations (1998), Water Supply Regulations (1999) and Sewerage Regulations (1999);
- The Rivers Act, CAP. 347;
- The Electricity Act, 1999;
- The Town and Country Planning Act, CAP 30;
- The Public Health Act;
- The Land Act (1998) and the Land Regulations, 2001*;
- The Factories Act, CAP 198;
- The Workers Compensation Act, 2000;
- The Investment Code, 1991;
- The Uganda Wildlife Act, CAP 2000;
- The National Wetlands Policy, 1995;
- The Traffic and Road Safety Act, 1998;
- The Fish Act, CAP 197 and the Fish (Beach Management) Rules, 2003*; and,
- The National Forestry and Tree Planting Act, 2003*.

In addition to the GoU requirements that will apply to the project, there are several major international lenders involved with the project, namely:

- The World Bank Group (IDA, IFC and MIGA) including specific reference to;
  - World Bank 'Safeguard' Policies;
  - World Bank Pollution, Prevention and Abatement Handbook (1998);
  - IFC 'Safeguard' Policies Policies and Performance Standards;
  - IFC's Environmental Guidelines for Electric Power Transmission; and, Distribution.
- The African Development Bank (AfDB) with specific reference to; and,
  - Integrated Environmental and Social Assessment Guidelines (IESA);

  - Environmental and Social Assessment Procedures for African Development Bank's Public Sector Operations (2001) and the Environmental Review Procedures for Private Sector Operations of the African Development Bank; and,
  - Policy on Resettlement and Involuntary Displacement (2004).
- The European Investment Bank (EIB).

Lenders and others that may be involved with the project's financing have their own environmental and social due diligence requirements. The SEA will address the relevant GoU legislation and standards and international lender, polices and guidelines that apply to the Bujagali HPP. Confirmation of these requirements with pertinent agencies, lenders and external stakeholders will serve as the basis for BEL's due diligence work on legislative, regulatory and policy compliance related to the project. BEL will conduct one SEA process and produce one SEA document for the Bujagali HPP that complies with all of the GoU and lender requirements. To achieve this, the Consultant will undertake a Concordance Analysis of the various requirements to demonstrate how each has been complied with. Additional relevant requirements will be incorporated as appropriate.

2.0 Key SEA Issues to be Addressed and Tasks to be Carried Out

Building on relevant work conducted to date, BEL shall prepare comprehensive SEA documentation designed to meet the environmental and social requirements of the GoU and all proposed multi-lateral, bi-lateral and international lenders and funders of the Bujagali HPP. The SEA will assess the Bujagali HPP and its associated facilities, including any 'legacy' issues or concerns attributable to the project in its previously proposed configuration. Public consultations will engage all potentially affected communities and will be designed with the objective of providing the information required to facilitate decision making about the status of broad community support for the project, as currently proposed. The SEA documentation will include, as necessary, work on project contextual issues such as alternatives to the project in terms of generation alternatives, conservation measures, and the "do nothing" alternative and alternative methods of carrying out the project cumulative effects, decommissioning, strategic implications, and regional-level impacts, including regional development and poverty alleviation.

The following sections outline the key issues to be addressed in the SEA and provide details on the proposed tasks and scope of work for each task that BEL proposes to address these key issues.

2.1 Hydrology

BEL shall also assess the Bujagali project in terms of its generation potential under existing and historic hydrological conditions, and in terms of the potential for the project to alleviate or exacerbate any hydrological issues in the downstream environment and upstream environments, including in Lake Victoria. For the purpose of these assessments, the Bujagali project shall be assessed both in terms of its effects on the baseline situation (Nalubaale and Kiira power stations operating), and cumulative effects in combination with feasible future hydropower developments, including the Karuma project, proposed approximately 200 km downstream. These assessments will be based upon a compilation of information from existing hydrological and power generation studies. Furthermore, maintenance of the "agreed curve" is a design component of the Bujagali project.

2.2 Bio-physical Environment

2.2.1 Fish Stocks and Baseline Information

The Ugandan Fisheries Resources Research Institute (FIRRI) carried out quarterly surveys of fish abundance and species composition on behalf of AESNP during 2000. These surveys included ancillary studies into the importance of the upper Victoria Nile fishery to local residents, for both subsistence and commercial purposes.

At the time of the 2000 surveys, it was recommended by lenders that additional baseline information be collected prior to the reservoir being filled. Furthermore, the hydrology of Lake Victoria and the Victoria Nile has changed since 2000 due to the drop in water levels, and there may have been changes in fish stocks in response to these or other environmental perturbations. In order to further investigate these issues, BEL shall carry out baseline surveys of fish stocks in the area of the Victoria Nile that is potentially affected by the project. The scope for these surveys shall be similar to the quarterly surveys that were carried out on behalf of the previous project sponsor (FIRRI, 2001), so that comparison of the new and former data sets can be undertaken readily. Transect surveys shall be carried out at one study site upstream of the proposed dam location (Kalange-Makwanzi) and three study sites downstream of the proposed dam location (Buyala-Kikubamutwe, Matumu-Kirindi and Namasagali-Bunyamira). The scope of the surveys shall include, but not be limited to:

- Water quality – *in situ* measurements of Secchi depth, dissolved oxygen, temperature, conductivity and pH; laboratory measurements of dissolved and total nutrients, suspended solids, algal biomass (chlorophyll *a*) and composition, oil/grease;
- Aquatic macrophytes – identification to species level, where possible, and quantification using the DAFOR system;
- Micro-invertebrates using conical Nansen nets; sediment macro-invertebrates using a ponar grab and invertebrates associated with macrophytes using sweep nets. Particular attention shall be paid to potential disease vectors, including *Bulinus* and *Biomphalaria* snails, *Anopheles* mosquito larvae, and *Simulium* flies;
- A single dry-season survey of potential disease vector habitat between the Nalubaale-Kiira power stations and Dumbbell Island, including sweep net sampling for vectors, including those named above;
- Fish species, distribution and abundance – using graded gillnets and beach seine nets. Biometric measurements to include size, weight, gut contents, fecundity;

- Fish catch survey (catch per unit effort), based on known number of canoes, gear sizes and fishing methods; and,
- Appropriate statistical comparison between sites and sampling occasions (2000 to present) using ANOVA or other techniques.

The survey will include the March-May 2006 'long-wet' season. A report shall be prepared for this survey, comparing the data with the corresponding survey from 2000 (FIRRI 2000b). If the results of this survey indicate substantive changes in fish stocks and fisheries livelihoods (see also Section 2.2.2 below), three further quarterly surveys shall be carried out to correspond with the three further surveys carried out in 2000: nominally in August and November 2006, and February 2007.

Digital versions of these reports shall be made available to stakeholders on request, but it must be recognised that not all reports will be available prior to completion of the SEA documentation for the project. For those reports completed after submission of the SEA documentation, BEL will build the results of the reports into the project's Environmental Action Plan (EAP) and reporting, as required (see Section 2.4.3).

Provision of a fish pass (also now as a fish ladder) was a requirement of the Certificate of Approval for Environmental Impact Assessment issued to AESNP for the previous project design. However subsequent studies by FIRRI indicated that the omission of the fish pass will not have a significant impact and that a fish ladder is not justified. As a result NEMA withdrew the requirement for a fish pass (Scott, Wilson Piesold, 2004).

2.2.2 Fisheries Livelihoods

With respect to aquatic ecology and fisheries in the River Nile and the proposed Bujagali reservoir, BEL shall assess fishing practices and livelihoods. In doing so, BEL will review the surveys that were undertaken on behalf of the earlier project sponsor and assess any significant changes. BEL will also propose any interventions that may be needed in response to the anticipated effects of the hydropower development, by means of socio-economic surveys of fishers in the project-affected area. Where appropriate, these surveys will include interfaces with Beach Management Committees (BMCs), which are provided for by the Fish Act and the Fish (Beach Management) Rules, 2003. The scope of the surveys shall include, but not be limited to:

- Community livelihood patterns, including the relative importance of fisheries compared to other livelihoods;
- Perceptions towards hydropower development;
- Training needs; and,
- Infrastructure needs (new fishing equipment, fish landing sites, boats).

Where a need is indicated by the socio-economic surveys, BEL shall revise the fisheries-related aspects of the Community Development Action Plan (CDAP), proposed for the hydropower component of the project's SEA (see Section 2.4.5), as appropriate.

2.2.3 Vector-borne Diseases

With respect to vector-borne diseases, BEL, in addition to the disease vector survey outlined in Section 2.2.1, shall assess the potential for the Bujagali impoundment to increase or decrease the incidence of vector-borne diseases. In so doing, BEL shall review the vector-borne disease surveys that were undertaken on behalf of the earlier project sponsor, and assess any significant changes, and liaise with relevant government officials, including the Vector Control Units (VCUs) of the Ministry of Health. Where the project is anticipated to cause adverse or positive impacts, such as increasing or decreasing vector habitats, respectively, appropriate mitigation or enhancement measures shall be devised and included in the EAP.

2.2.4 Terrestrial Ecology

With respect to terrestrial ecology of the riverbanks and the River Nile islands in the project-affected area, BEL shall carry out field surveys at a level of detail similar to that undertaken for the previous project sponsor in 1998-2001. This will enable a comparison of the two data sets so that BEL can assess any significant changes to the ecological baseline conditions of the project-affected area. The scope of these surveys shall include, but not be limited to:

- Transect surveys of plant species at five sites: Kikubamutwe, Malindi, Naminya, Bujagali camp site, and Namizi;
- Visual observations for terrestrial animals at above sites;
- Spot observations and timed-species counts for birds at four sites: Kikubamutwe, Namizi, Bujagali Camp and Kyabirwa Islands;
- A terrestrial assessment of plant and animal species on Dumbbell and the larger islands at Bujagali Falls that will be fully or partially inundated; and,
- Assessment of value of affected habitats and species.

BEL shall incorporate appropriate measures for avoidance and mitigation of adverse effects to identified features into the SEA's EAP. Where appropriate, these measures will be integrated into planned, off-site mitigation, compensation and enhancement activities in the Mabira Forest Central Forest Reserve and/or the so-called Kalagala-Itanda Offset[1].

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[1] As a compensation for the loss of the natural habitats at Bujagali Falls that would be inundated by the project reservoir, the GoU and IFC agreed in 2001 that the falls and natural habitats at the downstream Kalagala site would be protected in perpetuity and, where possible, enhanced.

An assessment of the impact of the project on the biophysical environment including the development of appropriate mitigation will be conducted. This will include for example an assessment of impacts on vegetation from the reservoir, impacts on water quality, risks of macrophyte development (water hyacinth) and impacts on future tourism developments. The SEA will also address the protection of the reservoirs banks and measures to reduce sedimentation in the reservoir (e.g., watershed management measures).

2.2.5 Construction-Related Issues

There are several issues associated with the construction of the Bujagali HPP that could potentially affect the biophysical and social environment, which BEL will assess. Examples of some of these issues are the mining of aggregate material required for the project, potential siltation of water bodies, the management of noise, dust and traffic issues associated with construction activities, a review of seismic vulnerability of the project, and an assessment of labour and health issues such as those resulting from an influx of people associated with construction camps. These issues will be assessed in detail by BEL so that the full scope of the proposed construction activities are understood and appropriate mitigation measures can be developed and built into the project EAP. Earlier work by the previous project sponsor and its engineering, procurement and construction (EPC) contractor on the identification and mitigation of these construction-related issues will also be reviewed.

2.3 Social Environment

2.3.1 Socio-economic Baseline Studies

BEL will undertake a socio-economic survey of the project-affected area at the hydropower site to characterize the socio-economic conditions and livelihoods of the people living in the eight project-affected communities. This will be done by reviewing the socio-economic baseline developed by the previous project sponsor around the proposed Bujagali hydropower site in late 1999 and early 2000 (ESG and WS Atkins, 2001a) and supplementing this information, where appropriate, with new survey data. BEL will also undertake a socio-economic and livelihood survey to monitor the current status of the previous Sponsor's resettlement activities (see details in Section 2.3.2, below). Information on the current status of public services in the project area will also be documented based on direct observations and interviews with local council representatives.

2.3.2 Resettlement and Compensation

Based on preliminary field observations and consultations with local leadership in project-affected villages and the Bujagali Implementation Unit (BIU), it appears that the previous project sponsor largely completed compensation and resettlement work at the hydropower site before its departure. As part of the SEA, however, BEL will verify this general observation by preparing a detailed monitoring of the status of those compensation and resettlement activities with commitments made in the earlier Resettlement and Community Development Action Plan (RCDAP). Should this monitoring identify outstanding issues or concerns, a corrective plan will be prepared by BEL in consultation with potentially involved stakeholders for subsequent implementation.

The monitoring activities proposed would include, but not necessarily be limited to the following:

- At the resettlement site at Naminya;
  - Check visually the structural soundness of resettlement housing and the quality and durability of construction; and,
  - Assess resettlers' satisfaction against the following criteria;
    - Site location and layout, house design, house construction;
    - Agricultural plots (fertility, size, assistance);
    - Public services (water, power, health and education);
    - Livelihood restoration (are they better or worse off?); and,
    - Check access of resettled people to ownership (actual delivery of title deeds) for the resettlement plots and houses.
- For the compensates;
  - Review and assess the compensation process and delivery of entitlements; and,
  - Review and assess compensation rates against the "full replacement value" requirements, and check whether those who were compensated for lost structures were able to rebuild similar buildings.
- Review livelihood restoration assistance and compare current livelihoods with those of the pre-compensation situation;
- Review the adequacy of the grievance mechanism process;
- Review the adequacy of vulnerable people support measures; and,
- Review the pending claims, and assess whether an amicable settlement is possible.

The monitoring shall be based on the following methods:

- Review all available monitoring reports of AESNP's that are maintained by BIU;
- Interview the BIU personnel in charge of monitoring resettlement and compensation;
- Interview local government representatives, particularly those at the LC3 and LC1 levels, in both Jinja and Mukono Districts;
- Visit resettlement site and assess physical resettlement infrastructure (both individual houses and public infrastructure); and,

- Conduct household interviews based on a questionnaire with the following sample2 totaling about 200 households;
  - All resettled households;
  - 50 percent of the other physically displaced households; and,
  - About 3 percent of the compensatees.

This survey will be used to assist in establishing the socio-economic baseline for the project-affected communities at the Bujagali hydropower site and to check the status of livelihood restoration and related commitments made in the 2001 RCDAP.

2.3.3 Cultural Properties Management and Status

BEL will review the Cultural Properties management work undertaken by the previous project sponsor, assess the adequacy and completeness of that work, and determine what further work needs to be undertaken. At the hydropower site, detailed archaeological investigations have already been undertaken for the project-affected area, compensation has been paid for people's shrines (*amasabo*) in the area and appeasement ceremonies have been undertaken to enable the relocation of the Bujagali spirits. However, it is important to corroborate if people who live in the project-affected area believe that the Cultural Properties management work undertaken by the previous project sponsor is truly complete. Accordingly, BEL commits to detailed consultation with locally affected communities on their observations and opinions on this issue, with follow-up and a revised Cultural Properties Management Plan, as necessary.

2.3.4 Broad Community Support

Certain lenders to the Bujagali HPP have an expectation that a "broad community support" decision can be made on the project before they decide to participate in the financing of the project. According to IFC, as one example:

> *Broad Community Support is a collection of expressions by the affected communities, through individuals or their recognized representatives, in support of the project.*

BEL commits to consultation with the lenders and other stakeholders, as appropriate; in order to provide the information it reasonably can to assist the lenders in their "broad community support" decision-making through the Bujagali HPP SEA process and documentation.

[2] The sample will be stratified by communities and otherwise randomly selected.

2.3.5 Tourism

BEL will assess current tourism activities in the project-affected area and what impacts the Bujagali HPP may have on tourism. The scope of the proposed tourism impact assessment work is as follows, the results from which will be documented in the final SEA report and Tourism Action Plan, as appropriate:

- Consult with all appropriate central government and local government authorities and tourism operators and their association(s) to determine the present status of tourism in the proposed hydropower development area;
- Assess the potential impacts of the Bujagali HPP on tourism in the hydropower development area, including any effects on the white water rafting (WWR) industry;
- Advise on potential measures to mitigate the effects to WWR and other tourist amenities at the hydropower site and propose alternative tourist development scenarios and/or facilities that could be developed on or adjacent to the proposed reservoir. This will include an assessment of tourism opportunities that can be promoted and developed at the "Kalagala Offset" site downstream; and,
- Consult with tourism operators and their association(s) and local communities and their leadership (LC1, LC3, and LC5 levels) on tourism impact mitigation measures and alternative tourism development strategies and how they can be involved in delivering future tourism services (e.g., accommodation, activities).

2.3.6 Dam Safety

BEL will re-assess the Dam Safety review that was commissioned by AESNP in 2000, to include an assessment against current ICOLD and International Hydropower Association guidelines. The Dam Safety Review will be updated as required to comply with these guidelines, and will include a Dam Safety Panel, as well. The SEA will describe the findings of the assessment, and set out the proposed framework for ongoing dam safety review and implementation during construction and operation of the Bujagali hydropower facility.

2.4 Preparation of Plans to Disclose SEA Details and Address Impacts

For each of the biophysical and socio-economic remits of work for the Bujagali hydropower site, described above, the assessment of effects will need to be categorized into short-term vs. long-term effects, construction versus operation effects, irreversible versus mitigable effects, and project-specific versus potentially cumulative effects. BEL will undertake this exercise of impact identification and assessment such that appropriate environmental and social action plans can be developed to address these effects spatially and temporally. Each of the plans developed will include anticipated cash flow requirements, implementation schedules and monitoring/mitigation roles, responsibilities and requirements for capacity building, where necessary. At present the various action plans are envisioned as stand-alone documents with cross referencing as appropriate.

2.4.1 Public Consultation and Disclosure Plan (PCDP)

The development and implementation of a Public Consultation and Disclosure Plan (PCDP) is a WB/IFC requirement for a "Category A" project such as the Bujagali HPP. WBG/IFC requirements have traditionally included a consultation process with two successive phases:

- Once the ToRs are available in draft form and before they are finalized, to obtain stakeholders' inputs on the ToRs themselves, and particularly to check that no issue of concern to stakeholders has been omitted in the SEA scope of work; and,
- Once when the draft SEA is available, and before it is finalized, to obtain stakeholders' inputs on the SEA conclusions, and particularly on the mitigation and action plans (e.g., the EAP and Resettlement Action Plan).

Project sponsors are generally expected to provide relevant material in a timely manner prior to consultation and in a form and language that are understandable and accessible to the groups being consulted, including:

- A summary of the proposed project's objectives, description, and potential impacts for the initial consultation; and,
- A summary of the SEA's conclusions for consultation after the draft SEA report is prepared.

For the Bujagali HPP SEA, BEL will make the draft SEA report available at a public place accessible to project-affected groups and local NGOs. In addition, environmental information will be available through the World Bank InfoShop for a disclosure period of no less than 60 days (IFC) and 120 days (IDA) before Board dates.

Should the Bujagali HPP have ongoing resettlement issues, the appropriate Resettlement Action Plan (RAP) documentation will also be submitted for public consultation by BEL, in coordination with the SEA-related consultation effort.

For the Bujagali HPP SEA, BEL shall abide by the above-noted PCDP requirements and, in addition, shall include the following details in its PCDP:

- Brief introduction, including a short description of the Project;
- Review of the legal context related with public consultation (both in-country and international requirements) for the SEA;
- Review of previous public consultation and disclosure related to the project, including a summary of the issues discussed;
- Identification and description of stakeholders in the Project (affected and impacted villages – village leaders and the general population, relevant Government authorities at local, regional and federal level, civil society organizations, including NGOs, village leaders, fishermen, international stakeholders);
- Identification of key issues and concerns identified by stakeholders;
- Development of the community engagement strategy and action plan for the whole project life (development, construction, operation), including communication methods applicable to each identified target group, detailed scheduling of activities during the SEA phase, resources and implementation arrangements (personnel, community information centre, etc.);
- Development of the public disclosure strategy at local, regional, national, and international levels, including the use of a web site and other means of disseminating information;
- Development of a grievance management mechanism; and,
- Implementation details, responsibilities, and schedule.

Close liaison with local authorities (LC5, LC3 and LC1) will be maintained for the development and implementation of public consultation activities.

The PCDP will be developed early in the process, and will be submitted to NEMA so that any specific requirements of the Ugandan EIA regulations are included in the draft final version of the PCDP.

2.4.2 Management Program

A Management Program will be developed which will set out the framework by which the Environmental management activities set out in the Environmental Action Plan (see Section 2.4.3) will be implemented. This will consist of an organizational structure and a framework for associated operational policies, procedures and practices.

2.4.3 Environmental Action Plan (EAP)

As part of the Bujagali HPP SEA, BEL shall prepare an Environmental Action Plan (EAP), consistent with the requirements of NEMA, and with IFC's Performance Standard 1: Social & Environmental Assessment and Management System. This Action Plan will include measures to avoid, prevent, reduce, mitigate, remedy or compensate any adverse effects on the environment in relation to the construction and operation of the Bujagali HPP.

The EAP will include, but not be limited to, outlines for the following component plans:

- Traffic Management Plan;
- Dust Management Plan;
- Waste Management Plan;
- Staff Training Plan;
- Pollutant Spill Contingency Plan;
- Emergency Response Plan;
- Monitoring Plan;
- Reporting and Change Management Plan; and,
- Health & Safety Management Plan.

It is recognized that the EPC contractor to be retained by BEL, as the party that will be responsible for the majority of day-to-day implementation of the EAP, may wish to amend the EAPs or its component plans before or during their implementation. Hence, provisions for a Change Management Plan within the EAP will be included.

2.4.4 Social Action Plan (SAP)

BEL shall prepare a Social Action Plan (a sub-plan of the general project EAP), which will be developed to address mitigation of potentially negative social impacts associated with the project and enhancement of positive impacts. In practice; it may include, but is not limited to, the following issues:

- Non-discrimination and Equal Rights Issues, as applicable;
- Employment issues, including labour rights and applicable human resources policies and procedures, which will be consistent with IFC Performance Standard 2 (Labor and Working Conditions) and the various International Labour Organization Conventions cited therein;
- Workers' accommodation;
- Benefits accruing to local communities (e.g., catering and other activities);
- Local governance;
- Vulnerable groups (e.g., elderly and disabled) within affected communities;
- HIV/AIDS prevention and other health-related issues;
- Gender-related impacts;

- Impeded access; and,
- Monitoring and community liaison at construction and operation phases.

The Social Action Plan (SAP) will be based on the same general format as the Environmental Action Plan, described in Section 2.4.3, above.

2.4.5 Community Development Action Plan (CDAP)

BEL proposes to develop a Community Development Action Plan (CDAP) for the eight project-affected villages around the Bujagali HPP site. This CDAP will focus on economic development and poverty alleviation activities in these communities in such potential sectors as health, education, water supply, electricity provision and micro-finance. BEL will review the CDAP undertaken by the previous project sponsor, assess its adequacy and completeness in consultation with appropriate stakeholders, and determine what further work needs to be undertaken. BEL will also reflect upon the current socio-economic conditions of the project-affected villages and best practice in the development and implementation of CDAPs. For its CDAP, BEL will:

- Detail the economic development and poverty alleviation activities proposed, reflecting new realities at the hydropower site (such as those related with alternative tourism development and community-based fisheries management); and,
- Make a clear distinction between "quick-impact" activities, predominantly for the pre-construction and construction phase (i.e., activities which can deliver quick, meaningful developmental impacts in project-affected communities), and the longer term developmental activities to accompany the operational phase of the project, which will require further consultations with the beneficiary communities and better integration with the GoU's developmental priorities for the area.

In addition, stakeholder involvement in planning and implementing community development activities will be a cornerstone of BEL's CDAP approach, ultimately leading to the creation of a specific vehicle associating BEL and local stakeholders around common developmental objectives.

The CDAP will be a "stand-alone" document, and shall include the following sections:

- General socio-economic background of the area;
- Development planning for the area and development priorities;
- Definition and justification of the CDAP area;
- Consultation on development priorities with Government agencies, Local Councils and representatives of the interested communities;
- Quick-impact activities;
- Longer-term activities;

- Implementation mechanisms, including the potential establishment of a specific, multi-stakeholder vehicle; and,
- Implementation schedule.

2.4.6 Resettlement Corrective Plan (RCP)

As noted in Section 2.3.2, BEL shall prepare a Resettlement Corrective Plan if issues or concerns associated with earlier RCDAP commitments and WBG policies are identified. This will be based on the results of the monitoring studies being undertaken, and will be prepared on an as-required basis.

2.5 Transmission System

As noted above, a complementary ToR is provided for SEA studies proposed for the transmission system that will evacuate electricity from the Bujagali HPP and is an associated facility to it.

3.0 SEA Institutional Arrangements

3.1 Institutional Arrangements for the Preparation and Review of the SEA

As noted in Section 1.1, the Consultant will conduct the SEA process and prepare the SEA documentation for both the transmission system facilities and the HPP. The Consultant will also undertake the public consultation and disclosure activities for the project, as described in Section 2.4.1 of this ToR.

In Uganda, NEMA will coordinate the review of both the ToRs for the SEAs, as well as the SEAs themselves, soliciting review inputs in each case from "lead agency" reviewers, such as DWD, the National Forestry Authority and the Uganda Wildlife Authority. The Executive Director of NEMA has the discretion to require a public hearing for the project before a decision on whether to approve it is made and it is NEMA that, ultimately, has the authority to issue a Certificate of Approval for the project in Uganda.

For civil society and broader public consultation procedural requirements, there are the two points of public consultation and disclosure, as described in Section 2.4.1 of this ToR. Additional public engagement and consultation activities in the project-affected communities are also planned, as detailed in Chapter 2 of this ToR and in the accompanying PCDP.

A Panel of Experts will be established and receive advice from independent environmental and social specialists who would review the Bujagali project. This Panel of Experts will visit the project site and report on its observations and public and agency consultation activities and make recommendations on how the Bujagali project should proceed. These documents will be made publicly available. The Panel of Experts will consult with a broad cross-section of stakeholders regarding the Bujagali project, reviewing environmental and social issues related to both the transmission and hydropower generation components of the project.

4.0 References

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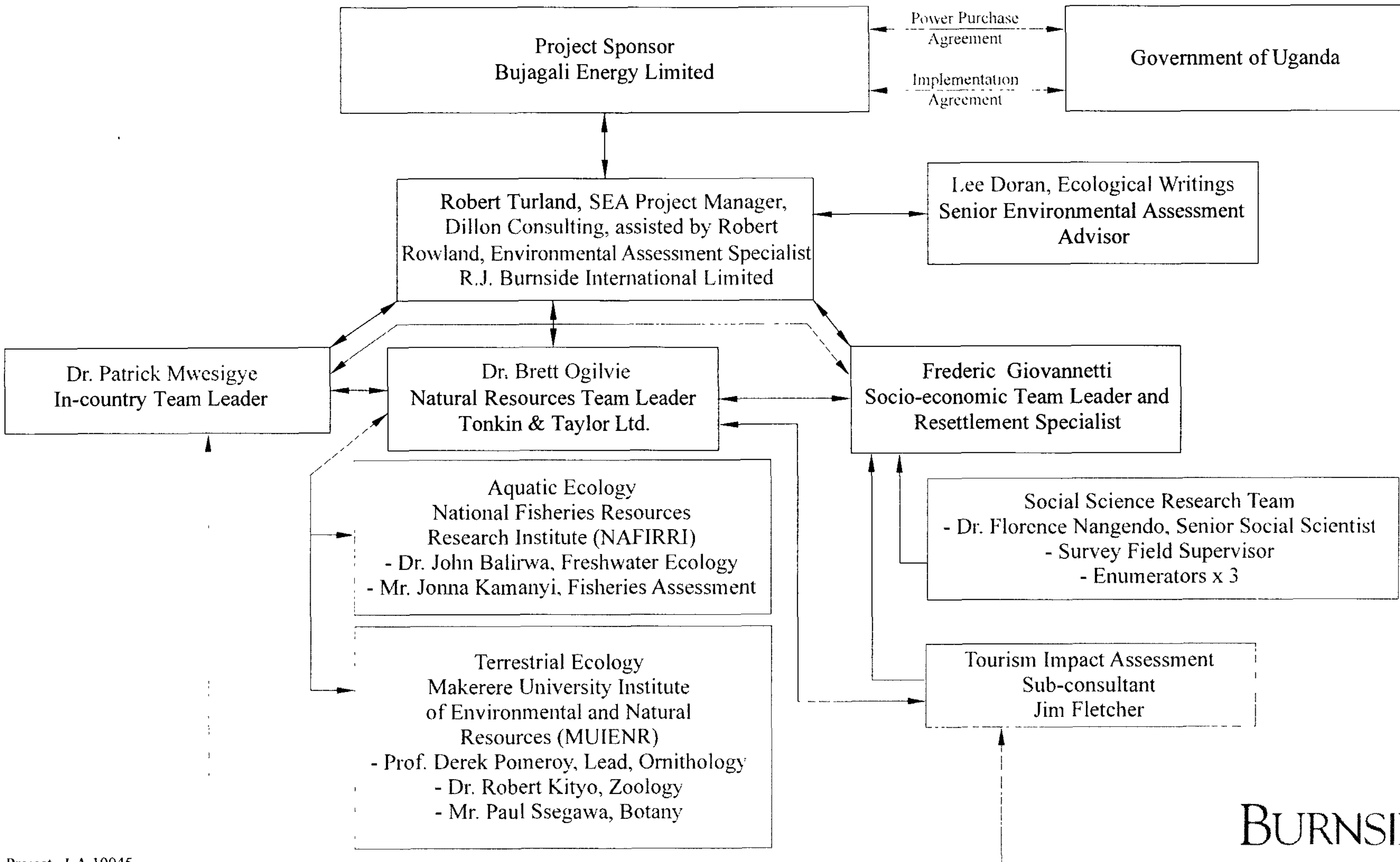
BURNSIDE

Figures

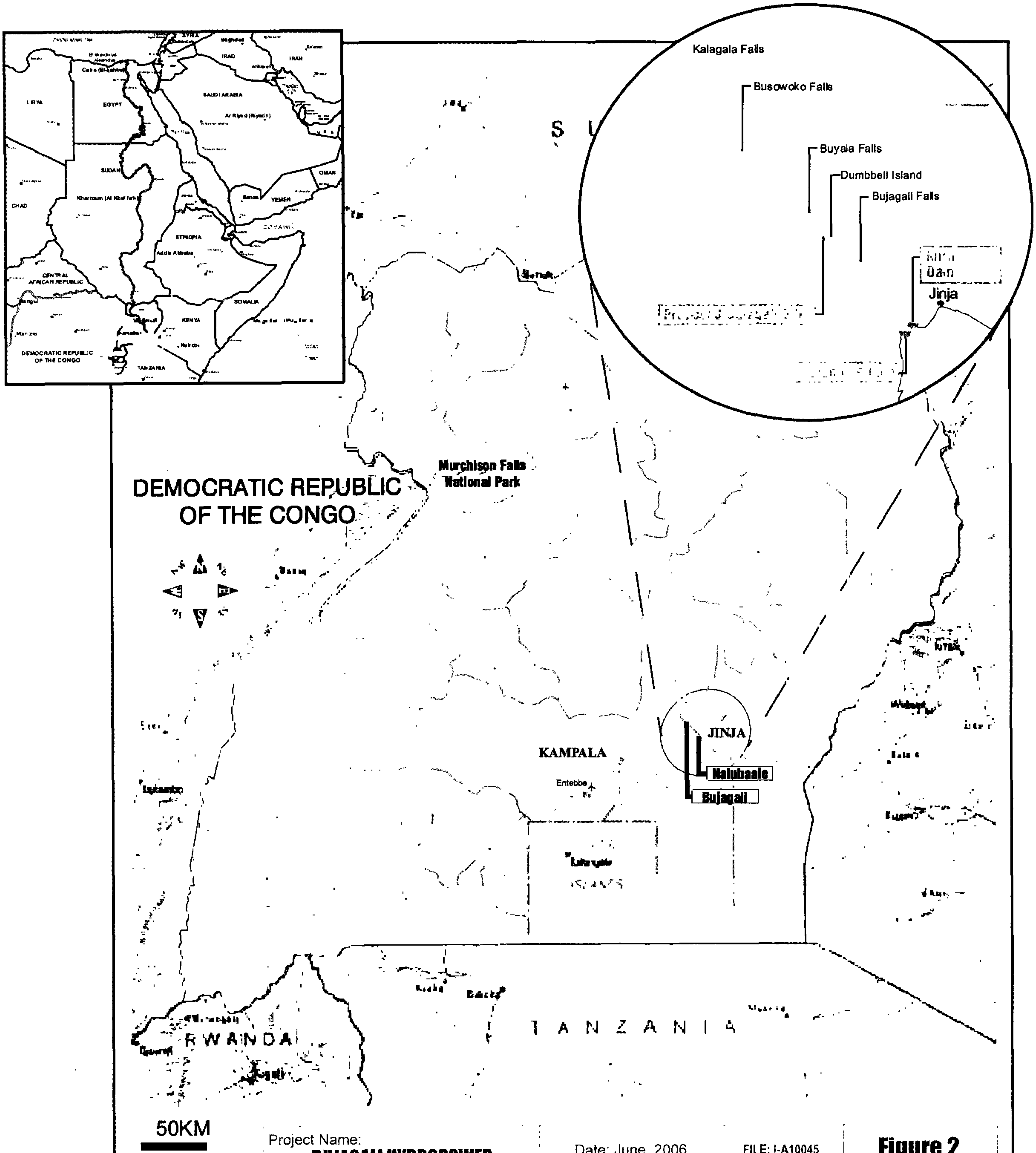
SEA TEAM REPORTING STRUCTURE
BUJAGALI HYDROPOWER PROJECT, UGANDA

FIGURE 1



BURNSIDE

Project I-A 10045



Project Name:
BUJAGALI HYDROPOWER PROJECT SEA

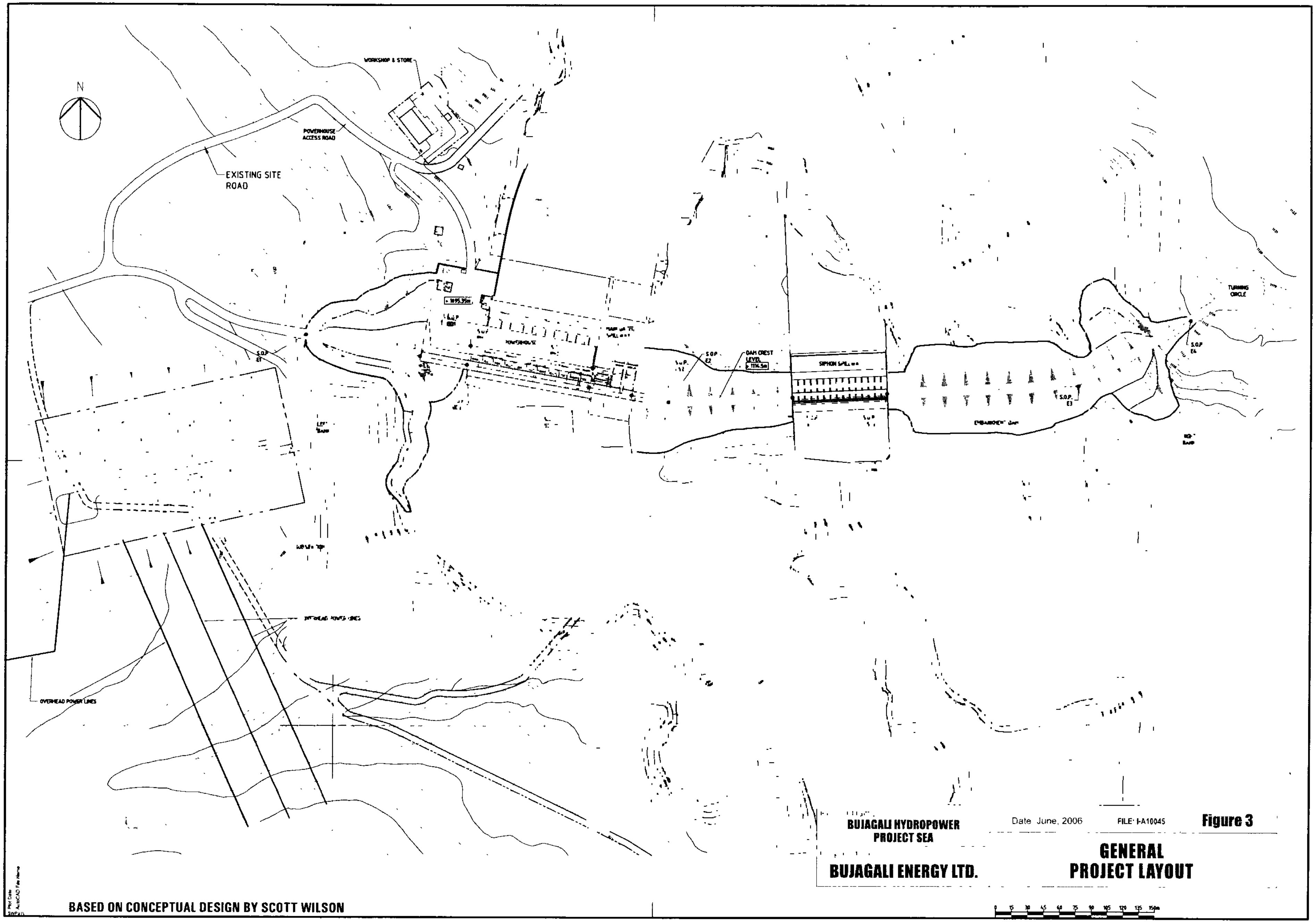
Prepared for:
BUJAGALI ENERGY LTD.

Date: June, 2006

FILE: I-A10045

Figure 2

LOCATION OF THE BUJAGALI PROJECT


N
WORKSHOP & STORE
POWERHOUSE ACCESS ROAD
EXISTING SITE ROAD
POWERHOUSE
DAM CREST LEVEL
TURNING CIRCLE
OVERHEAD POWER LINES
BUJAGALI HYDROPOWER PROJECT SEA
BUJAGALI ENERGY LTD.
Date June, 2006
FILE: I-A10045
Figure 3
GENERAL PROJECT LAYOUT
BASED ON CONCEPTUAL DESIGN BY SCOTT WILSON

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Appendix A.2
SEA Team Registration

COMMITTEE OF ENVIRONMENTAL PRACTITIONERS

REPUBLIC OF UGANDA

ENVIRONMENTAL PRACTITIONERS' CERTIFICATE

Certificate No. CC/EIA/034/06

Patrick Mwesigye

EICU P.O. BOX 20032 KAMPALA, TEL: 041-287938 / 0772 482057

Email:pmwesigye@ucpc.co.ug

10th *April* *06*

An Environment Impact Assessor

Waste Management; Cleaner Production/Pollution Prevention; Industrial Chemistry; Environmental Management.

- The practitioner shall practice as a **TEAM LEADER** of an Environmental Impact Assessment team.

31 December

COMMITTEE OF ENVIRONMENTAL PRACTITIONERS

REPUBLIC OF UGANDA

CERTIFIED FOREIGN ENVIRONMENTAL PRACTITIONERS

Certificate No. CC / F002 / 06

Mr. Robert S. Surland

DILLON CONSULTING CO., 5 CHERRY BLOSSOM ROAD, CAMBRIDGE, ONTARIO, CANADA

03rd *October* *06*

An Environment Impact Assessor

Thermal and Hydro Power Projects, Electrical Transmission Lines, Mines, Landfills; and Roads.

Ugandan Registered Env. Practitioner Team Member(s)

Dr. Partick Mwesigye
Enviro and Industrial Consult (U) Ltd., P.O. Box 20032 Kampala
Tel: 256 - 77-2482057Email:pmwesigye@ucpc.co.ug

- Certificate is valid for the Bujagali Hydropower Project only.

3rd October 07

Registrar

Chairman

COMMITTEE OF ENVIRONMENTAL PRACTITIONERS

REPUBLIC OF UGANDA

CERTIFIED FOREIGN ENVIRONMENTAL PRACTITIONERS

Certificate No. CC / F003 / 06

Mr. Brett Ogilvie

TONKIN & TAYLOR INTERNATIONAL, 19 MORGAN ST, NEWMARKET,

AUCKLAND, NEW ZEALAND

03rd *October* *06*

An Environment Impact Assessor

Hydro Power Projects; and, Aquatic and Terrestrial Ecology

Ugandan Registered Env. Practitioner Team Member(s)

Dr. Partick Mwesigye
Enviro and Industrial Consult (U) Ltd., P.O. Box 20032 Kampala
Tel: 256 - 77 - 2482057 Email:pmwesigye@ucpc.co.ug

- Certificate is valid for the Bujagali Hydropower Project only.

3rd October 07

Registrar

Chairman

REPUBLIC OF UGANDA

CERTIFIED FOREIGN ENVIRONMENTAL PRACTITIONERS

Certificate No. CC / F001 / 06

Mr. Fredric D. Giovannetti

6, RUE FRANCOIS-MAURIAC F-84000 AVIGNON FRANCE

TEL: 33-6-10-833855 Email:FredGiovannetti@aol.com

3rd *October* *06*

An Environment Impact Assessor

Resettlement and Rehabilitation, Environmental and Social Impact Assessments; and, Water Supply and Community Development.

Ugandan Registered Env. Practitioner Team Member(s)

Dr. Partick Mwesigye
Enviro and Industrial Consult (U) Ltd., P.O. Box 20032 Kampala
Tel: 256 - 77 - 2482057 Email:pmwesigye@ucpc.co.ug

- Certificate is valid for the Bujagali Hydropower Project only.

on the 3rd October 07

Registrar

Chairman

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Appendix B.2
Letter of No Objection from the Government of Egypt

65 Road 10, Maadi
Cairo, Egypt
Tel 3802514 3802489 Fax 3802504
... .link.net

Our Ref. :
Your Ref.

C. 81

The Embassy of the Republic of Uganda in Egypt presents its compliments to the Ministry of Foreign Affairs, Africa Department, and has the honour to request the esteemed Ministry for the response from the Government of the Arab Republic of Egypt on Uganda's request for renewal of Egypt's no objection to the development of Bujagali Hydro Electrical Project, as well as Egypt's no-objection to Uganda's development of the Karuma Project.

The Embassy of the Republic of Uganda avails itself of this opportunity to renew to the Ministry of Foreign Affairs, Africa Department, the assurances of its highest consideration.

Cairo, 3rd May, 2006

The Ministry of Foreign Affairs,
Africa Department,
Cairo.

Ministry of Foreign Affairs
Assistant Minister of Foreign Affairs
for African Affairs

Our Ref: 61

The Ministry of Foreign Affairs of the Arab Republic of Egypt (the Assistant Minister of Foreign Affairs for African Affairs) presents its compliments to the Embassy of the Republic of Uganda, and with reference to the latter's note no. C.81 dated 4/5/2006 concerning Uganda's request for the renewal of Egypt's no-objection to the development of Bujagali Hydro Electrical Project, as well as Egypt's no-objection to Uganda's development of the Karuma Project.

We would like to inform that the Egyptian competent authorities have no-objection concerning the development of Bujagali Hydro Electrical Project and the Karuma Project taking into account that the two stations do not affect Egypt's water shares from the river Nile -in accordance to the relevant existing agreements in this regards ;and on condition that these stations will be used for Hydro Electrical power uses only, and will not have any adverse environmental or strategic effects.

The Ministry avails itself of this opportunity to renew to the esteemed Embassy of the Republic of Uganda the assurances of its highest consideration.

Cairo,16/05/2006

The Embassy of the Republic of Uganda,
Cairo.

BURNSIDE

Appendix B.3
Notices to Riparian Countries

,ams: EXTERIOR, KAMPALA
phone 233922
.x: 341981
Website: www.mofa.go.ug
E-mail mofauganda@yahoo.com

THE REPUBLIC OF UGANDA

Office of the Minister
Ministry of Foreign Affairs,
P.O. Box 7048,
KAMPALA,
Uganda.

In any correspondence on this subject please quote No. MFA/MISC/11

11 September 2006

Hon. Dr. Lam Akol Ajawin
Minister of Foreign Affairs
KHARTOUM
Sudan

Honourable Minister,

The Government of Uganda (GOU) and her Parastatal, Uganda Electricity Transmission Company Limited (UETCL) are currently finalizing the documents for development of a 250 MW hydroelectric facility (Bujagali) on the Nile River near Bujagali Falls in Uganda. Bujagali will be developed as an independent power project by a consortium led by Industrial Promotion Services (IPS) of Kenya. Scott Wilson Piesold of United Kingdom on behalf of GOU has made the project designs.

Lake Victoria is controlled by the Owen Falls Hydroelectric facility (Kiira and Nalubaale) operated by Eskom Uganda Ltd. Eskom as a matter of practice releases water from the facility in accordance with the "agreed curve". The Bujagali documents, in turn require IPS to construct, and then operate, Bujagali facility preserving the water flows at all times within the "agreed curve". Scott Wilson Piesold has advised GOU that normal construction procedures, including river diversion and reservoir impoundment, will be done in a manner that maintains the water flows required by the "agreed curve" at all times. Because of the small reservoir, Bujagali effectively operates as a "run of the river" facility.

Attached, you will find (i) a map showing the exact location of the facility, (ii) design drawings of the dam and the powerhouse and (iii) technical specifications of the dam, powerhouse and the reservoir. Although no further action or approval is required on your part, we would be pleased to respond to any inquiries that you might have about this important project.

Please accept, Honourable Minister, the assurances of highest consideration and esteem.

Isaac I. Musumba (MP)
Minister of State for Foreign Affairs (Regional Cooperation) also holding the Portfolio of Minister of Foreign Affairs

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Office of the Minister
Ministry of Foreign Affairs,
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KAMPALA,
Uganda.

In any correspondence on this subject please quote No. MFA/MISC/11

11 September 2006

Hon. Dr. Asha Rose Mtengeti Migiro
Minister of Foreign Affairs
DAR-ES-SALAAM
Tanzania

Honourable Minister.

The Government of Uganda (GOU) and her Parastatal, Uganda Electricity Transmission Company Limited (UETCL) are currently finalizing the documents for development of a 250 MW hydroelectric facility (Bujagali) on the Nile River near Bujagali Falls in Uganda Bujagali will be developed as an independent power project by a consortium led by Industrial Promotion Services (IPS) of Kenya. Scott Wilson Piesold of United Kingdom on behalf of GOU has made the project designs

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KAMPALA,
Uganda.

In any correspondence on this subject please quote No. MFA/MISC/11

11 September 2006

Hon. Raymond Tawazani Baya
Minister of Foreign Affairs
KINSHASHA
Democratic Republic of Congo

Honourable Minister,

The Government of Uganda (GOU) and her Parastatal, Uganda Electricity Transmission Company Limited (UETCL) are currently finalizing the documents for development of a 250 MW hydroelectric facility (Bujagali) on the Nile River near Bujagali Falls in Uganda. Bujagali will be developed as an independent power project by a consortium led by Industrial Promotion Services (IPS) of Kenya. Scott Wilson Piesold of United Kingdom on behalf of GOU has made the project designs.

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P.O. Box 7048,
KAMPALA,
Uganda.

In any correspondence on this subject please quote No. MFA/MISC/11

11 September 2006

Hon. Charles Murigande
Minister of Foreign Affairs
KIGALI
Rwanda

Honourable Minister,

The Government of Uganda (GOU) and her Parastatal, Uganda Electricity Transmission Company Limited (UETCL) are currently finalizing the documents for development of a 250 MW hydroelectric facility (Bujagali) on the Nile River near Bujagali Falls in Uganda. Bujagali will be developed as an independent power project by a consortium led by Industrial Promotion Services (IPS) of Kenya. Scott Wilson Piesold of United Kingdom on behalf of GOU has made the project designs.

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Ministry of Foreign Affai
P.O. Box 7048,
KAMPALA,
Uganda.

In any correspondence on this subject please quote No. MFA/MISC/11

11 September 2006

Hon. Ato Seyoum Mesfin
Minister of Foreign Affairs
ADDIS ABABA
Ethiopia

Honourable Minister,

The Government of Uganda (GOU) and her Parastatal, Uganda Electricity Transmission Company Limited (UETCL) are currently finalizing the documents for development of a 250 MW hydroelectric facility (Bujagali) on the Nile River near Bujagali Falls in Uganda. Bujagali will be developed as an independent power project by a consortium led by Industrial Promotion Services (IPS) of Kenya. Scott Wilson Piesold of United Kingdom on behalf of GOU has made the project designs.

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Isaac I. Musumba (MP)
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Uganda.

In any correspondence on this subject please quote No. MFA/MISC/11

11 September 2006

Hon. Raphael Tuju, EGH, MP
Minister of Foreign Affairs
NAIROBI
Kenya

Honourable Minister,

The Government of Uganda (GOU) and her Parastatal, Uganda Electricity Transmission Company Limited (UETCL) are currently finalizing the documents for development of a 250 MW hydroelectric facility (Bujagali) on the Nile River near Bujagali Falls in Uganda. Bujagali will be developed as an independent power project by a consortium led by Industrial Promotion Services (IPS) of Kenya. Scott Wilson Piesold of United Kingdom on behalf of GOU has made the project designs.

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Uganda.

In any correspondence on this subject please quote No. MFA/MISC/11

11 September 2006

Hon. Antoinette Batumubwira
Minister of Foreign Affairs
BUJUMBURA
Burundi

Honourable Minister,

The Government of Uganda (GOU) and her Parastatal, Uganda Electricity Transmission Company Limited (UETCL) are currently finalizing the documents for development of a 250 MW hydroelectric facility (Bujagali) on the Nile River near Bujagali Falls in Uganda Bujagali will be developed as an independent power project by a consortium led by Industrial Promotion Services (IPS) of Kenya. Scott Wilson Piesold of United Kingdom on behalf of GOU has made the project designs.

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THE REPUBLIC OF UGANDA

Office of the Minister
Ministry of Foreign Affairs,
P.O. Box 7048,
KAMPALA,
Uganda.

In any correspondence on this subject please quote No MFA/MISC/11

11 September 200[illegible]

Hon. Ali Said Abdella
Minister of Foreign Affairs
ASMARA
Eritrea

Honourable Minister,

The Government of Uganda (GOU) and her Parastatal, Uganda Electricity Transmission Company Limited (UETCL) are currently finalizing the documents for development of a 250 MW hydroelectric facility (Bujagali) on the Nile River near Bujagali Falls in Uganda. Bujagali will be developed as an independent power project by a consortium led by Industrial Promotion Services (IPS) of Kenya. Scott Wilson Piesold of United Kingdom on behalf of GOU has made the project designs.

Lake Victoria is controlled by the Owen Falls Hydroelectric facility (Kiira and Nalubaale) operated by Eskom Uganda Ltd. Eskom as a matter of practice releases water from the facility in accordance with the "agreed curve". The Bujagali documents in turn require IPS to construct, and then operate Bujagali facility preserving the water flows at all times within the "agreed curve". Scott Wilson Piesold has advised GOU that normal construction procedures, including river diversion and reservoir impoundment will be done in a manner that maintains the water flows required by the "agreed curve" at all times. Because of its small reservoir Bujagali effectively operates as a "run of the river" facility.

Attached, you will find (i) a map showing the exact location of the facility, (ii) design drawings of the dam and the powerhouse and (iii) technical specifications of the dam, powerhouse and the reservoir. Although no further action or approval is required on your part, we would be pleased to respond to any enquiries that you might have about this important project.

Please accept Honourable Minister, the assurances of highest consideration and esteem.

Isaac I. Musumba (MP)
Minister of State for Foreign Affairs (Regional Cooperation) also holding the Portfolio of Minister of Foreign Affairs

BURNSIDE

Appendix C.1
Fisheries Report

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) OF THE BUJAGALI HYDROPOWER PROJECT (BHPP), UGANDA FISHERIES COMPONENT

The First Quarter Survey of the Aquatic System and Fisheries of the Upper Victoria Nile, 6^{th} – 13^{th} April 2006

A Report Prepared For R.J. Burnside International Limited

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Executive Summary

In pursuit of developing a 250MW hydropower plant on the Upper Victoria Nile in Uganda, the EIA recommends collection of baseline data prior, during and post plant construction. In 2000, AES Nilepower commissioned an Aquatic and Fisheries Survey of the Upper Victoria Nile to identify potential impacts upstream and downstream of the project site at Dumbbell Island, which was done by NAFIRRI (FIRRI at the time). The present survey assignment was conducted during April corresponding to the Second quarter of AES Nilepower Survey of 2000 and covered similar transects between Kalange (Upstream of the proposed site) and Namasagali (furthest site downstream of the proposed site). The four sampling sites were chosen considering the ease of sampling, transport logistics and ecological diversity. The studies were carried out under standard and acceptable methodologies for the assessment of aquatic system and included socio-economics, bilharzias and other disease vectors and sanitation which were not covered during AESNP Survey of 2000.

The first quarter report on Environmental, Social/Sanitation/Vectors and Impact Assessment (ESIA) undertaken during April 2006 by the National Fisheries Resources Research Institute (NAFIRRI) contracted by Burnside includes introductory chapter, field procedure, sampling protocal and data analysis and eleven chapters on:

- Water quality characteristics
- Algal biomass and species composition
- Aquatic macrophytes
- Micro-invertebrate fauna
- Macro-invertebrate surveys
- Fish species composition and relative abundance
- Biology and ecology of the fishes
- Fishery catch survey
- Bilharzias, other disease vectors and status of sanitation
- Socio-economics
- Discussion and conclusion

The present survey information is compared with the AES Nilepower second quarter survey both having been conducted in the rainy month of April.

Findings were:

Water quality characteristics

Conductivity patterns (2006) reduced progressively downstream while in 2000 it was relatively stable. NO_3-N were higher in 2000 compared to 2006 survey while TP was higher in 2006 compared to 2000. Chl-a showed a progressive reduction in 2006 while oil and grease showed an increase at all transects. Less suspended solids were noted in 2006 at all transects compared to 2000. Along all the transects H_2S and C_2H_4 never

changed much at all the transects and these were not analysed in the April 2000 survey.

Algal biomass and species composition

Blue-green algae dominated the algal community in all transects with similar algal distribution and abundance patterns in both surveys.

Aquatic macrophytes

41 macrophyte species (2006) compared to 46 species were encounted. In 2006 however, transect 4 had four times more species in 2006 than in 2000 due to colonization as a result of lower water levels of a wider transect. Water hyacinth (*Eichhornia crasipes*) and Hippo grass (*Vossia cuspidata*) remained the same during the two compared quarters.

Micro-invertebrates

Similar longitudinal patterns, abundance and species richness were observed for the two surveys with more species being upstream and transects 1-3 dominated by copepoda.

Macro-invertebrates

Highest total benthic density dominated by mollusks was transect 1at Kalange (April 2000) and at transect 3 (Kirindi) in 2006. Ephemenoptera (mayflies) and Tricoptera (Caddis fry) were less abundant (2000), probably due to reduced water levels and sampling in restricted habitats.

Fish species composition and relative abundance

The same keystone species (*Mormyrus kannume, Barbus altianalis, Lates niloticus* were encounted both surveys. In April 2000, 21 species compared to 18 in April 2006 were noted; *M. kannume* dominated in 2000 while Haplochromines were more dominant in 2006 both in biomass and number.

Biology and ecology of the fishes

There were no major differences in the diet and ecology of keystone species in April 2006 compared to April 2000. Fecundity in almost all species (in 2000 and 2006) was not easy to determine as specimens with ripe eggs were not easily obtainable.

Fishery survey

No major changes in fishing effort (crafts) were recorded. The types in use (57% increase in Ssese type, 39% decrease in dugout crafts) and increase in fishers (89 in

April 2000 to 128 in April 2006) this leading to increase in fish traders from 12 in 2000 to 47 in 2006. Target species remained the same and *Rastrineobola argentea* had the highest catch rate (300 kg boat^{-1}). Haplochromines and *R. argentea* were important in April 2006 commercial fishery. The main fishing gears remained the same so were the hook sizes in use. Monthly fish yield from the four transects increased from about 8,000 kg (April 2000) to 17,000 kg (April 2006) with a value of 4m and 12m Ug. Shs respectively.

Bilharzias, other disease vectors and status of sanitation

The baseline information on vector snails (spread of bilharzia) and non-vector snails showed that non-vector snails were more abundant than vector snails except at Namasagali (Transect 4). Of the two-vector snail genera encounted, *Biomphalaria* sp were more abundant at Kalange (Transect 1) and Kirindi (Transect 3) showing a high risk of *Schistosoma monsoni* than *Schistosoma haematobium* at these transects. Samples collected from a range of water users showed that 50% of the population were infested with *Schistosomiasis.* These were mainly the fishers, swimmers/bathing where there was the highest risk.

Feacal coliform contamination due to *Salmonella* and *Shigellosis* contamination was higher at the shallow human and water contact points than in deeper waters. All sites were far above acceptable limit of 5 celonies per 100 mls of water. Crabs collected during the survey did not have Simulim larvae that cause river blindness.

Socio-economic findings

The major economic activity at the four sampled sites is agriculture supplemented by subsistence fishing. The fish species harvested include Nile perch (*Lates niloticus*), Nile tilapia (*oreochromis niloticus)*, *Barbus* - Semutundu, M*ormyrus* - Kasulu and *Barbus* sp – Kisinja. Beach Management Units are not fully established.

The fishers on average earns US$ 5.5-16 per week but only 9.8% of the fishers had the culture of saving.

89% of the fishers own fishing assets while the rest rent these inputs that include multifilament gill nets, hooks, oars and boats.

However, the fishers experience fewer fishing areas leading to reduced fish catch and income from fishing.

1. Background to the Baseline Aquatic Monitoring and Fisheries Survey of the Upper Victoria Nile

1.1. Introduction

Burnside Bujagali Hydropower Project is to develop a 250 MW hydroelectric power plant on the River Nile. The project site is located at Dumbbell Island near the source of the Victoria Nile in Uganda and is about 2.5 km downstream from Bujagali falls (Fig. 2.1a). The ESIA is a follow-up of AESNP EIA conducted in 2000 but has been overtaken by events since then. The ESIA has been conducted in conformity with the methodologies used during AESNP survey.

An Environmental Impact Assessment (EIA) report together with the Environmental Action Plan and Monitoring Plan was submitted by AESNP to Government of Uganda. The EIA recommended collection of baseline water quality and aquatic ecology data, which included the following:

- Hydrology
- Water quality
- Indicators of productivity of lower trophic levels (invertebrates) including critical or keystone species
- Fish and fish population
- Human uses of the aquatic ecosystem particularly as a source of food

The Burnside Bujagali Hydropower Project in addition to the above has included fisheries Socio economics and disease vectors/sanitation. EASNP commissioned FIRRI in 2000 to undertake the required data collection for the pre-construction phase and as a follow up once more, the Burnside Bujagali Hydropower Project has commissioned NAFIRRI.

NAFIRRI is one of the institutes of NARO charged with the responsibility to promote, undertake and coordinate applied research in fisheries, fish production systems and the environment, aquaculture, fisheries, socio-economics while conserving the natural resource base in Uganda. The Institute is also responsible for packaging and transferring research results to users of research information.

The applied research assists among other issues to ensure,

- Increased supply of adequate and balanced food,
- Maintenance and sustainability of fish production, water quality and a healthy aquatic environment,
- Sustained supply of raw material for local industries,
- Stimulation of production for export diversification,
- improvement in rural incomes and quality of life,
- Conservation of the natural resource base for sustainable development,

- The task of NAFIRRI, therefore, is to contribute to modernisation of the fishery sector whilst ensureing sustainable management of natural resources is incorporated into developments.

1.2. Objectives

A major objective of the ESIA study is to carry out surveys at three monthly intervals over one year prior to commencement, during and after construction of the BHPP with emphasis on the following aspects:

- To study an area large enough as to encompass significant impacts anticipated both upstream and downstream of the site at Dumbbell island
- To monitor hydrological water quality determinants
- To carry out algal species composition
- Determine macrophyte composition and distribution
- To carry out invertebrate surveys
- To study the biology of fishes and food webs
- To carry out fish stock and fish catch surveys
- To carry out fisheries socio-economic surveys
- To carry out sanitation/vector studies.

The purpose of this present study therefore is to provide and update the AES Nile Power EIA baseline information on the ecology of the river ecosystem prior to the construction of the dam. The study is intended to provide a basis for evaluating the impact of the project on the river environment, the biological resources associated with it and fisheries socio-economics and the vector/sanitation status.

This report presents the findings of the first sampling regime which was conducted between the dates of 6^{th} – 13^{th} April 2006 and compared with the AESNP Environmental Impact Assessment findings of the second quarter carried out during 5^{th} – 14^{th} April 2000.

CHAPTER 2

2.0. General Methodology and Data Collection

2.1. Materials and Methods

The selected section of the Victoria Nile lies between Kalange/Makwanzi (GPS 36N 0516569, UTM 0054358) to Namasagali/Bunyamira (GPS 36N 049400, UTM 0112000). Kalange/Makwanzi was recognized as the main upstream site and three others downstream of the project site were with increasing distance from Dumbbell Island: Buyala, Kibubamutwe, Kirindi/Namasagali/Bunyamira (Fig.2.1a). The sections of the Victoria Nile in which these sites lie is characterized by rapids, rocky outcrops and river bends. However, such sections merge into slow flowing water zones downstream of numerous islands.

The hinterland along the banks of the study area has been transformed by human activity from the originally wooded savannah landscapes to one dominated by smallholdings of a variety of crops. Perennial crops especially coffee and bananas and annual crops such as maize presently cover the banks and islands. In the more northerly downstream sections, the banks still retain a more natural cover of the original vegetation and a wider flood plain.

For purposes of the survey, four sites were selected. Transects at these sites were recognized according to accessible locations on opposite sides of the river (Table 2.1).

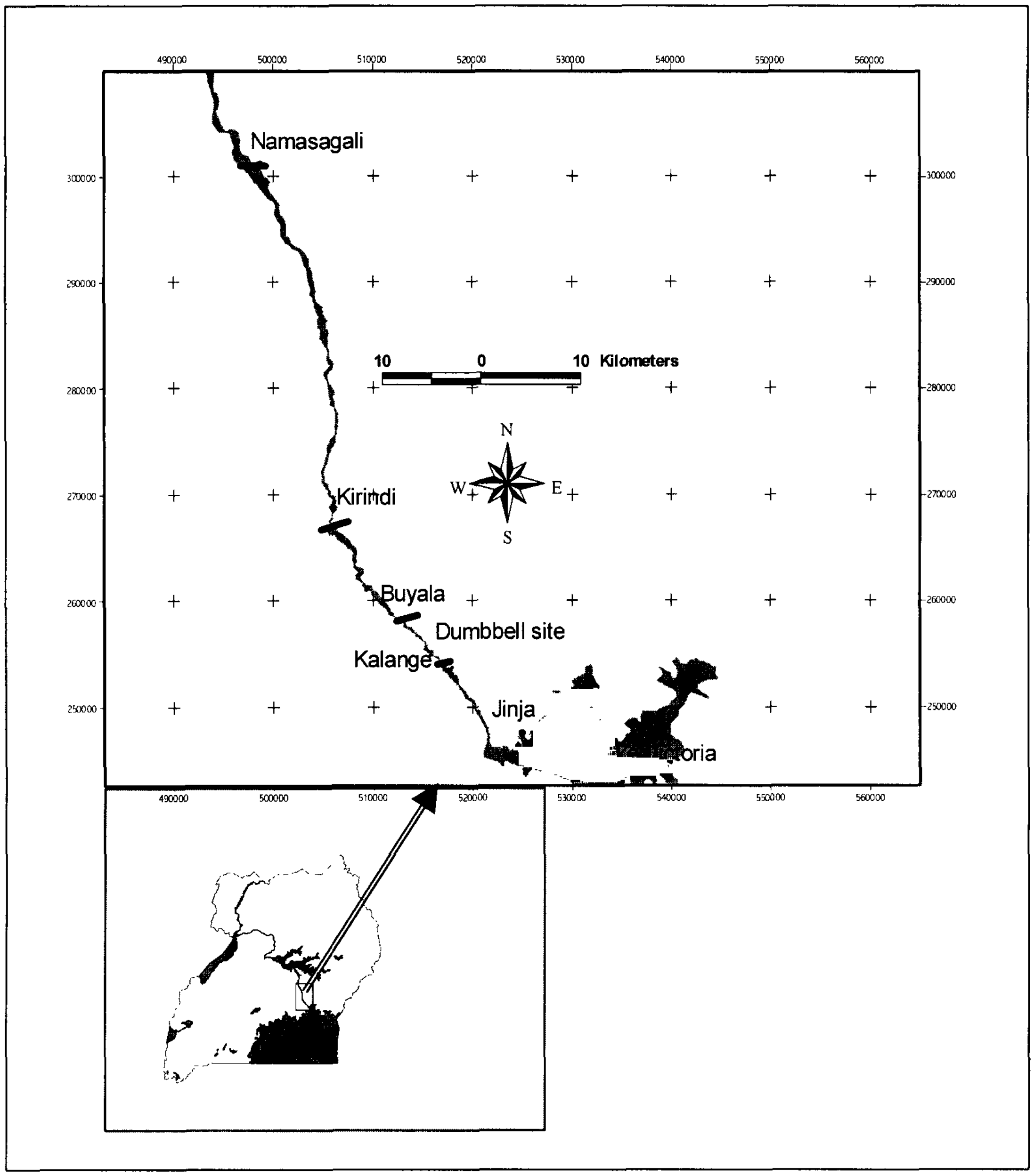


Fig. 2.1a. Location of Project site at Dumbbell Island and the four sampled transects on the Upper Victoria Nile - Uganda

Table 2.1. The distribution of sampled transects and sites along the Victoria Nile

Transect	Location in relation to Dumbbell Island	Sampling base on eastern bank	Sampling base on western bank	Associated villages
1	Upstream GPS 36N 0516569 UTM 0054358	Kalange	Makwanzi	Kikonko Kunjaba Makwanzi Is.
2	Downstream GPS36N 0514575 UTM 0056409	Buyala	Kibubamutwe	Naminya Kisadha Ofwono Zaire Mugalya Kisoga
3	Downstream GPS 36N 0506200 UTM 0075800	Nankandulo	Kirindi	Matumu Kisoga A, B, C Damba
4	Downstream GPS 36N 0494000 UTM 0112000	Karawe - Namasagali	Bunyamira	Kasanga Kibuye Sajjabi

2.2. Identification of Transects along Victoria Nile

The study transects were identified by a team of FIRRI scientists (2000) together with the representatives of AESNP and WS Atkins International Ltd and revisited before the present survey was conducted. The criteria to identify the sampling transects were based on:

- Accessibility on either side of the bank
- Fishing activities in the transect
- Proximity upstream or downstream of the proposed hydro-electric power site at Dumbbell Island
- Transect that covers a wide range of habitats
- Ease to sample aspects of the project objectives
- Transects chosen to be representative of the upper Victoria Nile as a whole

The transects identified (Fig 2.1b) and agreed upon by the two parties were:

Transect 1. Kalange/Makwanzi (36N 0516559, UTM 0054358)

Six km upstream of the proposed hydroelectric power station at Dumbbell. This transect lies downstream of the Bujagali falls. Five islands occur in the transect. The east bank is more gently sloping towards the river and more extensively cultivated than the west bank. Along the river margins *Vossia cuspidata* is the dominant macrophyte occurring in 5 to 15 m wide strips. The tree cover on islands was composed of *Tremor orientalis* and *Ficus* species. The transect was chosen because it had plenty of islands which could shelter more fish and provide more presence of diverse communities.

Transect 2. Buyala/Kibubamutwe (36N 0514575, UTM 0056409)

1km downstream of the proposed hydroelectric power station at Dumbbell Island. This zone is characterized by steep banks on both sides of the river channel. There are rocky reaches and the shoreline for the most part was free of stable vegetation cover. At Buyala/Kibubamutwe, several islands interrupt the flow of the river and create some gentle water flow in restricted zones. The transect was chosen because of its characteristic steep banks on both sides of the river.

Transect 3. Kirindi/Matumu (36N 0506200, UTM 0075800)

24 km downstream of the proposed hydroelectric power station at Dumbbell Island. This site was approached from the more gently sloping west bank at Kirindi. The river channel here is interrupted by a series of islands in an otherwise fast current. At the river margins, the main plant communities were associated with *Vossia cuspidata* and *Phragmites mauritianus*. Beyond the river margins, the land on both sides of the channel was extensively cultivated. The transect sites were selected because they were intensively cultivated near the banks

Transect 4. The furthest downstream transect was located at Namasagali/Bunyamira (36N 0494000, UTM 0112000)

65km downstream of Dumbbell Island. This is the most down-stream site of the survey area and is located at Namasagali/Bunyamira. In comparison to the upstream sites, the river channel here is wider, about 1.5 km and characterized by a more gentle flow. The channel is also associated with a narrow but more defined flood plain at its margins. Both banks are fringed by extensive *Cyperus papyrus* swamp. The river shoreline had frequent patches of *Eichhornia crassipes* and other floating water plants. The transect was chosen because of the gentle wide flowing river.

The detailed locations of the four sampled transects and associated villages are shown in Figure 2.1b.

2.3. Hydrology

Hydrological information is expected to be obtained from DWD and in the form of direct data by Burnside.

2.4. Sampling

Sampling was conducted between the period of 6th – 13th April 2006. The weather for the sampling period was wet.

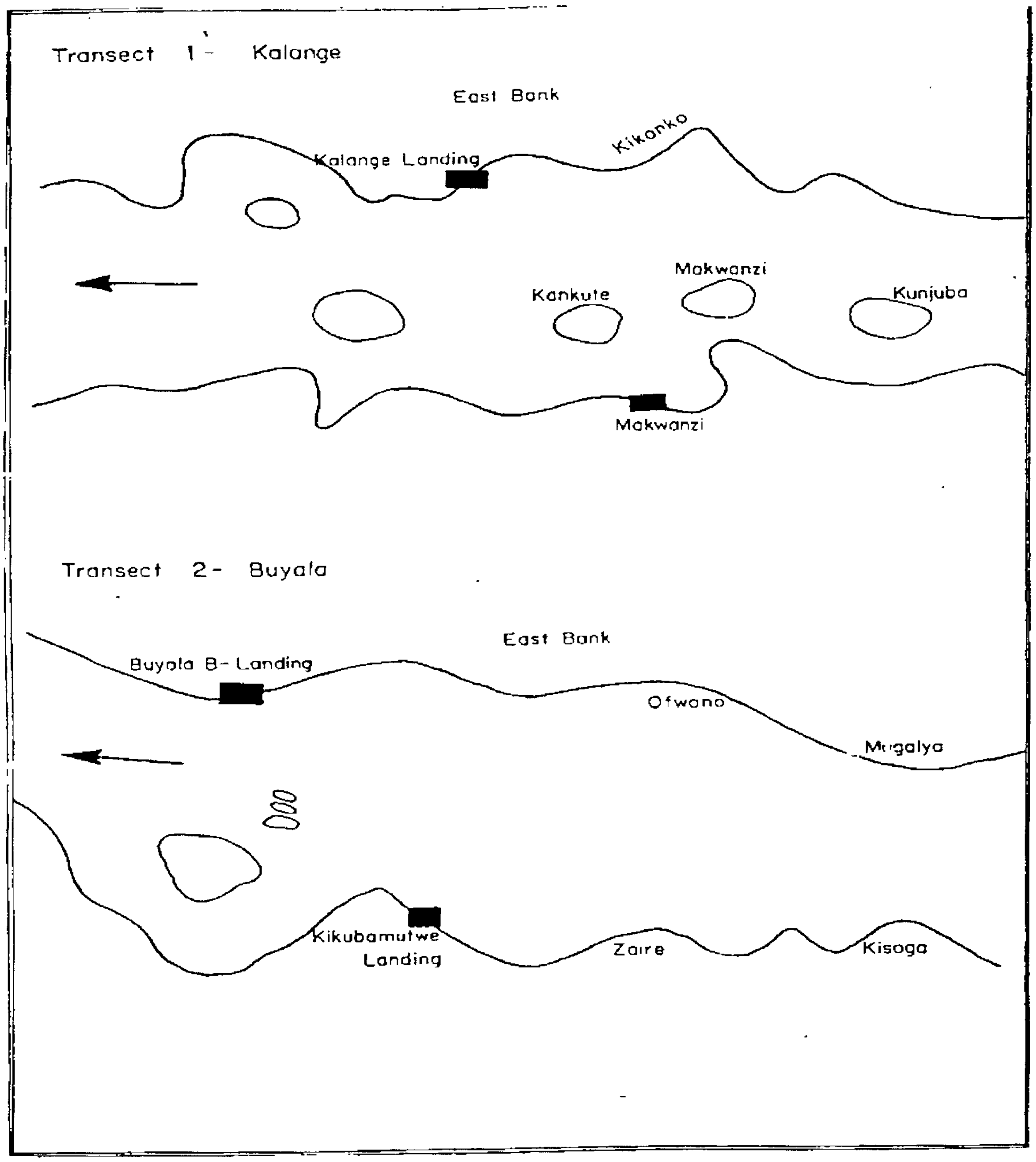
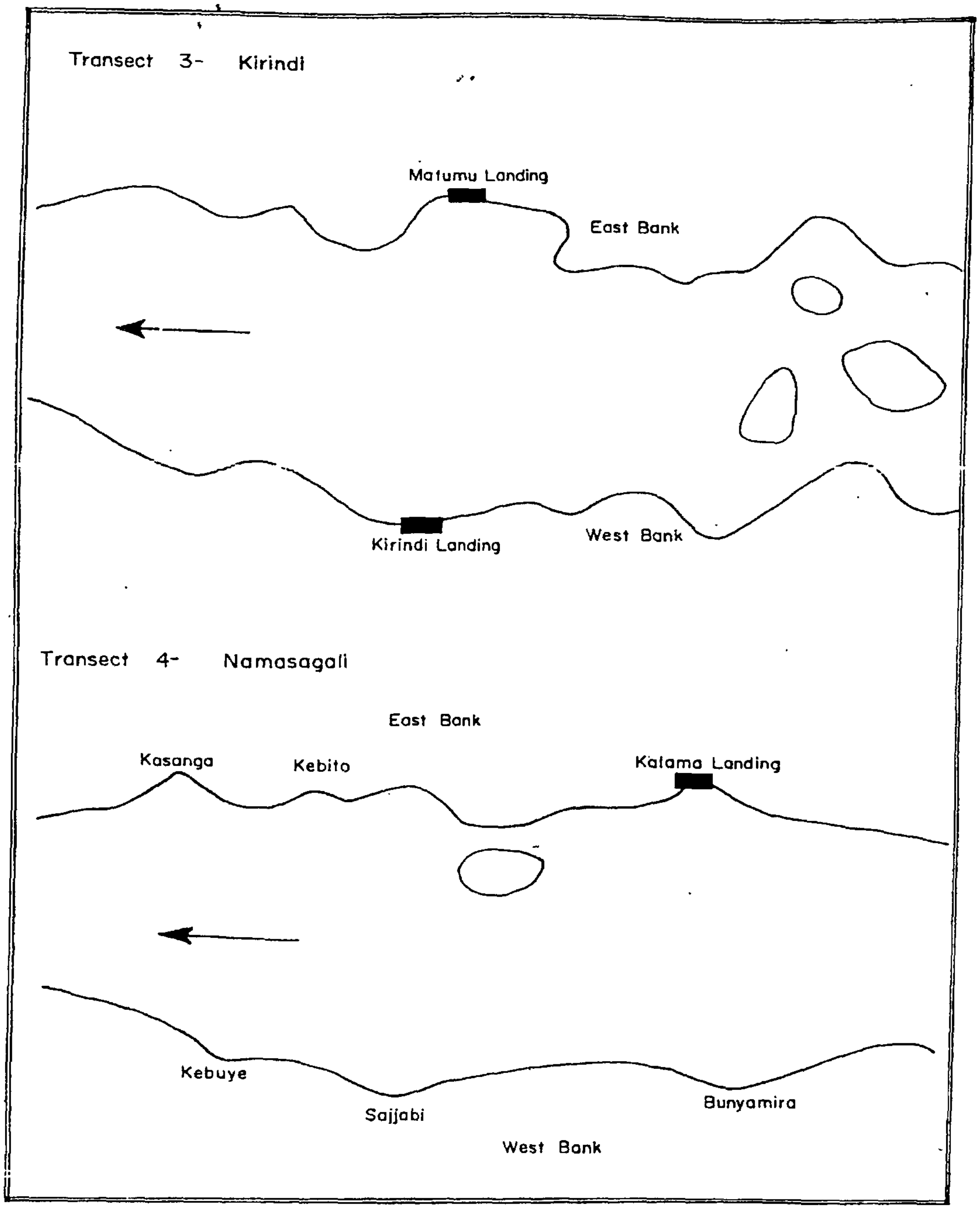


Fig. 2.1b. A description of the sampled transects (Transect 1 = Kalange; Transect 2 = Buyala; Transect 3 – Kirindi; Transect 4 = Namasagali) and associated locations on the Upper Victoria Nile.


Transect 3- Kirindi
Matumu Landing
East Bank
Kirindi Landing
West Bank
Transect 4- Namasagali
East Bank
Kasanga
Kebito
Kalama Landing
Kebuye
Sajjabi
Bunyamira
West Bank

CHAPTER 3

3.0. Water Quality Characteristics

3. 1. Background

A hydroelectric power dam is to be constructed at the Bujagali waterfalls along the Upper Victoria Nile. As part of an Environment Impact Assessment, a survey was conducted to collect information on the status of water quality. Data was collected on a range of physico-chemical parameters namely total suspended solids (TSS), temperature, dissolved oxygen, conductivity, water transparency, pH, various species of nitrogen and phosphorus, silica, methane, hydrogen sulphide, oil and grease, in addition to chlorophyll-a. This data was then compared with that collected at the same transects during the same period i.e. April 2000. This particular survey of April 2006 was carried out during the onset of the first rains in the year.

3.2. Materials and Methods

Four transects sampled along the upper Victoria Nile were at Kalange, Buyala, Kirindi and Namasagali. Temperature (°C), dissolved oxygen (mg L^{-1}), conductivity (µS cm^{-1}) and pH were measured in situ using Orion portable meters. Water transparency was measured in meters (m) in the shade of the boat using a 25 cm diameter white disc at all sites during sample collection. A 3 L van dorn water sampler was used to draw water samples for analysis of nutrients, oil and grease. Samples for nutrient analysis were immediately kept in a cool box stocked with ice to reduce deterioration of perishable nutrients. Unless otherwise specified, most of the analyses were done following standard methods for the examination of water (Greenberg *et al,* 1992). Water samples for dissolved nutrients were filtered within four hours of collection and analyzed immediately. Water samples for oil and grease were put in glass bottles and those for methane and hydrogen sulphide in plastic bottles. All samples were kept on ice in a cool box and delivered to the laboratory for analysis the same day. The nutrients (i.e. ammonium nitrogen (NH_3-N), nitrite-nitrogen (NO_2-N), nitrate-nitrogen (NO_3-N), total nitrogen (TN), soluble reactive phosphorus (SRP), total dissolved phosphate (TDP), total phosphate (TP) and silica (SRSi)) were determined as described in Stainton *et al.* (1997).

Analyses of water for suspended solids were determined by weight difference. Here, the initial weight of an oven-dried filter paper (Whatman GFC filters) was obtained before using it to filter a known volume of water. After the filtration, the filter papers were then dried for 1 hour at 105°C before reweighing. Water samples for oil and grease were preserved using hydrochloric acid whereas those for methane and hydrogen sulphide were kept at low temperature under ice. These had to be delivered to the laboratory in Kampala the same day in order to meet the critical holding time of the gaseous state.

Analysis was carried out by the National Water and Sewerage Corporation (NWSC) Laboratory using the partio-gravimetric method as described in Greenberg *et., al.* (1992). Chlorophyll a was determined by the standard spectrophotometric method (Greenberg *et al,* 1992).

3.3 Results

3.3.1. Physical parameters

Physico-chemical and biological parameters are given in Tables 3.1 and 3.2. Electrical conductance of the water in April 2006 ranged between 78.7 and 102.9 μScm^{-1}, with the lowest mean (80 μScm^{-1}) at Buyala and highest (102.5 μScm^{-1}) at Kalange, both of which are upstream transects. Variability in electrical conductivity did not however, differ greatly from previous data of 2000 (Table 3.2). Dissolved oxygen ranged between 4.0 and 7.0 mg L^{-1}, with the lowest mean (4.2 mg L^{-1}) at Kalange and highest mean (6.5 mg L^{-1}) at Kirindi, but with minimal variation. It was noted that dissolved oxygen concentration tended to increase downstream. Comparison of data for April 2006 and that of April 2000 indicated higher mean concentrations of dissolved oxygen during the latter period (Table 3.2). Mean water temperatures varied between 26.4 ^{o}C at Buyala and 27.0 °C at Kalange and Kirindi during 2006 survey. A similar trend was noted for the 2000 survey, with temperature ranging between 26.3 ^{o}C at Buyala and 26.6 ^{o}C at Kirindi. The pH ranged between 6.9 and 7.7 for the 2006 data, with most of the figures centering around circumneutral. The 2000 data however, showed a wider range (5.7 to 8.9). Mean secchi depth during the 2006 survey decreased steadily downstream while the opposite was generally true for the 2000 survey (Table 3.2). During the two surveys, suspended solids were highest at Kirindi and lowest at Namasagali. At Kirindi, mean suspended solids were 2,500 µg L^{-1} in 2006 and 3,250 µg L^{-1} in 2000. At Namasagali, the mean suspended solids were 1,500 µg L^{-1} in 2006 and 818 µg L^{-1} in 2000 (Table 3.2).

Table 3.1. Comparison in the ranges of physico chemical parameters at the four sampling stations of the Upper Victoria Nile

Variables	2006				2001			
	Kalange	Buyala	Kirindi	Namasagali	Kalange	Buyala	Kirindi	Namasagali
Cond. (μScm^{-1})	102.1 - 102.9	78.7 - 98.2	79.8 - 80.2	81.6 - 88.1	96.0 - 101.0	95.0 - 100.0	98.0 - 101.0	96.0 - 102.0
DO (mg/L)	4.0 - 4.4	6.2 - 6.4	6.0 - 7.0	6.0 - 6.2	4.1 - 10.2	6.7 - 8.3	6.1 - 10.7	5.4 - 8.3
Temp. (C)	26.4 - 27.0	26.3 - 26.5	26.7 - 26.8	26.5	25.3 - 26.8	26.0 - 26.7	26.4 - 26.7	25.3 - 26.6
pH	6.9 - 7.1	7.2 - 7.7	6.93 - 7.6	6.86 - 7.29	5.68 - 7.72	6.75 - 8.28	5.64 - 8.86	6.58 - 7.87
SD (m)	1.8 - 2.0	1.6 - 1.9		1.0 - 1.6	0.95 - 2.16	1.52 - 1.97	1.23 - 1.96	1.22 - 2.9
SS (μg L^{-1})	0.0 – 3,000	0.0 – 3,000	0.0 – 4,000	0.0 – 2,000	400 – 1,800	500 – 1,400	900 – 2,200	200 – 1,300
NH_4-N (μg/L)	3.97 - 96	15.48 - 57.65	2.03 - 20.69	0 - 0.46	0.0 - 16.81	0.0 - 18.79	0.0 - 13.84	0.0 - 26.21
NO_2-N (μg/L)	8.0 - 9.3	8.0 - 9.3	8.4 - 10.2	8.9 - 10.2	0.2 - 7.07	0.0 - 3.45	0.56 - 2.01	0.0 - 1.64
NO_3-N (μg/L)	11.6 - 13.7	11.1 - 13.7	11.1 - 14.3	11.6 - 14.8	0.0 - 33.45	52.9 - 83.5	150.62 - 158.5	145.1 - 251.1
Tot-N (μg/L)	877.8 - 1655.6	766.7 - 544.4	877.8 - 1322.2	1211.1 - 2100	388.23 - 834.72	596.6 - 864.49	864.9 - 1013.32	N/A
Tot-P (μg/L)	78.7 - 145.3	65.3 - 132	105.3 - 125.3	92.0 - 152.0	5.81 - 161.77	63.36 - 83.79	67.08 - 80.08	59.65 - 76.36
SRP (μg/L)	13.2 - 23.2	13.2 - 24.8	23.2 - 29.9	14.8 - 24.8	0.0 - 5.81	0.2 - 18.8	7.66 - 37.57	5.81 - 24.37
TDP (μg/L)	18.33 - 27.22	25.0 - 33.89	25.0 - 33.89	23.89 - 31.67	0.0 - 3.95	0.0 - 5.81	13.23 - 24.35	16.95 - 31.80
Chl-a (μg/L)	0.0 - 7.0	2.1 - 6.3	0.0 - 4.2	2.1 - 2.8	22.9 - 53.5	18.77 - 25.02	8.34 - 24.3	1.39 - 63.94
Oil (mg/L)	0.1 - 3.9	0.1 - 5.3	0.4 - 1.4	11.3 - 12.50	0.13 - 0.29	0.21 - 0.27	0.22 - 0.63	0.23 - 0.66
H_2S (mg/L)	0.064 - 0.074	0.053 - 0.064	0.064 - 0.074	0.035 - 0.063	0	0	0	0
C_2H_2 (mg/L)	0.015 - 0.017	0.012 - 0.015	0.015 - 0.017	0.008 - 0.012	0	0	0	0
SRSi (μg/L)	237.2 - 372.2	167.2 - 395.5	260.5 - 677.2	222.2 - 421.56	167.1 - 269.5	198.5 - 279.5	216.7 - 224.7	219.97 - 421.56

Table 3.2. Comparison in the mean values of both the nutrients and physico chemical parameters at the four sampling stations of the Upper Victoria Nile

Variables	2006				2001			
	Kalange	Buyala	Kirindi	Namasagali	Kalange	Buyala	Kirindi	Namasagali
Cond. (μScm^{-1})	102.5	88.5	80	84.8	97.8	97.2	99.5	97.2
DO (mg/L)	4.2	6.3	6.5	6.1	7.38	7.47	8.2	7.16
Temp. (C)	26.7	26.4	26.7	26.5	26.39	26.33	26.58	26.11
pH	7	7.4	7.2	7	7.36	7.81	7.1	7.36
SD (m)	1.9	1.7		1.3	1.27	1.76	1.6	2.46
SS ($\mu g\ L^{-1}$)	2,000	2, 000	2,500	1,500	2,400	1,333.3	3,250	818.28
NH_4-N (µg/L)	42.26	29.45	8.62	0.46	1.26	6.77	3.76	5.85
NO_2-N (µg/L)	8.7	8.7	9	9.3	1.83	1.7	1.21	1.02
NO_3-N (µg/L)	12.5	12.6	12.7	12.9	8.68	66.05	154.14	203.73
Tot-N (µg/L)	1174	1192.5	1127.7	1544.4	585.15	699.12	574.27	868.74
Tot-P (µg/L)	108.6	100.8	118.6	118.6	64.38	71.35	85.27	74.04
SRP (µg/L)	19	19.2	27.1	21.2	0.29	4.23	15.46	15.09
TDP (µg/L)	23.1	28.3	30.2	27.4	64.38	71.35	85.27	74.04
Chl-a (µg/L)	3.7	4	3.4	2.4	26.86	21.34	8.48	14.73
Oil (mg/L)	6	8.9	4.7	11.7	0.21	0.24	0.35	0.5
H_2S (mg/L)	0.07	0.06	0.07	0.043	0	0	0	0
C_2H_2 (mg/L)	0.016	0.014	0.016	0.01	0	0	0	0
SRSi (µg/L)	319.9	309.4	443.6	494.3	236.57	219.8	243.43	296.53

3.3.2 Nutrients (NH_4-N, NO_2-N, NO_3-N, TN, Tot P, SRP, and SRSi) and pollutants (Oil, grease, H_2S and C_2H2)

At the Kalange, Buyala and Kirindi transects, the mean concentration of mean ammonium-nitrogen (NH_4-N) was generally higher in 2006 than in 2006. Additionally, NH_4-N showed a clearly decreasing trend downstream in 2006 while there was no clear pattern during the 2000 survey (Table 3.2). In Namasagali at all sampling points, very low concentrations of NO_4-H were detected. Along all transects, mean nitrite–nitrogen (NO_2-N) concentration was higher during the 2006 compared to that in 2000 (Table 3.2). While the concentration of NO_3-N was lower at all transects during the 2006 than the 2000 surveys, there was a general increasing trend of this nitrogen species along the stream flow (Table 3.2). Also noted was the higher concentration of TN during the 2006 than the 2000 survey. Low algal biomass (Chl-a) was recorded during the 2006 than the 2000 survey, and during both sampling events,. there was no clear pattern along the stream flow.

Although the concentration of Total Dissolved Phosphorus (TDP) showed a generally increasing trend in the downstream direction, mean concentrations were lower (range of 23.1 to 30.2 $\mu g\ L^{-1}$) in 2006 than in 2000 (64.3 to 85.2 $\mu g\ L^{-1}$). However, concentrations of Total Phosphorus (TP) and Soluble Reactive Phosphorus (SRP) increased along the stream flow for both sampling events. Additionally, higher concentrations of TP and SRP were recorded during 2006 compared to the 2000 survey. Higher concentrations of silica were recorded during the 2006 than the 2000 survey, with concentrations generally increasing along the stream flow.

Data on grease and oil in addition to H_2S and C_2H_4 are given in Table 3.3. The concentration of oil and grease was higher in the 2006 samples than in those of 2000 by more than five fold. In the 2000 data, oil concentration increased in the downstream trend but no definite trend was noted in the 2006 data although the lower most transect (i.e. Namasagali) had the highest concentration. It was not possible to compare data on H_2S and C_2H_2 since these parameters were not assessed during the 2000 survey.

Table 3.3: Comparison in the mean values of oil and grease, hydrogen sulfide and methane at the four transects of the Upper Victoria Nile. (nd = not done).

	Year	Transects			
		Kalange	Buyala	Kirindi	Namasagali
Oil and grease (mg/l)	2006	6	8.9	4.7	11.7
	2000	0.21	0.24	0.35	0.5
H_2S (mg/l)	2006	0.07	0.06	0.07	0.04
	2000	nd	nd	nd	nd
C_2H_4 (mg/l)	2006	0.016	0.014	0.016	0.01
	2000	nd	nd	nd	nd

3.4. Discussion

The decreasing trend in the mean electrical conductance along the river could be attributed to reduction in the amount of rapids thus leading to settling of adsorbed ions on various particles in the water. However the range in conductivity values reflected the normal conductivity ranges of Lake Victoria waters.

The concentration of dissolved oxygen did not vary much among the four transects. However, dissolved oxygen increased in the downstream direction and could have been partly attributed to input from the atmosphere as a result of turbulence. In addition, as the water became calmer (reduced currents) along the stream flow, it was likely that the role of algae through photosynthesis became more important in recharging the system with oxygen. The higher algal biomass in 2000 could easily be related to the higher dissolved oxygen concentration in the water column compared to that determined during the 2006 survey. The low algal biomass (Chl-a) resulting into low primary production and productivity, is thought to have largely accounted for the low oxygen concentrations during April 2006.

Although some slight variations were noted, temperatures were generally higher than normal at all transects. It is likely that with the reduced water volume in the channel, the water column was receiving excess solar energy during the day thus leading to fairly high water temperatures. This could be the case since light penetration through the water column was down to the streambed at most sampling stations.

The wide range in pH in 2000 was probably due to the higher algal biomass at that time compared to that of 2006 bearing in mind the influence of algal photosynthesis on pH. The difference in secchi depth could be attributed in part to differences in the amount of suspended solids flowing downstream from Kalange as a result of landscape erosion by the fast flowing stream waters along the less vegetated river banks. Several stretches of the adjacent banks were devoid of natural vegetation due to clearing to give way to farmlands particularly crops. It was observed in this context that some slopes were so steep (> 45^{O}) that they were prone to severe erosion even with minimal rain events. Reduction in suspended solids along the stream flow could be a result of reduced stream currents thus allowing ample time for settling of particles.

The higher concentration of NH_4-N in the 2006 compared to that during the 2000 survey was probably an indication of a relatively degraded or deteriorating environment. This could be supported by the high concentrations of NO_2-N whose presence could imply the inability of the system to oxidize NO_2-N to NO_3-N. The decreasing trend in the concentration of NH_4-N downstream could be attributed to either loss through volatilization into the atmosphere or conversion to NO_2-N or uptake by microbes. In addition, the decreasing trend in the concentration of NO_3-N could also be attributed to the degrading environment resulting into rapid denitrification, or rapid biological uptake e.g. by algae and other microbes. Input of nutrients into the river through landscape erosion could be one of the major contributing factors to increased concentrations of nitrogen, phosphorus and silica in the water column compared to what was noted in 2000.

The high levels of oil and grease detected in April 2006 compared to 2000 was probably due to increased activities in the upstream reaches. Some of these activities could be increase use of outboard engines on the lake, tourism activities on the river, car washing or small spillages from the new dam. However, since there is no data on these activities, it is difficult to justify this statement. The higher concentration of oil and grease downstream at Namasagali could be a result of accumulation. Detection of some hydrogen sulphide (H_2S) and methane (C_2H_2) were evidence that the environment was relatively degraded. It is however, not possible to compare with the situation in the 2000 survey since these two parameters (H_2S and C_2H_2) were not determined.

3.5.1 Conclusions

Although some parameters such as electrical conductance and temperature did not show much variance during the two survey periods, a relative shift in most of the water quality parameters was noted. The noted shifts were reduced dissolved oxygen coupled with a reduction in algal biomass. Others included an increase in the amount of suspended solids, increase in nutrients (N, P & Si), and increase in the amount of oil and grease. In addition, detection of hydrogen sulphide, methane, ammonium-nitrogen and nitrite-nitrogen were indications of a deteriorating water environment. The results presented in this report are preliminary hence need more data to enable detailed analysis and interpretation in order to come up with sound scientific recommendations.

CHAPTER 4

4.0. Algal Biomass and Species Composition

4.1. Introduction

Algae are major primary producers in aquatic systems by harnessing solar energy in the presence of chlorophyll and carbondioxide, form carbohydrates that can then be tapped directly by primary consumers or indirectly by secondary consumers. This process, sometimes referred to as photosynthesis, also aerates aquatic systems with oxygen as its by-product, thus making such systems habitable to a range of aquatic organisms including fish. Algae is also an important food in aquatic food webs hence sustainability of this resource is crucial to proper management. Changes in the water environment will alter the composition and abundance of the algal communities and may lead to changes in fish species abundance and species composition. A survey of algal communities of the Upper Victoria Nile was carried out between 6-13th April 2006 in four transects (1-Kalange-Makwanzi, -2 Buyala-Kikubamutwe, 3 -Kirindi-Matumu, and 4- Namasagali-Bunyamira) along the river to determine the species composition, distribution and biomass (Chlorophyll-a).

4.2. Materials and methods

Water samples from the four transects along the Nile were taken using a van dorn sampler. Lugols solution was used as preservative immediately after sampling. Algal biomass as chlorophyll-a was determined by filtering water through a 0.45μm pore size GF/C filter papers and using methanol as an extract (Stainton, 1977); FIRRI lab manual 1996).

In the laboratory 2 mls of the sample was put in Sedgewick counting chamber and allowed to settle for three hours. Algal composition was determined using an inverted microscope at 400X magnification.

4.3. Results

Five major taxonomic groups of algae (Blue-green, Diatoms, Chlorophyta, Cryptophyta and Euglenophyta) constituted the algal community in the four sampled transects along the Upper Victoria Nile (Table 4.1). The blue-green algae were dominant at all transects with Kirindi exhibiting the highest percentage while the green algae and the diatoms were consistently low (Table 4.1). The blue-green algae of the genera *Anabaena, Aphanocapsa, Merismopedia, Planktolyngbya* and the green algae of the genera *Ankistrodesmus, Closterium and Pediastrum* occurred in all the transects. The species number increased progressively from the previous sampling of 2000 with Namasagali transect recording the highest number of species (50) compared to the other three transects (Table 4.2).

4.4. Discussion

The algal taxonomic composition was similar to that of lake Victoria and was comparable to the previous AESNP survey of 2000 which was curried out in the same month. Blue green algae dominated in all the transects but there was no significant difference in the species composition with in the transects in this group. The dominance of blue green algae at all sites may be an indication of declining water quality, resulting from nutrient loads that could be coming from the extensive agricultural activities in the sub-catchments along the Nile. The occurrence of nitrogen fixing algae *Anabaena* in all the sites could be an indication of a system that has already started suffering from nitrogen deficiency and this is likely to affect the fishery of the river.

4.5. Conclusion

Five major taxonomic groups of algae (Blue green, Diatoms, Chlorophyta, Cryptophyta and Euglenophyta) constituted the algal community of the Upper Victoria Nile with the blue-green algae of the genera *Anabaena*, *Aphanocapsa*, *Merismopedia*, *Planktolyngbya* dominating in all the transects

The continued influx of nutrients into the river from the catchment may have consequences for algal species composition, which in turn could affect the structure and composition of higher trophic levels

Table 4.1. Numerical abundance (%) of the major algal taxonomic groups in the four transects

Transect	Stations	Blue-Green (%)	Diatoms (%)	Chlorophyta (%)	Cryptophyta (%)	Euglenophyta (%)
Kalange	East	86.36	2.25	11.24	0.15	
	Middle	85.46	3.86	10.39	0.3	
	West	83.73	4.13	11.89	0.13	0.13
Kikubamutwe	East	96.57	1.27	2.03	0.06	0.06
	Middle	85.86	1.63	12.27	0.13	0.13
	West	92.82	2.01	5.09	0.08	
Kirindi	East	97.5	1.25	1.25		
	Middle	97.67	1.85	0.48		
	West	98.56	0.42	1.01		
Namasagali	East	89.85	1.94	8.10		
	Middle	85.74	13.16	0.55		0.55
	West	57.11	2.24	3.47		

Table 4.2. Checklist of the algal species composition from the four sampled transects

Class	Kalenge	Kikubamutwe	Kirindi	Namasagali
Blue-green				
Anabaena circinalis	X	X	X	X
Aphanocapsa decatissima	X		X	X
Aphanocapsa incerta	X			
Aphanocapsa sp	X	X	X	X
Chroococcus dispersus	X	X		
Chroococcus turgidus			X	X
Chroococcus limeticus	X		X	X
Chroococcus sp	X	X		X
Ceolomoron sp			X	X
Gloeococcus sp				X
Ceolosphaerium sp			X	
Cylindrospermopsis africana	X	X		
Cylindrospermopsis cupsis	X			
Cylindrospermopsis sp	X	X		
Cyanodycton sp			X	X
Merismopedia glauca	X	X		X
Merismopedia tenuissima	X	X	X	X
Merismopedia elagans			X	
Microcystis flos-aqaue	X	X	X	
Microcystis sp	X	X		
Planktolyngbya circumcreta	X	X	X	X
Planktolyngbya contarta	X	X		
Planktolyngbya limnetica	X	X		X
Planktolyngbya tallingii	X	X	X	X
Romeria gracile	X	X		
Rhodomonas sp	X	X		
Diatoms				
Cyclostephanodiscus sp	X	X	X	
Cyclotella sp	X	X	X	
Navicula gastrum	X			
Navicula sp			X	X
Navicula lacoelata				X
Navicula radiosa	X	X		
Nitzschia acicularis	X	X	X	X
Nitzschia mediocris				X
Nitzschia fonticola	X	X	X	X
Synedra cunningtonii		X		
Cocconeis sp				X
Centric diatoms			X	X
Euglenophyta				
Euglena acus	X			
Trachelomonas sp		X		X

Class	Kalenge	Kikubamutwe	Kirindi	Namasagali
Green Algae				
Ankistrodesmus falcatus	X	X	X	X
Ankistrodesmus fusuformis	X	X		
Ankistrodesmus setigera				X
Chodetella sp		X	X	X
Chodetella subsala			X	
Closterium acicularis	X	X		
Closterium sp	X	X	X	X
Dictyosphaerium sp				X
Kircheriella obesa	X	X	X	X
Botryococcus braunii				X
Monoraphidium contartum	X	X		X
Monoraphidium sp			X	X
Dydmocystis sp			X	
Oosystis sp				X
Oocytistis lucutris	X	X		
Oocytistis soltaria	X			
Oocytistis borgei				X
Pediastrum boryanum				X
Pediastrum dumplex	X	X		X
Pediastrum simplex	X	X	X	X
Pediastrum tetras		X		
Selenastrum gracile				X
Scenedesmus acuminatus	X	X		X
Scenedesmus armatus			X	X
Staurastrum curvatum				X
Scenedesmus bijugatus				X
Scenedesmus arcuatus	X	X		X
Scenedemus apiculatus				X
Scenedesmus quadricuada	X	X		
Scenedesmus perforatus				X
Shroederia setigera				X
Scenedesmus sp	X	X		X
Scenedesmus castato			X	
Stuarastrum cuspdatum	X			
Stuarastrum gracile	X	X		
Stuarastrum sp		X		
Crucigenia fenestrata			X	X
Crucigenia sp				X
Coelastrum sp	X	X		X
Dinoflagelletes				
Glenodinium sp				X
Species	**44**	**41**	**30**	**50**

CHAPTER 5

5.0. Aquatic Macrophytes

5.1. Introduction

Human activities have transformed the catchment area of the River Nile to the extent that the original landscape is not recognized in most sections of the riverbanks. The original vegetation has mostly been replaced with crop cover, and to a smaller extent grazing of domestic animals. Due to the steep slopes in most sections of the riverbank, conversion of the landscape to agricultural land has left the slopes bare, exposing the soils to various forms of erosion (Plate 5.1).

Plate 5.1: Cultivation at the river bank down to the watermark

Areas most denuded of natural vegetation are those in the upstream reaches of Kalange-Makwanzi, Buyala-Kikubamutwe and Kirindi-Matumu transects. Further downstream, the areas around the Namasagali-Bunyamira transect were relatively better vegetated.

Given the significantly low 2006 water levels in the stream channel that has led to exposure of formerly shallow areas, some aquatic plants had rapidly started colonizing the exposed sections of the river with opportunistic plants. Exposure of shallow areas (Plate 5.2) would imply enhanced biogeochemical cycles that are likely to lead to enhanced availability of nutrients (Barbanti *et al.*, 1992; Bates & Neafus, 1980; Bostrom & Petterson, 1982; James *et al.*, 1996) that foster plant growth. Colonization by plants at exposed sites is also thought to have been favored by the assumed nutrient-rich guano from aquatic birds around shallow rocky areas (Plate 5.3).

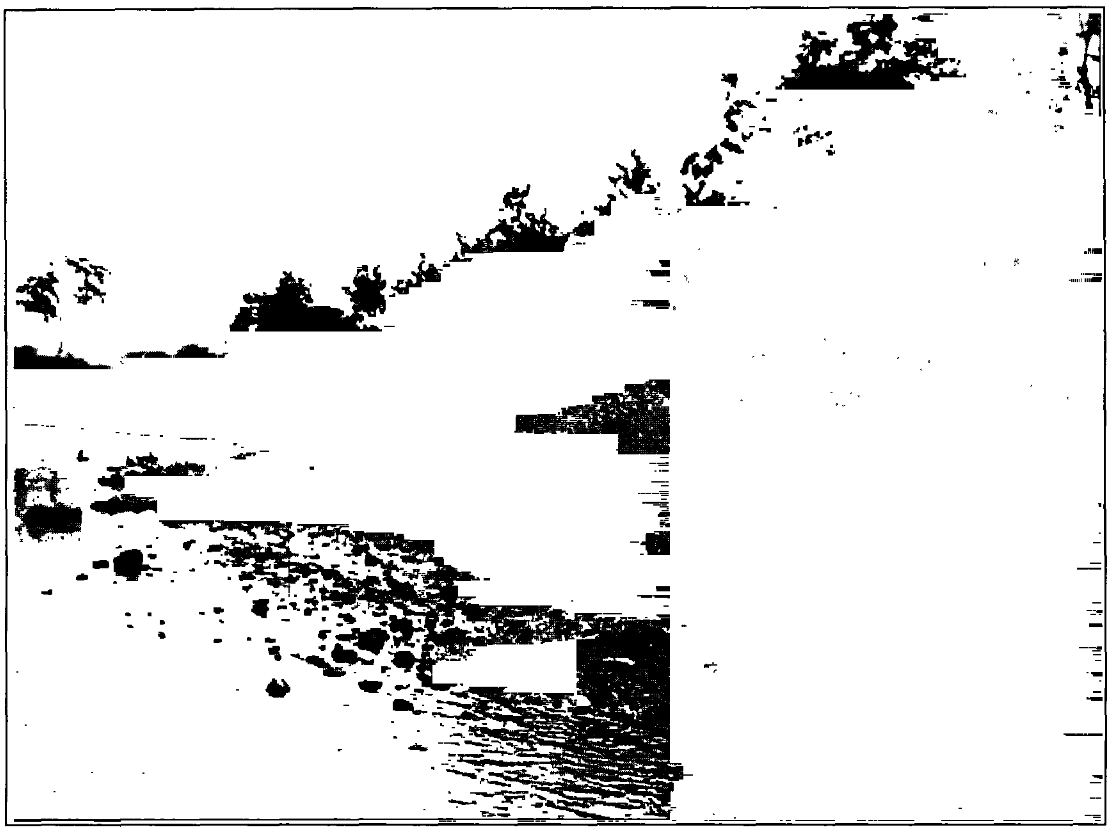


Plate 5.2. Exposed shallow zone of the river bank at Kikubamutwe

This study was intended to provide baseline information on the diversity and relative cover abundance of aquatic macrophytes in the four transects of Kalange-Makwanzi, Buyala-Kikubamutwe, Kirindi-Matumu and Namasagali-Bunyamira. This information is to form part of the baseline data upon which future ESIAs are to refer to.

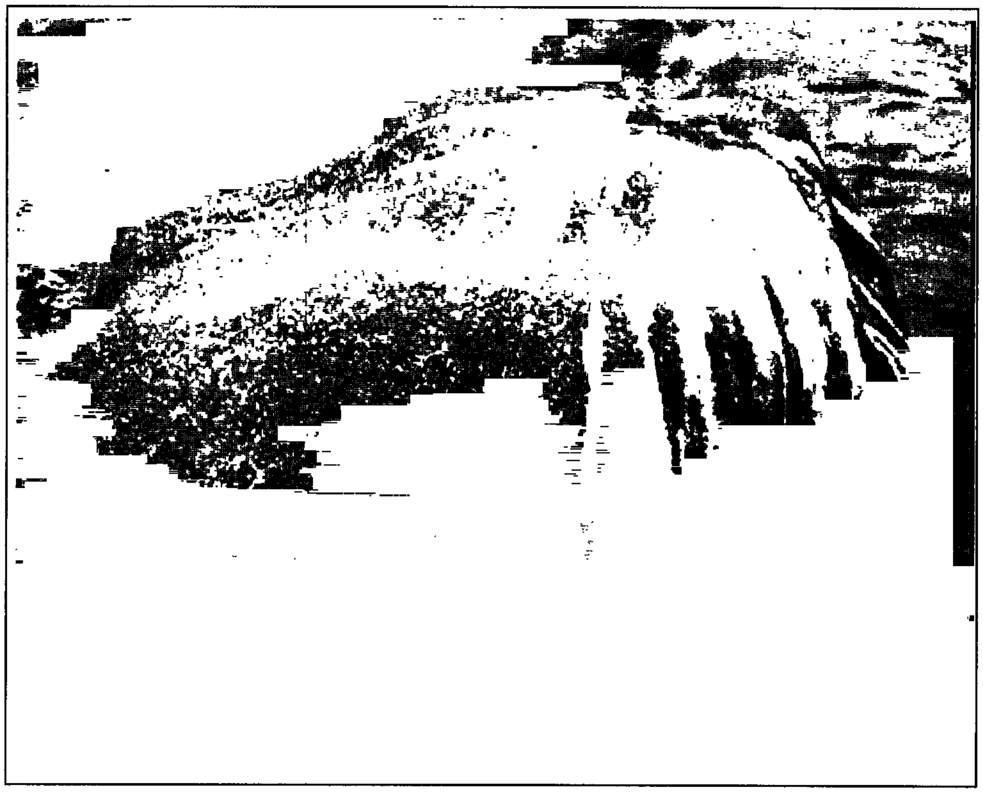


Plate 5.3: An exposed rock with guano from aquatic birds

5.2. Study area

This study was undertaken at the same four transects as used in 2000, namely 1-Kalange-Makwanzi, 2- Buyala-Kikubamutwe, 3- Kirindi-Matumu, and 4- Namasagali-Bunyamira between 6^{th} – 13^{th} April 2006.

5.3. Materials and methods

Sampling sites were georeferenced using a GPS hand set (GARMIN 175), with coordinate references recorded in decimal degrees. Water based surveys were conducted on a motorized boat along the shores of the riverbanks and around islands wherever they occurred. Stretches of 300 m were determined and all species of aquatic macrophytes were recorded; data on macrophyte abundance was determined by three independent observations and the mean evaluation was agreed on. The evaluation of abundance was at five levels i.e. dominant, abundant, frequent, occasional and rare (DAFOR). Those plants that could not be identified on site were pressed and kept for exact identification at some later date, preferably from Makerere University herbarium. A checklist was then prepared to determine the presence or absence of these plants.

5.4. Results

The determination of macrophyte presence based on the DAFOR system is presented in Table 5.1. Though variations occurred among sites, it was found that water hyacinth was ubiquitous despite variations in its occurrence based on the DAFOR system. In an ascending order of species diversity, Kalange-Makwanzi had 6, Kirindi-Matumu had 13, Kikubamutwe-Buyala had 15 and Namasagali-Bunyamira had 37 (Fig. 5.1).

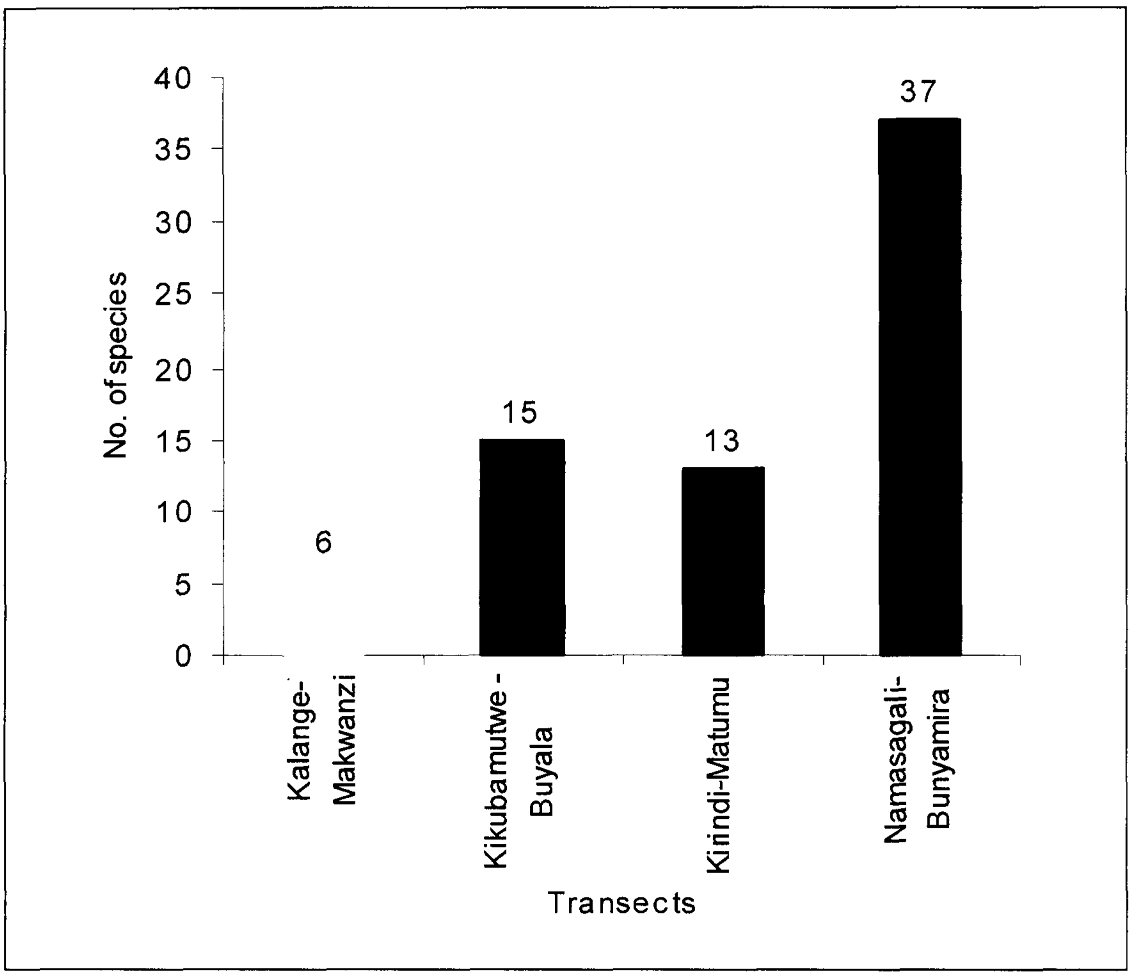


Fig. 5.1: Diversity of aquatic macrophyte species at the four transects

Description of macrophyte occurrence at the transects

5.4.1. Kalange-Makwanzi (Transect 1)

Four sites were sampled at this transect, with replicates of A, B and C i.e. Bubaale, Mukikonko, and Kuntukulu 1 and Kuntukulu 2. This transect was characterized by very steep banks on either side, with the eastern section more cultivated compared to the western part that was mainly a residential area. At Bubaale, the order of occurrence of aquatic macrophytes was such that *Vossia cuspidata* was dominant, *Eichhornia crassipes* was frequent, while *Pistia stratiotes* was rare. At Mukikonko, similar observations as at Bubaale were made; with *V. cuspidata* being the dominant plant, while *Eichhornia crassipes* and *Pistia stratiotes* were frequent and rare, respectively. Other plants that were present were majorly rare and included some climbers locally called libombwe, in addition to *Ipomoea aquatica*. Around the Kuntukulu Island, *V. cuspidata* was frequent, *E. crassipes* was rare, while other were rare and included *Ipomoea aquatica*, *Polygonum* sp., and some unidentified climbers locally called Musasizi. The riverbanks on the western side were denuded of aquatic plants and instead colonized by a weedy tree locally called Nkulaidho. At all these sites, a plant belonging to Asteraceae (Compositae) was present but rare.

5.4.2. Kikubamutwe-Buyala (Transect 2)

This transect was characterized by cultivation down to the watermark, thus exposing the banks to erosion by rain. Sites sampled at this transect were Kikubamutwe A and B on the western side, and Buyala A, B and C on the east. On the western side, *V. cuspidata* was abundant and *E. crassipes* was frequent. Other macrophytes such as *Ipomoea* spp., sedges, *P. stratiotes*, *Lemna* sp., and some genera belonging to the family Asteraceae were occasional. Among the rare plants were *Ficus* sp. and some species belong to Asteraceae.

On the eastern portion of the transect (Buyala), with common plants being *E. crassipes* and *V. cuspidata*. The former ranged from abundant to dominant, while the latter from rare to frequent. Other macrophytes were rare and included some sedges, *Leisia lexadra* and *Lemna* sp.

5.4.3. Kirindi-Matumu (Transect 3)

Like at the Kikubamutwe-Buyala transect, this area was characterized by cultivation down to the watermark, thus making the landscape vulnerable to rain erosion. Sites sampled were Kirindi A and B, Damba on the western part in addition to Nankandulo A and B on the east. On the western part of the transect, *V. cuspidata* ranged from frequent to abundant. Plants that occurred frequently were *Hydrocotyle ranunculoides* and *Cyperus mundti,* while those that were occasional included *E. crassipes*, *Phragmites mauritianus*, *Lemna* sp. and *Azolla africana*. Others such as *Ludwigia* sp., *Ipomoea* sp., *Sesbania sesban*, some climbers, some species of Asteraceae, sedges, and *P. stratiotes* were rare.

On the east of the transect, *V. cuspidata* and *E. crassipes* were locally abundant, while occasionally occurring plants included *S. sesban*, *P. mauritianus*, and sedges. The rest of the plants were rare and included species of Asteraceae, *Cyperus papyrus* and *I. aquatica*.

5.4.4. Namasagali-Bunyamira

This transect had the highest diversity of aquatic macrophytes probably because of its fairly quiescent waters. The sites sampled were Nsangabiyire and Kasimwe A and B on the east, and Lwabyata A and B and Bunyamira to the west. The landscape on either side of the river was relatively well covered with vegetation compared to the other three transects. There were extensive stretches of swamp with *C. papyrus* as the dominant macrophyte (Plate 5.4). *E. crassipes* on the other hand was the abundant macrophyte (Plate 5.4)

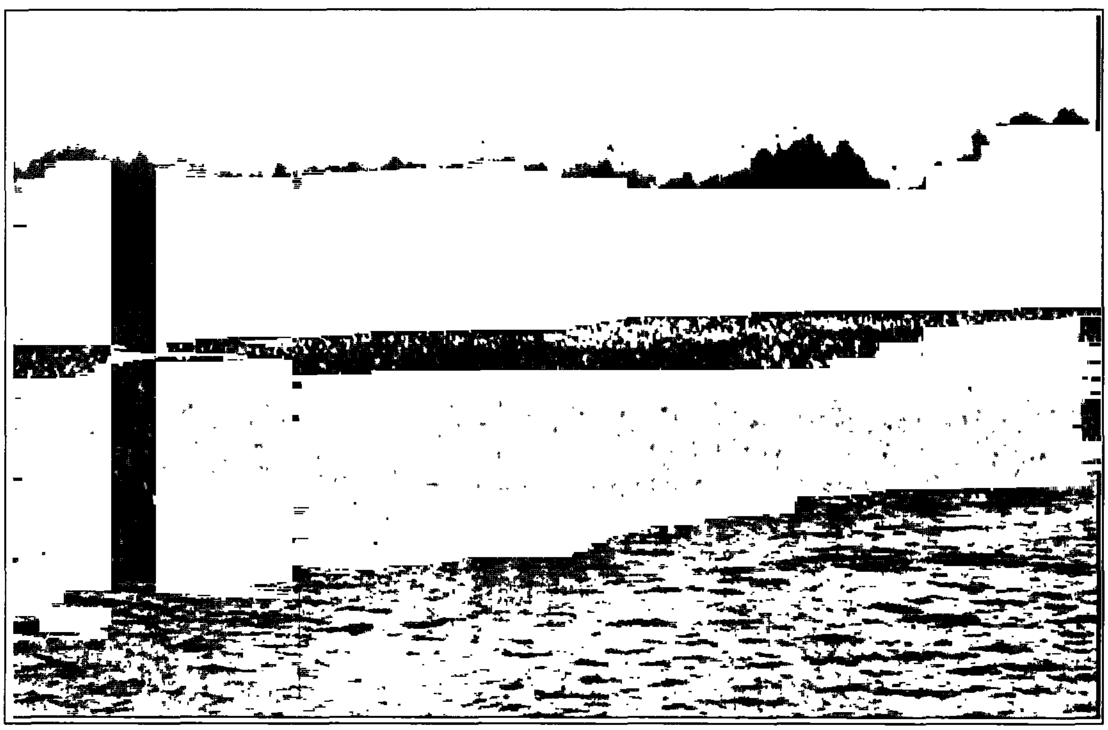


Plate 5.4. An extensive fringe of *E. crassipes* with a papyrus background

Those macrophytes that were frequent included *Ceratophyllum demersum*, *Vallisneria* sp. and *Nymphaea* sp. on the eastern side; on the west were *C. papyrus*, *P. mauritianum*, *Commelina* sp., *Polygonum* sp. Plants that occurred occasionally on the east were *Azolla africana*, *Cayratia ibuensis*, *Polygonum* sp., *Lemna* sp., *Vallisneria* sp., *Cayratia ibuensis* and *C. mundtii*, while on the west were *E. crassipes*, *S. seban*. *Sudia sagitifolia*, *C. demersum*, *Nymphaea* sp., *Najas horrida*, *Lemna* sp., *A. africana*, *Vallisneria* sp., *Cayratia ibuensis*, *C. demersum*, *Nymphaea* sp. and *Polygonum* sp. Several rare plants were identified and on the east were *Lemna* sp., *N. horrida*, *H. verticilata*, *C. bengalensis*, *P. stratiotes*, *V. cuspidata*, *Polygonum* sp., *Virginia* sp. On western side of the river, rare plants included some members of Asteraceae, *C. bengalensis*, *H. verticilata*, *C. mundtii*, *P. stratiotes*, *Sudia* sp., *V. cuspidata*, *Vallisneria* sp., *Lemna* sp. and *A. africana*.

5.5. Discussion

The observed recession in water levels has resulted into expansion of the aquatic macrophyte bed into the river channel, with exposed areas being colonized by opportunistic plants that were characteristic of muddy substrates. Exposure of sediments is known to result into enhanced nutrient release (Barbanti *et al.*, 1992; Bates & Neafus, 1980; Bostrom & Petterson, 1982; James *et al.*, 1996), a process that likely contributed to the expanded vegetated zones. In addition, low water levels led to exposure of rocks that formed ideal perching sites for various water fowl; their guano is assumed to contribute to nutrient enrichment of the system hence favoring rapid colonization of aquatic plants at exposed sites.

A total of 41 species of aquatic macrophytes were encountered (Table 5.1). Despite this diversity, the Kalange-Makwanzi transect had the lowest number of species (maximum of only 6), followed by Kirindi-Matumu transect with 13 species, Buyala-Kikubamutwe with 15 species, while Namasagali-Bunyamira transect registered the highest diversity of 37 macrophyte species. This was likely reflecting the level of human interference on the landscape, with Namasagali-Bunyamira area being the least disturbed hence highest macrophyte species.

5.6. Conclusions

The diversity of aquatic macrophytes was more than twice higher at the Namasagali-Bunyamira transect compared to that at the other three transects. This contrasts sharply from the conclusion made during the former surveys under AES Nile Power (2000). This assumed significant difference could be attributed to the low survey coverage that was done at the Namasagali-Bunyamira transect during 2000. Additionally, the low water levels that have characterized the river led to cultivation along some stretches down to the water mark thus leading to destruction of established macrophyte beds; this was especially so along the Buyala-Kikubamutwe, Kirindi-Matumu and to a lesser extent at the Kalange-Makwanzi transects. It is also possible that the draw down of the river water volume left some sites bare of water hence could have resulted into disappearance of some aquatic macrophytes previously encountered.

Table 5.1a: Check list for aquatic macrophytes at the four transects

SITE	*Vossia cuspidata*	*Eichhonia crassipes*	*Pistia stratiotes*	*Lemna trisulca*	*Polygonum setulosum*	*Ipomea aquatica*	*Commelina bengalesis*	*Ipomea rubens*	*Enhyndra feactuans*	*Sesbania sesban*	*Mikania cordata*	*Amaranthus dibuis*
Kalange-Bubale A	A	F	_	_	_	R	_	R	_	_	_	_
Kalange-Bubale B	A	F	R	_	_	R	_	_	_	_	_	_
Kalange-Bubale C	A	F	R	_	_	R	R	_	_	_	_	R
Kalange-mukikonkoA	A	F	R	_	_	R	_	_	_	_	R	_
Kalange-Mukikonko B	A	F	R	_	_	R	_	_	_	_	_	_
Kalange-Mukikonko C	R	A	_	F	_	_	_	_	_	_	_	_
Kalange-Kuntuukulu A	F	O	_	_	A	R	_	_	_	_	R	_
Kikubamutwe Landing A	A	R	R	_	A	R	R	R	R	R	R	R
Kikubamutwe Landing B	A	F	_	_	A	_	_	_	_	_	_	_
Kikubamutwe Landing A	A	A	R	R	_	_	_	_	_	_	R	_
Kikubamutwe-landing B	O	F	_	_	_	_	_	_	_	_	_	_
Kikubamutwe Landing C	F	_	_	R	_	_	_	_	_	_	_	_
Kirindi-Kirindi A	A	R	_	_	_	_	_	_	R	R	_	_
Kirindi-Kirindi B	F	R	_	R	_	_	_	_	R	_	R	_
Kirindi-Damba A	A	F	R	_	_	_	_	_	R	_	_	_
Kirindi-Nankandulo A	F	R	_	_	_	_	_	_	_	_	R	_
Kirindi-Nakandulo B	A	A	_	_	_	_	R	R	_	R	R	_
Namasangali-Nsangabiyire A	R	A	R	R	A	_	R	_	_	_	.R	_
Namasangali-Kasimwe A	R	A	R	R	A	_	R	_	_	_	_	_
Namasangali-Kasimwe B	R	A	R	R	R	_	_	_	_	_	_	_
Namasangali-Kaita A	R	R	_	_	_	_	F	_	_	R	R	_
Namasangali-Lwabyanta A	_	A	R	R	F	_	R	_	_	_	_	_
Namasangali-Bunyamira A	R	A	R	10	R	_	_	_	_	_	_	_

Table 5.1b

SITE	*Leersea hexadra*	*Solanum nigrum*	*Cyperus pectinantus*	*Ficus amadiensis*	*Cyperus munditii*	*Hydrocotyle ranunculoides*	*Phragmites australis*	*Azolla pinnata*	*Punchea diascoridis*	*Vernonia amygdalina*	*Sarcocephalus latifolius*
Kalange-Bubale A	–	–	–	–	–	–	–	–	–	–	–
Kalange-Bubale B	–	–	–	–	–	–	–	–	–	–	–
Kalange-Bubale C	–	–	–	–	–	–	–	–	–	–	–
Kalange-mukikonkoA	–	–	–	–	–	–	–	–	–	–	–
Kalange-Mukikonko B	–	–	–	–	–	–	–	–	–	–	–
Kalange-Mukikonko C	–	–	–	–	–	–	–	–	–	–	–
Kalange-Kuntuukulu A	–	–	–	–	–	–	–	–	–	–	–
Kikubamutwe Landing A	R	R	R	R	–	–	–	–	–	–	–
Kikubamutwe Landing B	–	–	–	–	–	–	–	–	–	–	–
Kikubamutwe Landing A	–	–	–	–	–	–	–	–	R	–	–
Kikubamutwe-landingB	R	–	O	–	–	–	–	–	–	–	–
Kikubamutwe Landing C	R	–	R	–	–	–	O	–	–	–	–
Kirindi-Kirindi A	–	–	–	–	F	F	R	–	–	R	R
Kirindi-Kirindi B	–	–	–	–	R	F	R	R	–	R	R
Kirindi-Damba A	–	–	R	–	–	–	–	–	–	–	R
Kirindi-Nankandulo A	–	–	O	–	R	–	–	R	F	–	–
Kirindi-Nakandulo B	–	–	R	–	–	–	R	R	–	–	–
Namasangali-Nsangabiyire A	–	–	R	–	R	R	–	R	–	–	–
Namasangali-Kasimwe A	–	–	R	–	R	–	R	R	R	–	–
Namasangali-Kasimwe B	–	–	R	–	R	R	–	R	R	–	–
Namasangali-Kaita A	–	–	R	–	R	–	F	–	–	–	R
Namasangali-Lwabyanta A	–	–	R	–	R	–	–	–	–	R	–
Namasangali-Bunyamira A	R	R	R	R	R	–	–	R	–	–	–

Table 5.1c

SITE	*Mondia whytei*	*Psychatia sesensis*	*Ludwigia stolonifera*	*Cyperus papyrus*	*Phoenix reclinata*	*Najas horrida*	*Hydrilla verticilata*	*Vallisneria americana*	*Europhia harsfarthii*	*N. lotus*	*Cayratia ibuensis*	*C. demersum*	*Hibiscus diversifolia*
Kalange-Bubale A	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalange-Bubale B	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalange-Bubale C	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalange-mukikonkoA	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalange-Mukikonko B	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalange-Mukikonko C	-	-	-	-	-	-	-	-	-	-	-	-	-
Kalange-Kuntuukulu A	-	-	-	-	-	-	-	-	-	-	-	-	-
Kikubamutwe Landing A	-	-	-	-	-	-	-	-	-	-	-	-	-
Kikubamutwe Landing B	-	-	-	-	-	-	-	-	-	-	-	-	-
Kikubamutwe Landing A	-	-	-	-	-	-	-	-	-	-	-	-	-
Kikubamutwe-landing B	-	-	-	-	-	-	-	-	-	-	-	-	-
Kikubamutwe Landing C	-	-	-	-	-	-	-	-	-	-	-	-	-
Kirindi-Kirindi A	R	R	-	-	-	-	-	-	-	-	-	-	-
Kirindi-Kirindi B	R	R	-	-	-	-	-	-	-	-	-	-	-
Kirindi-Damba A	-	R	-	-	-	-	-	-	-	-	-	-	-
Kirindi-Nankandulo A	-	-	R	-	-	-	-	-	-	-	-	-	-
Kirindi-Nakandulo B	-	-	-	R	-	-	-	-	-	-	-	-	-
Namasangali-Nsangabiyire A	-	-	R	D	-	R	R	F	R	F	R	F	R
Namasangali-Kasimwe A	-	-	R	D	-	R	R	R	R	-	R	-	-
Namasangali-Kasimwe B	-	-	R	D	-	-	-	R	R	-	R	-	-
Namasangali-Kaita A	-	-	R	F	-	-	-	-	R	-	-	-	-
Namasangali-Lwabyanta A	-	-	R	D	-	R	R	R	R	D	R	R	-
Namasangali-Bunyamira A	-	-	R	A	-	-	R	R	R	R	R	R	-

Key to codes:

D: Dominant
A: Abundant
F: Frequent
O: Occasional
R: Rare
-: Absent

CHAPTER 6

6.0. Micro-invertebrates Fauna

6.1. Background

A hydropower plant is planned to be built at Bujagali site located in the upper reaches of the Victoria Nile near Jinja. The status and dynamics of micro-invertebrate (zooplankton) fauna constitutes part of the investigations within a broad study of the fisheries and environment of the river prior to construction of the hydropower station. The study is intended to provide a basis for evaluating the impact of the project on the environment and the biological resources associated with it.

This report presents results on the micro-invertebrate/zooplankton community of the first quarter field sample collections from one site upstream and three sites downstream of Dumbbell Island, the proposed site of the power plant. This study was conducted between 6^{th} – 13^{th} April 2006, and comparison with data from April 2000 are made.

6.2. Materials and methods

Four study/sampling sites are located at Kalange upstream of Dumbbell, Buyala, Kilindi and Namasagali; all lying at increasing distances downstream of the proposed dam site (Fig. 2.1a). The same transects were sampled during April 2000.

Zooplankton were sampled using conical nets of the Nansen type, having a 0.25m mouth diameter and with a 60 μm nitex mesh size net. At each sampling site, one transect was established with five sampling points (except Kirindi and Namasagali which had three) covering as much as possible, the river width. For ease of sampling in running water conditions, sampling points were generally located in areas of low water currents i.e. downstream of islands or rocky outcrops or quiescent bays. At each sampling point, three vertical hauls were taken from about 0.5m above the riverbed and combined to make a composite sample. The samples were preserved in 4% sugar formalin solution (to stop 'ballooning' of Cladocera and consequent loss of contents of the brooding pouch). In the laboratory, each sample was placed in a clean glass beaker and diluted to a suitable volume (depending on the numerical concentration of the organism). Sub-samples of 2 and 5ml were taken from a well-mixed sample using a calibrated bulb pipette, placed on a counting chamber and examined under an inverted microscope (mag. X 20). The organisms were taxonomically identified to species level (adults only) using appropriate identification keys for Copepoda, Cladocera and Rotifera) and count data of the different taxa compiled.

6.3. Results

6.3.1. Faunal composition and frequency of occurrence

The zooplankton community was composed of six species of Cyclopoid copepods, one species of Calanoid copepods, seven species of Cladocera and 12 species of Rotifera (Table 6.1). The most frequent taxa in the samples were *Thermodiaptomus galeboides* (69%), *Thermocyclops neglectus* (62%), *Tropocyclops confinnis* (75%), *Tropocyclops tennelus* (75%), copepodite and naupliar growth stages of copepods (>75%), *Bosmina longirostris* (63%) and *Keratella tropica* (75%). Rare taxa (<10%) included *Ceriodaphnia cornuta*, *Daphnia lumholtzi, Macrothrix* sp., and several species of Rotifera.

Table 6.1. Checklist of zooplankton taxa encountered in samples from sites along four transects in Upper Victoria Nile, April 2006.

	Transect 1(Upstream) Kalange to Makwanzi					Transect 2 (Downstream) Buyala to				Transect 3 (Downstream)			Transect 4 (Downstream) Namasagali to				
Sites	Kalange 1	Kalange 2	Kalange 3	Kalange 4	Kalange 5	Mukisoga	Mugalya	Mukisajja	Kazinga	Edge	Mutuma middle	Mutuma edge	Rwabyata inshore	Rwabyata	Nsangabwire egde	Nsangabwire off	Frequency of occurrence
Copepoda																	
Thermodiaptomus galeboides	P	P	P	P	P	P	P	A	P	A	P	P	A	A	P	A	68.8
Mesocyclops sp.	P	P	P	A	P	A	A	P	A	A	A	P	A	A	A	P	43.8
Thermocyclops emini	A	P	A	P	P	P	A	P	A	A	A	A	A	A	A	A	31.3
Thermocyclops incisus	A	A	A	A	A	P	A	P	P	A	A	A	A	A	A	A	18.8
Thermocyclops neglectus	P	P	P	P	P	P	P	P	P	A	A	P	A	A	A	A	62.5
Tropocyclops confinnis	P	P	P	P	P	P	A	P	P	P	P	A	P	P	A	A	75.0
Tropocyclops tenellus	P	P	P	P	P	P	A	P	P	A	P	A	P	P	A	P	75.0
Calanoid copepodites	P	P	P	P	P	P	P	P	P	P	P	A	A	P	A	A	75.0
Cyclopoid copepodite	P	P	P	P	P	P	P	P	A	P	P	A	P	P	P	P	87.5
Nauplius larvae	P	P	P	P	P	P	P	P	P	P	P	A	P	A	P	P	87.5
Cladocera																	
Bosmina longirostris	P	P	P	P	P	A	A	A	P	P	A	P	A	P	A	P	62.5
Ceriodaphnia cornuta	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	6.3
Daphnia lumholtzi	A	A	A	A	A	A	A	A	A	A	A	A	A	A	P	A	6.3
Daphnia lumholtzi(helm)	A	A	P	P	A	P	A	P	P	A	A	A	A	A	A	A	31.3
Diaphanosoma excisum	P	A	P	P	P	A	A	A	A	A	A	A	A	A	A	A	25.0
Moina micrura	A	P	A	P	P	A	A	A	A	A	A	A	A	A	A	P	25.0
Macrothrix sp.	A	A	A	A	A	A	A	A	A	A	P	A	A	A	A	A	6.3
Chydorus sp	A	A	A	P	A	A	A	A	A	P	A	A	A	A	A	A	12.5
Rotifera																	
Brachionus angularis	A	P	P	A	A	P	A	P	A	A	A	A	P	A	A	A	31.3
Brachionus calyciflorus	P	A	P	P	P	A	A	A	P	P	A	A	A	P	A	A	43.8
Brachionus falcatus	A	A	A	A	A	A	A	A	P	A	A	A	A	A	A	A	6.3
Euclanis sp	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	6.3
Filinia longiseta	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	6.3
Filinia opoliensis	A	P	A	A	A	A	A	A	A	A	A	A	A	A	A	A	6.3
Keratella cochlearis	P	A	P	P	P	A	P	P	A	A	A	P	A	A	A	A	43.8
Keratella tropica	P	A	P	P	P	P	P	P	A	P	P	P	A	P	A	P	75.0
Lecane bulla	P	A	P	P	A	A	A	A	P	A	A	P	A	A	A	P	37.5
Polyarthra sp	A	A	A	P	A	A	A	A	A	A	A	A	A	A	A	A	6.3
Synchaeta sp	P	P	P	A	P	A	A	A	P	A	A	A	A	A	A	A	31.3
Trichocerca cylindrica	P	P	P	A	A	A	A	P	A	A	A	A	A	A	A	A	25.0

Elements of some macro-invertebrate community such as chaoborid and chironomid larvae, *Caridina nilotica* etc. that were caught along with zooplankton were eliminated from the present analysis.

6.3.2. Species richness

Species richness generally decreased with increasing distance downstream (Fig. 6.2). There was considerable variation in species richness exhibited by the three broad taxonomic groups between and within sampled sites. Upstream sites supported up to 6-8 species of Copepoda, Cladocera and Rotifera while downstream sites had at most 2-3 species.

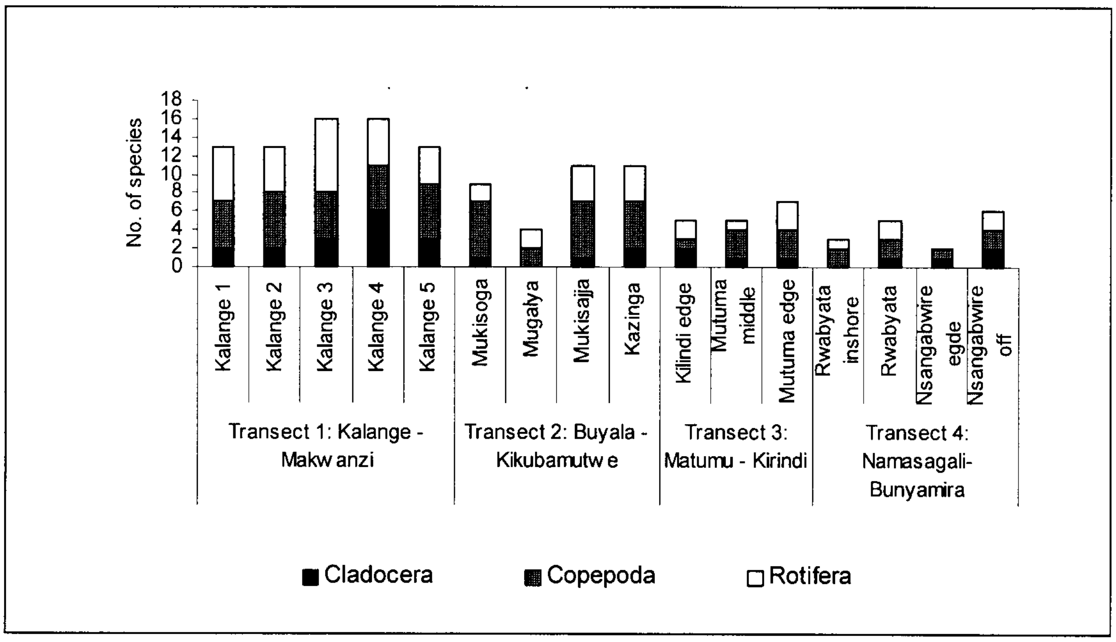


Fig. 6.2. Zooplankton species richness at sampled sites along four transects in Upper Victoria Nile April 2006.

6.3.3. Zooplankton distribution, densities and relative abundance

Most cyclopoid copepod taxa exhibited wide distribution being recovered at most sites especially in the upstream section of the sample area (Table 6.1, Fig. 6.3). Cladoceran and Rotiferan taxa, however, showed discontinuous distribution patterns throughout the sample area. *Keratella tropica*, exhibited the highest frequency of occurrence (75%) among rotiferan species.

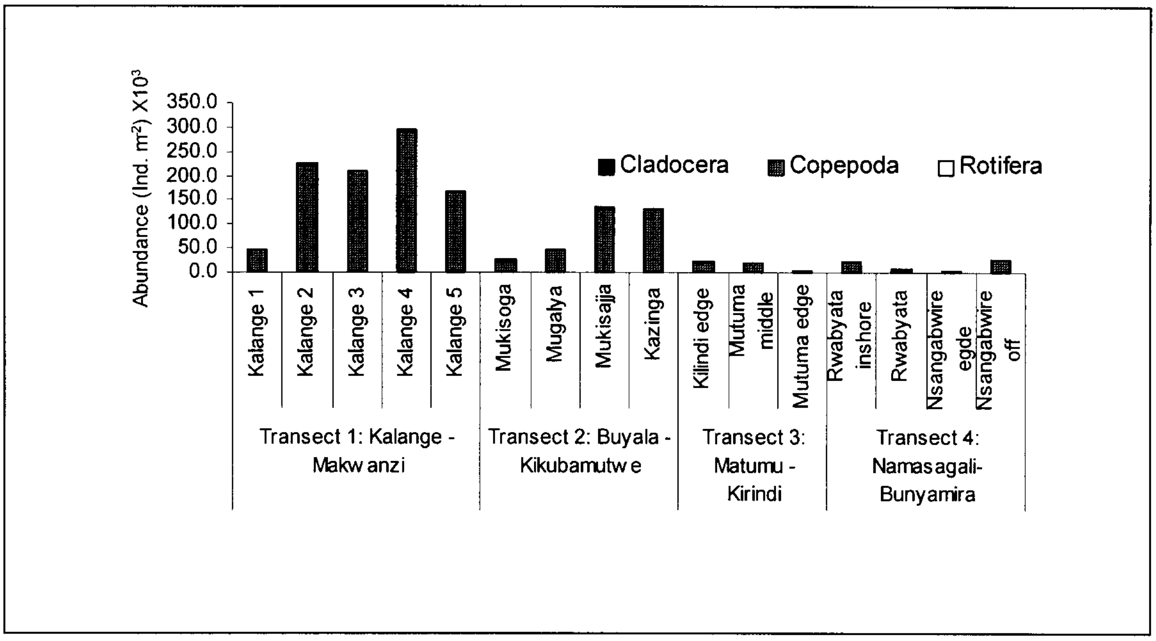


Fig. 6.3. Numerical abundance of zooplankton taxa at selected sampled sites along transects in Upper Victoria Nile, April 2006.

Copepod taxa generally exhibited higher abundance estimates (up to 290,000 indiv. m^{-2}) especially in the upstream sites between Kalange-Makwanzi and Buyala-Kikubamutwe (Fig. 6.3, Table 6.2). Other taxa occurred with generally much lower abundance (<5000 indiv m^{-2}) at most sites.

Table 6.2. Mean percentage composition of zooplankton taxa at the four sampling stations/transects along Upper Victoria Nile between Kalange and Namasagali, April 2006. Numbers in parentheses refer to Standard Errors (SE).

Parameters	Transect 1 Upstream Kalange to Makwanzi	Transect 2 Downstream Buyala to Kikubamutwe	Transect 3 Downstream Matumu to Kirindi	Transect 4 Downstream Namasagali to Bunyamira
Copepoda	97.3 (0.3)	98.5 (0.2)	73.0 (22.1)	88.1 (7.4)
Cladocera	1.1 (0.2)	0.1 (0.1)	4.3 (3.1)	3.9 (1.8)
Rotifera	1.6 (0.4)	1.4 (0.2)	22.6 (19.0)	7.9 (5.8)

Upstream sites exhibited considerably higher total zooplankton abundance (range 130,000-290,000 indiv. m^{-2}) compared to downstream sites (20,000-30,000 indiv. m^{-2}).

6.4. Discussion

The taxonomic composition reported here is comparable to that observed in the April 2000 AES report. In the 2000 survey, the second quarter report (Mwebaza-Ndawula *et al.* 2005; NARO AES Report 2000) indicated only a single species of Cladocera, *Diaphanosoma excisum*. This time round, the cladoceran species composition was much more diverse and comprised *Bosmina longirostris, Ceriodaphnia cornuta, Daphnia lumholtzi, D. excisum, Moina micrura* and *Macrothix* sp. Downstream decrease of zooplankton densities was also similar to the pattern observed in April 2000. The magnitude of the total densities observed (<5000 - 290,000 indiv. m^{-2}) is within range of those observed in April 2000 surveys (700-130,000 indiv. m^{-2}) but is well below density estimates for Lake Victoria which is the ultimate source of the River Nile water. In the 2000 AES report it was suggested that flowing water conditions probably have a major bearing on the biological mechanisms regulating zooplankton abundance as noted by Rzoska (1978). Such and other differences may be expected in comparisons of communities involving standing and running water ecosystems. Species richness decreased from 13-16 upstream to 2-7 in downstream sites. While the trend is similar to that of the 2000 AES data, these ranges appear to be wider than those observed in the 2000 surveys i.e. 2-6 recorded in the April 2000 data. The superabundance of copepods over other taxa is in consonance with observations in the AES data of April 2000.

6.5. Summary

- Species composition was dominated by rotifera while both Cladocera and copepods contributed nearly an equal number of species at most sites.
- Species richness decreased progressively from upstream to downstream sites
- Cyclopoid copepod taxa generally exhibited higher abundance estimates (up to 287,000 indiv. m^{-2}) especially in upstream sites at Kalange-Makwanzi and Buyala-Kikubamutwe.
- Upstream sites exhibited higher total zooplankton abundance (range 130,000-290,000 indiv. m^{-2}) compared to downstream sites (20,000-30,000 indiv. m^{-2}).
- In all cases, Copepoda contributed the greatest percentage of the total zooplankton (> 70%).

6.6. Conclusion and way forward

The survey reveals considerable similarity between the present data and that collected earlier by the AES project in April 2000. Some key aspects of the environment appear to have changed significantly over time. The current low water level is a case in point. This phenomenon was clearly visible during sampling with the watermark having receded as much as 10 metres in some places. Notably however, such changes in water level did not affect the location of sampling sites established during the 2000 AES surveys, which were the same points sampled in the present investigation.

The data generated here will, in due course, be compared to that to be generated in subsequent quarters in order to reveal temporal-spatial patterns of the zooplankton community constituents along the stretch of Upper Victoria Nile under study.

CHAPTER 7

7.0. The Diversity and Relative Abundances of Macro-invertebrates in the Upper Victoria Nile

7.1. Background

Aquatic macro-invertebrates mostly live in/on the bottoms of rivers, streams and lakes but some can live under roots of marginal plants. All macro-invertebrates macro-inveterbrates can be seen with naked eyes and have their own adaptations and requirements to life under water. They are good indicators of water quality due to their varying sensitivity to water pollution. Thus, diversity and abundance of macro-invertebrate types and how they frequently occur can be an indication of environmental quality of an aquatic system.

This report provides baseline information on the diversity and relative abundance of macro-invertebrates for the pre-construction period (1st quarter) of the Bujagali Hydropower Project at Dumbbell site on the Upper Victoria Nile. This study was conducted between 6th –13th April 2006. The assessment survey was conducted at three points (east, mid and west) on one upstream transverse transect (Kalange-Naminya) and three downstream transects (Buyala-Kikubamutwe, Kirindi-Matumu and Sangabwire-Lubwata/Namasagali). Similar data will be collected in the subsequent quarters and during construction and post-construction operation of the project. Results from this survey are compared with those that were obtained in April 2000 under AESNP EIA study of the second quarter.

7.2. Materials and Methods

Samples were collected from among plant roots and from benthic sediments. Sediment samples were collected in triplicate using a ponar grab of surface area 236.45 cm^2 at three points namely, west, mid and east along the transverse transects, one of which is upstream and three downstream the proposed Hydropower Dam project at Dumbbell site (Fig.2.1a). The macro-invertebrates from plant roots were collected using a 400 μm mesh net of cross-section area 1885 cm^2. The net, mounted on a long handle, was inserted below the plant roots and moved vertically up and down several times to dislodge and collect the organisms. The samples were sieved through a washing bag of mesh size 500 μm and preserved with 70% alcohol in plastic sample bottles. In the laboratory, the macro-fauna were sorted, identified mostly to genus level (Merritt & Cummins 1997, Pennak 1989, Voshell 2002) and enumerated. Part of each sample was re-preserved in 70 % alcohol and stored in plastic vials for future reference. Results were computed as number of organisms per square meter.

7.3. Results

7.3.1. Comparison of total benthic density: April 2000 and 2006

Total benthic density was highest at Kalange-Naminya (Transect 1) during April 2000 survey whereas in this survey, density was highest at the Matumu-Kirindi (Transect 2) (Fig. 7.2). The overall areal density at the former reached a high of 14,705 ind. m^{-2} on the eastern sampling point of the transect and 11128 ind. m^{-2} on the western point. At the latter, maximal densities of 2580 and 2453 ind. m^{-2} respectively were registered at the eastern and western sampling points of the transects.

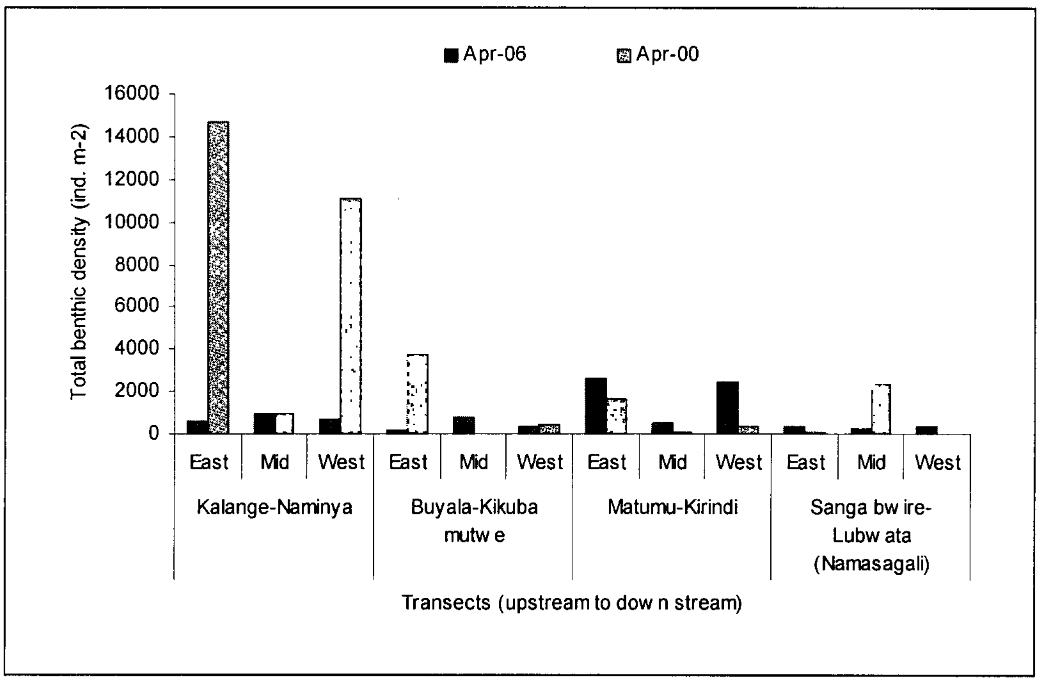


Fig. 7.2. Comparison of overall benthic macro-invertebrates density across four transects on the upper Victoria Nile during April 2000 and 2006.

7.3.2. Comparison of total macro-invertebrate density under plant roots:April 2000 and 2006

The densities of macro-invertebrates under plant roots for this survey were slightly higher than those during April 2000 survey (Fig. 7.3). Density during this survey ranged from 57 ind.m^{-2} at the mid point on Kalange-Naminya transect to 354 ind.m^{-2} at western edge of Sangabwire-Lubwata (Namasagali) transect. During the April 2000 survey, the density varied from 44 ind.m^{-2} at the eastern edge of Sangabwire-Lubwata (Namasagali) transect to 153 ind.m^{-2} at the eastern edge of Kalange-Naminya transect.

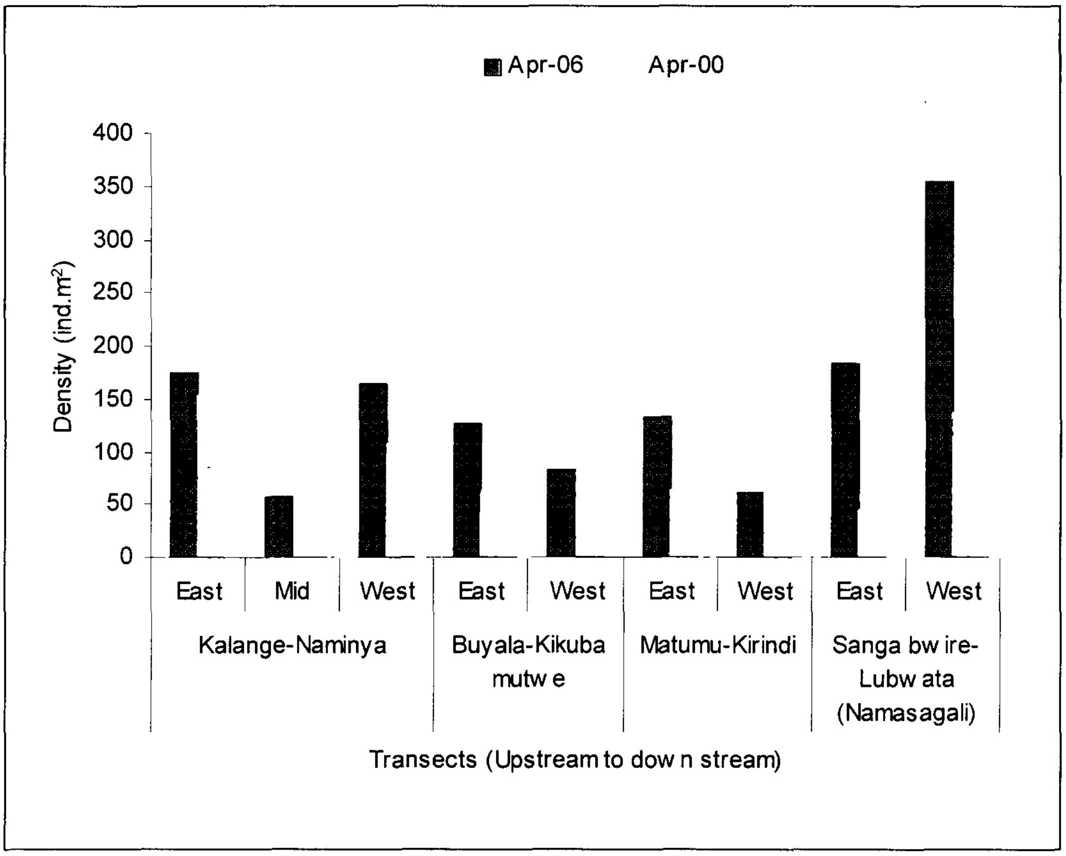


Fig. 3. Comparison of overall macro-invertebrates density under plant roots across four transects on the Upper Victoria Nile during April 2000 and 2006.

7.3.3. Comparison of macro-invertebrate density: benthic and under plant roots

Along all transects benthic macro-invertebrates density was much higher than that under plant roots (Fig. 7.4). The highest benthic density was recorded at the eastern and western sample points of Matumu-Kirindi transect, up to 2580 and 2453 indi. m^{-2}, respectively. Along the Sangabwire-Lubwata Namasagali transect, density ranged between 240 at the mid point and 381 indi. m^{-2} at the eastern point (Fig. 7.4). For densities under plant roots, there were no samples obtained at mid points except on Kalenge-Naminya transect, where there was a small island, which had plants.

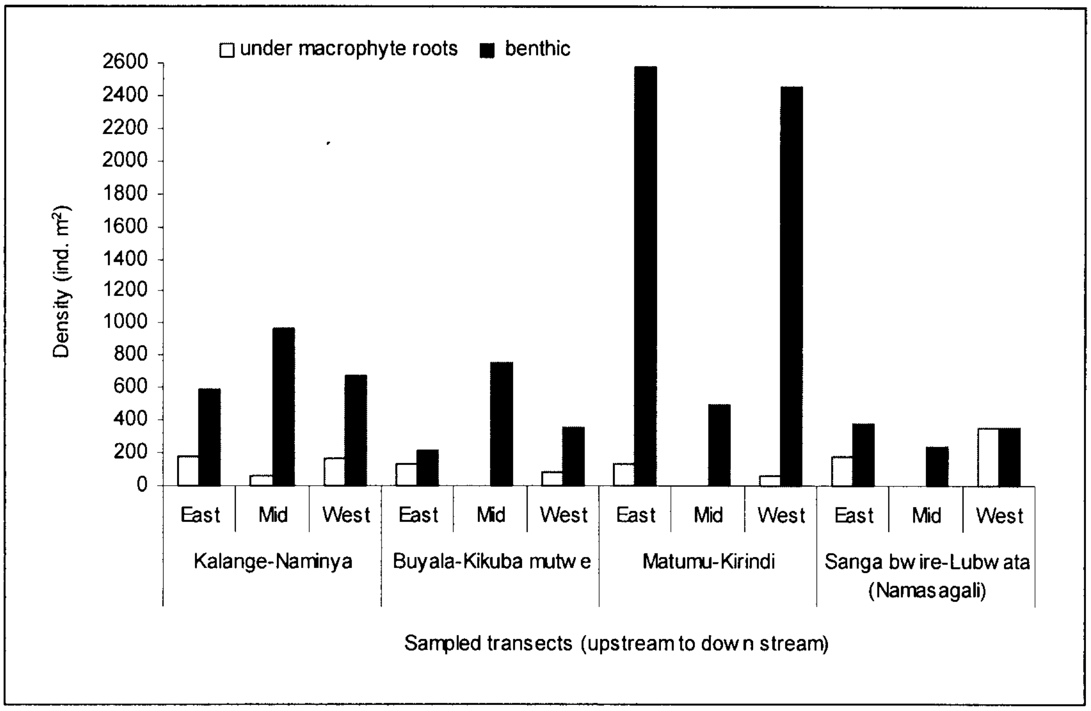


Fig. 7.4. Comparison of benthic macro-invertebrates density and of macro-invertebrates under roots of marginal plants along four transects, April 2006

7.4. Relative taxa densities under plant roots

Along the most downstream transect, Sangabwire-Lubwata/Namasagali, *Caridina nilotica* was the most dominant taxon comprising 69% (244 ind. m^{-2}) and 82 % (150 ind. m^{-2}) of density at western and eastern points of the transect, respectively (Fig. 5). The other taxa at the western edge of the transect were: Ephemeroptera (9%), Bivalvia (9%), Chironomidae (6%), Gastropoda (3%), Odonata (3%), Coleoptera (2%) and Hydracarina (2%); and at the eastern point, they were: Ephemeroptera (6%), Chironomidae (6%), and Hydracarina (3%). During April 2000 survey, *C. nilotica* was as important as during this survey, contributing 64% (28 ind. m^{-2}) and 83% (114 ind. m^{-2}) at the eastern and western edges of the transects, respectively (AESNP report, 2nd quarter 2000). Taxa like Ephemeroptera and Chironomidae contributed 17% and 4% respectively at the western edge of the transect during April 2000 survey. Hydracarina was the only other taxon that was recorded at the eastern edge during second quarter April 2000 survey.

At the eastern point on Matumu-Kirindi transect, the bivalves dominated the density by 56% (74 ind. m^{-2}), followed by gastropods 36% (48 ind. m^{-2}), *Caridina nilotica* 16% (21 ind. m^{-2}), ephemeropterans 14% (19 ind. m^{-2}), odonates 8% (11 ind.m^{-2}) and hemipterans 3% (4 ind.m^{-2}) (Fig. 7.3). At the western point on Matumu-Kirindi transect, *C. nilotica* contributed the highest density 45 % (28 ind. m^{-2}), then followed by Bivalvia 19% (12 ind. m^{-2}), Ephemeroptera 15 % (9 ind. m^{-2}) and Odonata 11% (7 ind. m^{-2}) and Gastropoda 8% (12 ind. m^{-2}). During the April 2000 survey, five taxa were encountered as follows: ephemeropterans 35% (22 ind. m^{-2}), Gastropds 10% (6 ind. m^{-2}), odonates 18 % (11 ind. m^{-2}), tricopterans 10% (6 ind. m^{-2}) and Hydracarina 27% (17 ind. m^{-2}) at the western edge. On the eastern edge too, 5 taxa were recorded which included ephemeropterans 37% (23 ind. m^{-2}), chironomides 37% (23 ind. m^{-2}) Gastropds 10% (6 ind. m^{-2}), tricopterans 10% (6 ind. m^{-2}) and plecopterans 10% (6 ind. m^{-2}) at the western edge.

At the Buyala-Kikubamutwe western point, Ephemeroptera contributed 52% (44 ind. m^{-2}) the highest density followed by Bilvalvia 13% (11ind. m^{-2}), *C. nilotica* 11 % (9 ind. m^{-2}), Gastropoda 11% (9 ind. m^{-2}), Odonata 8% (7 ind. m^{-2}) and Chironomidae 6% (5 ind. m^{-2}) (Fig. 7.4). At the eastern point on Buyala-Kikubamutwe transect, *C. nilotica* 49 % (62 ind. m^{-2}) was the most dominant, then followed by Ephemeroptera 29 % (37 ind. m^{-2}), Bilvalvia 11% (14 ind. m^{-2}), Gastropoda 11% (14 ind. m^{-2}) and Hemiptera 9% (11 ind. m^{-2}) (Fig 7.5). There were three taxa recorded at the western edge of the transect during April 2000 survey namely: Gastropoda 5 % (6 ind. m^{-2}), Bivalvia 90% (108 ind. m^{-2}) and chironomidae 5% (6 ind. m^{-2}). During the same survey, four taxa were encountered, including Gastropoda 13% (8 ind. m^{-2}), Bivalvia 64% (40 ind. m^{-2}), Hemiptera 18 % (11 ind. m^{-2}) and Chironomidae 3% (2 ind. m^{-2}).

At the Kalange-Naminya western point, Ephemeroptera contributed the most by 34% (55 ind. m^{-2}), followed by Chironomidae 13% (21 ind. m^{-2}), *C. nilotica* 13% (21 ind. m^{-2}), Bilvalvia 13% (21 ind. m^{-2}), Simulium sp. 13% (21 ind. m^{-2}), Gastropoda 7% (12 ind. m^{-2}), Hemiptera 7% (12 ind. m^{-2}) and Odonata 4% (7 ind. m^{-2}). At the eastern point on the same transect, Ephemeroptera 27% (48 ind. m^{-2}) was the most dominant, then followed by Gastropoda 21 % (37 ind. m^{-2}), Odonata 16 % (28 ind. m-2), Chironomidae 15% (27 ind. m^{-2}), *C. nilotica* 7% (12 ind. m^{-2}), Hydracarina 8% (14 ind. m^{-2}) and Hemipera 2% (4 ind. m^{-2}). It was only on this transect that the mid point was sampled for macro invertebrates under plant roots, which consisted of Ephemeroptera 72% (41 ind. m^{-2}), Coleoptera 4% (2 ind. m^{-2}) and Chironomidae 16% (9 ind. m^{-2}) (Fig. 7.5). Unlike in the current survey, during April 2000 survey, Nematodes were recorded at both the eastern and western edges of the transect, contributing 60% (91 ind. m^{-2}) and 6% (6 ind. m^{-2}) of total density respectively. Apart from Nematodes, three other taxa were recorded at the eastern edge, and these included gastropods 30% (46 ind. m^{-2}), ephemeropteran 7% (11 ind. m^{-2}) and hemipterans 4% (6 ind. m^{-2}). Then on the western edge, six other taxa were encountered and these were: gastropods 21% (23 ind. m^{-2}), ephemeropterans 21% (23 ind. m^{-2}) and hemipterans 16% (17 ind. m^{-2}), chironomids 10% (11 ind. m^{-2}), odonates 16% (17 ind. m^{-2}) and Hydracarina 10 % (11 ind. m^{-2}).

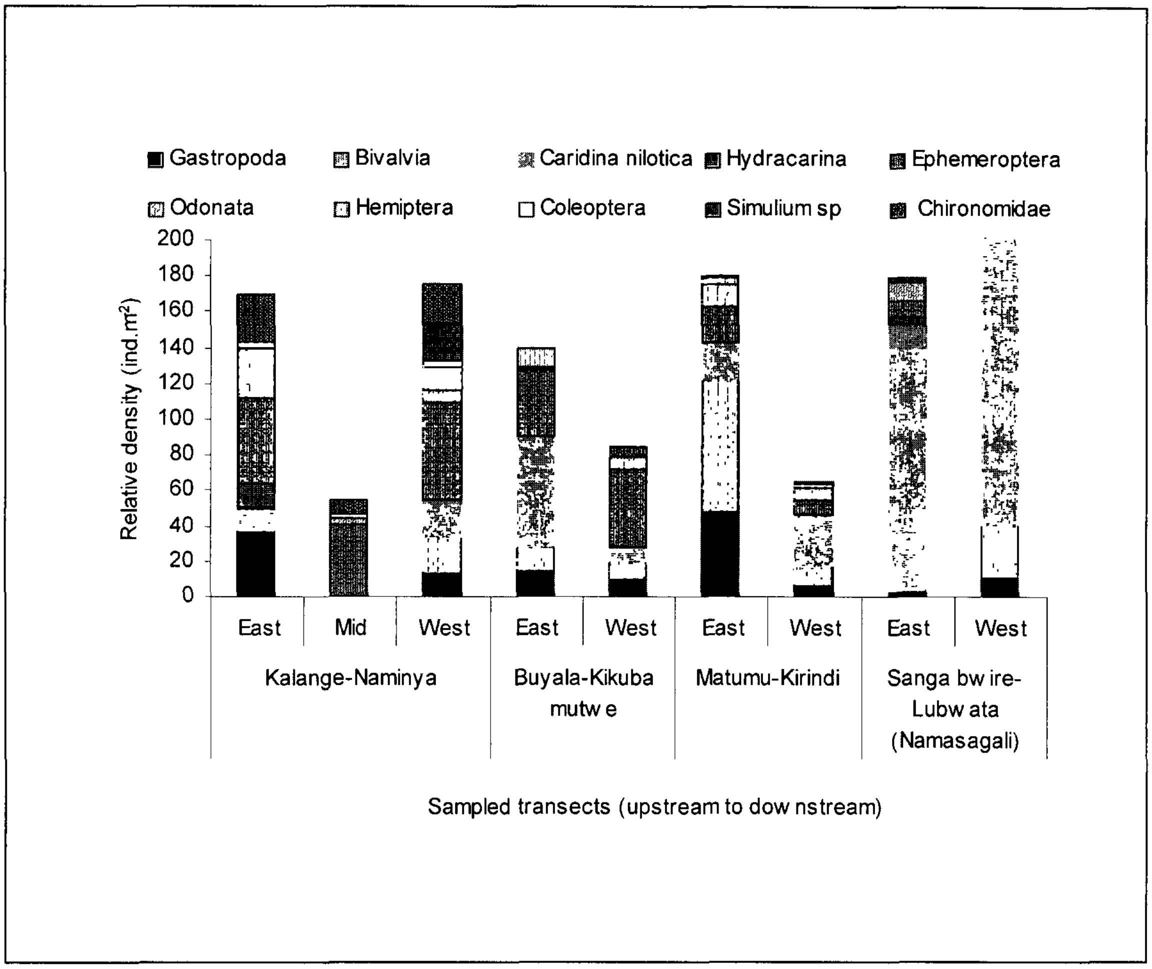


Fig. 7.5. Relative density of major taxa of macro-invertebrate under roots of plants along four sampling transects on Upper Victoria Nile, April 2006.

7.5. Relative taxa densities of benthic macro-invertebrates

Along Sangabwire-Lubwata Namasagali transect, at western and eastern points respectively, only one taxon, Chironomidae at densities of 310 and 296 ind. m^{-2} was encountered (Fig. 7.6). However, at the mid of the transect, three taxa were found namely Chironomidae 47% (113 ind. m^{-2}), Bivalvia 18% (42 ind. m^{-2}) and Ephemeroptera 6% (14 ind. m^{-2}). During the April 2000 survey, two taxa, Nematoda 63% (68 ind. m^{-2}) and Chironomidae 37% (41 ind. m^{-2}) were recorded at the eastern edge. At the western edge too in this survey, two taxa, Bivalvia 67 % (27ind. m^{-2}) and Chironomidae 33% (14 ind. m^{-2}) were encountered, and at the mid point, six taxa groups were encountered dominated by Bivalves 82% (1972 ind. m^{-2}). The other taxa included Ephemeroptera, Trichoptera, Odonata, Nematoda and Chironomidea.

At the eastern point on Matumu-Kirindi transect, Chironomidae dominated the density by 61% (1579 ind. m^{-2}) followed by Bivalvia 16% (409 ind. m^{-2}), Gastropoda 10% (268 ind. m^{-2}), *Ostracoda* 7% (169 ind. m^{-2}) and Ceratopogonidea 3% (70 ind.m^{-2}). At the western point on this transect, Chironomidae still contributed *the* most by 61% (1508 ind. m^{-2}) followed by Bivalvia 28% (677 ind. m^{-2}), Gastropoda 7% (169 ind. m^{-2}) and Ceratopogonidea 2% (42 ind.m^{-2}). The mid point on the transect registered very low benthic density that comprised of three taxa: Chironomidae 31% (155 ind. m^{-2}), Ephemeroptera 26% (127 ind. m^{-2}) and Bivalvia 17% (85 ind. m^{-2}). During the April 2000 survey, 5 taxa group were recorded at both the western and eastern edge of the transect. At the eastern edge, these were Chironomidae 74% (1197 ind. m^{-2}), Ephemeroptera 24% (380 ind. m^{-2}), Tricoptera 1% (14 ind. m^{-2}), Bivalvia 1% (14 ind. m^{-2}) and Gastropoda 1% (14 ind. m^{-2}). At the western edge, Chironomidae 52% (190 ind. m^{-2}), Bivalvia 30% (108 ind. m^{-2}) Odonata 11% (41 ind. m^{-2}), Tricoptera 4% (14 ind. m^{-2}), and Nematoda 4% (14 ind. m^{-2}) were recovered. At the mid, two taxa, Chironomidae 57% (54 ind. m^{-2} and Tricoptera 43% (41 ind. m^{-2}) were recorded.

At the Buyala-Kikubamutwe western point, three taxa were encountered namely: Ephemeroptera 56% (197 ind. m^{-2}), Gastropoda 16% (56 ind. m^{-2}) and Chironomidae 16% (56 ind. m^{-2}) Fig. 6. At the mid point of the transect, three taxa too were encountered as follows: Bivalvia 35% (268 ind. m^{-2}), Gastropoda 37% (282 ind. m^{-2}) and Chironomidae 26 % (197 ind. m^{-2}). At the eastern point on the transect, Bilvalvia was 20% (42 ind. m^{-2}). The other two taxa were Chironomidae and Gastropoda each contributing 33 % (70 ind. m^{-2}). During April 2000 survey, Bivalvia was the most dominant taxon at both eastern and western edges of the transect by 70% (2643 ind. m^{-2}), and 58% (258 ind. m^{-2}),, respectively. At the eastern edge during the same survey, five other taxa were recorded as follows: Gastropoda 21% (784 ind. m^{-2}), Ephemeroptera 2% (81ind. m^{-2}), Tricoptera 1 % (45ind. m^{-2}), Odonata <1% (14 ind. m^{-2}), Chironomidae 5% (204 ind. m^{-2}) and Nematoda <1% (23 ind. m^{-2}). The mid point registered no benthos during this survey.

At the Kalange-Naminya eastern point, three taxa were encountered, namely Chironomidae 62% (367 ind. m^{-2}), Bivalvia 29% (169 ind. m^{-2}) and Ceratopogonidea 2% (14 ind. m^{-2}). At the mid point, three taxa were encountered as follows: Chironomidae 52% (508 ind. m^{-2}), Bivalvia 25% (240 ind. m^{-2}) and Ephemeroptera 10% (99 ind. m^{-2}). At the western point, only two taxa were encountered, Gastropoda 27% (183 ind. m^{-2}) and Bivalvia 62 % (423 ind. m^{-2}). During April 2000 survey, Gastropoda was the most dominant taxon at both eastern and western edges of the transect by 53 % (7768ind. m^{-2}), and 89% (9862 ind. m^{-2}), respectively. At the eastern edge during the same survey, six other taxa were recorded as follows: Ephemeroptera 23% (3414 ind. m^{-2}), Tricoptera 1% (45ind. m^{-2}), Bivalvia 3% (462ind. m^{-2}), Odonata <1 % (14 ind. m^{-2}), Chironomidae 5% (204 ind. m^{-2}) and Nematoda <1% (23 ind. m^{-2}). Apart from gastropods, five other taxa were encountered namely: Ephemeroptera 2% (299 ind. m^{-2}), Tricoptera <1% (14 ind. m^{-2}), Bivalvia<1% (54 ind. m^{-2}), Chironomidae 4% (490 ind. m^{-2}) and Nematoda 3 % (408 ind. m^{-2}).

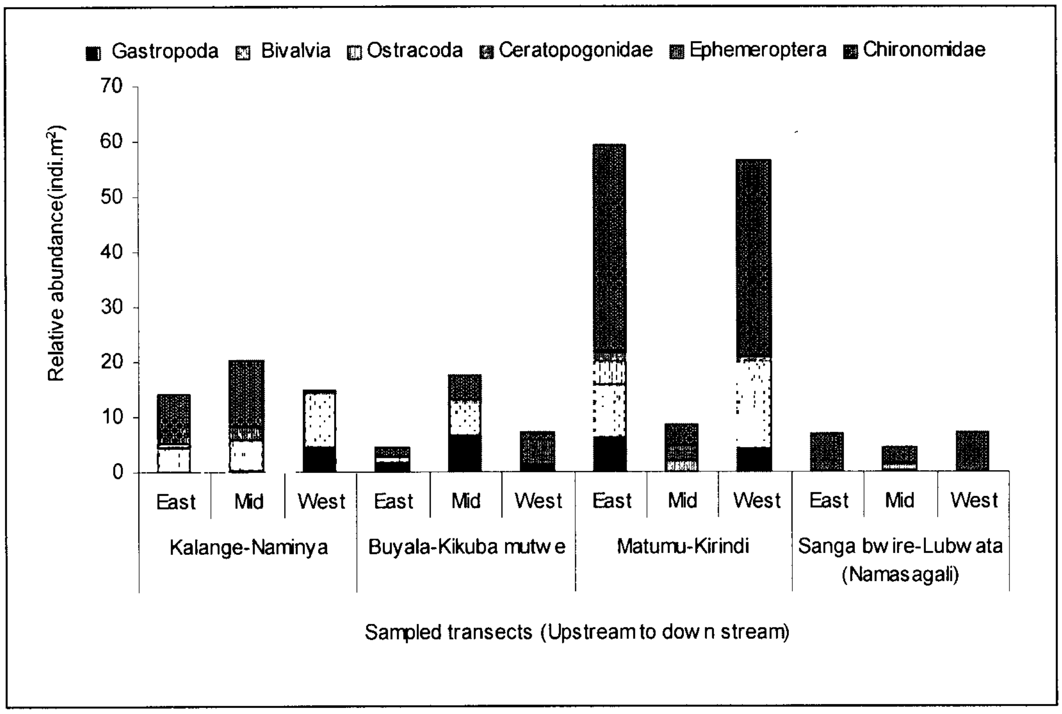


Fig. 7.6. Relative taxa composition and abundance of benthic macro-invertebrates at the eastern, mid and western sampling points on four transects across the upper River Victoria Nile, April 2006

7.6. Discussion

One group of organisms especially sensitive to water pollution are the combined insect Orders of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies), abbreviated EPT. High numbers (at least 100 indi. m^{-2}) of these organisms in a river represent good water quality. Their absence or just occasional occurrence may indicate a pollution problem. A macro-invertebrate community dominated by organisms more tolerant of pollution, such as aquatic worms and midges, usually indicates a problem.

CHAPTER 8

8.0. Fish species Composition and Relative Abundance

8.1. Background

Construction of the proposed Bujagali Hydroelectric dam at Dumbbell Island on the River Nile is likely to cause changes in the river water regimes both upstream and downstream. This may affect fish habitats and thus composition and abundance of fish populations above and below the dam. Many fish species presently occurring in this river are suited to particular types of habitats that may be altered by the presence of the dam. Water quality characteristics during construction are likely to be altered and could also affect fish distribution along the river. Considering that fish provide the cheapest source of animal protein and income to the riparian human populations along this river any change in the fish populations could affect the livelihood of these people. It is therefore necessary to monitor changes in fish composition and abundance to mitigate dam construction effects. The objectives of this study therefore were to:

a) Determine fish species composition at selected transects upstream and downstream of the proposed dam site.
b) Determine changes in their size distribution over time at those sites.
c) Assess the relative abundance of the species.
d) Monitor the above parameters during and after dam construction.

This part of the report gives the present fish species composition, distribution and their relative abundance along transects upstream and downstream of Dumbbell Island and compares the results with the April 2000 study. Monitoring the above parameters is expected to be done prior to, during and after construction in order to determine changes in fish population as influenced by both the construction and the presence of the dam.

8.2. Materials and Methods

Three fleets of gill-nets comprising pieces of mesh sizes 1" to 5.5" in 0.5" increments, and 6 to 8 in 1" increments were set overnight twice at each of the four transect stations between 6^{th} – 13^{th} April 2006. A similar procedure was used during the April 2000 survey. At each station, fleets were set so as to cover a broad range of habitat conditions i.e. of different bank features such as vegetation or rock, adjoining bays, mid-channel, and off islands. Locality names were noted.

The nets were set between 1800hr to 1900hr, and removed between 06.00h and 07.00h the following day. Each block of nets was separated and handled according to fishing grounds.

Experimental catch and biometric data on large sized fish species were taken on spot while the smaller sized ones were preserved for laboratory examination. Fish were sorted according to mesh size, identified and separated into species

Measurements (weight in grams, length as total length in centimetres) and other biometric indices (sex, gonad condition, degree of stomach fullness and fat content) were recorded. Gonad maturity state was based on I to VII - scale according to the method of (Bagenal and Braum, 1978). Stomach fullness and fat content were assessed by eye as empty, ¼, ½, ¾ and full.

Stomach contents of small fishes and the tilapiines and ripe ovaries - states V and VI were preserved respectively in a mixture of 5-10% formalin and 50% ethanol for laboratory analyses. Due to their growth form, the length (in centimeters) of fish was measured either as Total Length (TL), Forkal Length (FL), or Standard Length (SL).

8.3. Results

8.3.1. Catch composition

A total of 18 fish species were recorded at all stations along the river (Table 8.1). 11 species were recorded at Buyala, 10 at Kalange, seven at Namasagali, and six at Kirindi. *L. niloticus* and the Haplochromines were caught at all stations sampled. Although experimental nets missed *Rastrineobola argentea,* the species was observed at Buyala from the local fisher's catches.

In terms of numbers, catches were dominated by the haplochromines. *M. kannume* and *L. niloticus* were second and third respectively in importance (Fig. 8.1). By weight, *M. kannume* became the dominant fish species followed by *L. niloticus* and then the haplochromines (Fig. 8.2).

8.3.2. Catch rates / biomass estimates

As a measure of standing biomass, catch rates (i.e. catch per net per night) was used as indicator of relative abundance of fish species from the stations under survey. To analyze for catch per net, gillnets were grouped into three size categories, small (1 to 2½ inches stretched mesh), medium (3 to 4½) and large (5 to 8 inches). There was no order of biomass with distance from either lake. Highest biomass was recorded at Buyala and lowest at Kirindi. The overall catch per net both by numbers and weight decreased with the size category of net (Fig. 8.3). Total catch rates of different fish species from the four stations during the current and a similar quarter in 2000 are given in Table 8.2. Highest biomass in the river comprised of the haplochromines with a catch rate of 188.7g per net. *M. kannume* with a mean catch rate of 165.7.2g per net was second. Other fish species showing high rates in order of importance were *L. niloticus* (70.4g), *Tilapai zillii* (30.4g) and *Barbus altianalis* (29.3g). All these are species that grow to large adult sizes (keystone species) and therefore form the basis of the artisanal fishery along this river. With the exception of the haplochromines which dominated the catch, catches of all species from the April 2006 survey were lower compared to a similar period in 2000.

8.3.3. Length frequency Distribution

Size distribution of *Lates niloticus* caught during the survey (Fig. 8.4) ranged from 8 to 37cm TL. All the *Lates* specimens caught were immature with mean length ranging from 18.3 cm in Buyala to 21.6cm TL in Kirindi. *M. kannume* ranged in size from14 to 64cm FL. Fishes of the size range 21 to 25 cm FL dominated the population of this species in the river (Fig. 8.5). The overall mean length was calculated at 19 cm TL. The largest *Mormyrus* was at 64 cm FL and was recorded at Buyala. All *R, argentea* caught in the artisanal fishery at Buyala were immature with an average length of 19 mm SL.

8.4. Discussion

Fish species caught in the Upper Victoria Nile are typical Victorian (inshore) and Kyoga fauna. At Kirindi, the middle station yielded *Xystichromis bayoni,* a typical Upper Victorian haplochromine. Using catch rates (catch per net), one can arrive at an indication of the biomass of different fish species found in the river. These rates will over time be the basis of comparative assessment of stocks at different times and from different transects. Gillnetting revealed low catch rates compared to a similar period in 2000. The order of importance of fish species also shifted in favour of the haplochromines in the April 2006 survey. This is in agreement with the current trends in the two lakes terminal to the upper Victoria Nile. In these lakes a recovery of haplochromines has been observed (IFMP reports 2005, NAFIRRI Report 2006). There was also a noticeable increase in the biomass of *Oreochromis variabilis* a species native to the two lakes, (Lake Victoria and Lake Kyoga) whose numbers had been greatly reduced in these waters. *O. niloticus* performed poorly compared to the previous April 2000 survey. Even among the artisanal catches this species was prominent in Kalange the nearest station to Lake Victoria and at Namasagali, nearest to L. Kyoga. Low catches of *O. niloticus* are common during breeding periods of the species as mobility and thus access to gillnets is reduced due to breeding activities.

8.5. Summary

- 18 fish species were recorded from experimental nets along the river, between Kalange and Namasagali.
- Highest species diversity was observed from Namasagali consisting mainly of anadromous fish species from Lake Kyoga.
- All keystone species identified during the previous survey were present. Commercially important fish species in the river *M. kannume, B. altianalis,* and *L. niloticus* were encountered at all stations along the river.
- Gillnets set in shallow waters very close to the shores recovered fish species that grow to a small adult size and juveniles of the large species while the large adults tended to be found in the deeper waters in the middle of the river.

- Small sized fishes dominated catches with the highest rates registered by the haplochromines.

8.6. Conclusion

All keystone fish species expected in the river were recorded. Poorer fish catches were realized compared to a similar season in 2000. This could have probably been due to less amount of movement due to breeding activities. This time round, the perennial problem of net loss in the river was minimal. It occurred only at Namasagali where on the first day of setting, a whole fleet was washed away by the strong current.

Table 8.1. Fish species recorded at the four sampling stations on the Upper Victoria Nile April 2006

Family	Species	Transect 1 Upstream Kalange to Makwanzi	Transect 2 Downstream Buyala to Kikubamutwe	Transect 3 Downstream Kirindi to Matumu	Transect 4 Downstream Namasagali to Bunyamira	All Transects April 2000
Bagridae	*Bagrus docmak*			p		p
Centropomidae	*Lates niloticus*	p	p	p	p	p
Characidae	*Brycinus jacksonii*		p			p
	B. sadleri	p				p
Cichlidae	*Oreochromis niloticus*	p	p			p
	O. leucostictus	p	p			p
	O. variabilis	p	p			p
	Tilapia zillii	p	p		p	p
	Haplochromines	p	p	p	p	p
Cyprinidae	*Barbus altianalis*	p	p	p		p
	B. paludinosus		p			p
	Labeo victorianus			p		p
	Rastrineobola argentea					p
Mochokidae	*Synodontis afrofischeri*	p				p
	S. victoriae				p	p
Mormyridae	*Marcusenius grahami*					p
	Mormyrus kannume	p	p	p		p
	M. macrocephalus					p
	Gnathonemus victoriae				p	p
	G. longibarbis				p	p
Schilbeidae	*Shilbe intermedius*					p

(p = present)

Table 8.2. Catch per net per night (g) of fish species from experimental gillnets during the 1st quarter (April 2006) at the four transects along River Nile.

Species	Transect 1 Upstream Kalange to Makwanzi		Transect 2 Downstream Buyala to Kikubamutwe		Transect 3 Downstream Kirindi to Matumu		Transect 4 Downstream Namasagali to Bunyamira		All Transects April	
	2000	2006	2000	2006	2000	2006	2000	2006	2000	2006
Bagrus docmak	0	0	19.1	0	131.0	11.2	0	0	37.5	3.5
Lates niloticus	39.9	20.6	48.7	141.5	184.2	12.4	86.6	180.3	89.9	70.4
Brycinus jacksonii	1.6	0	0	3.3	0	0	0	0	0.4	1.0
B. sadleri	0	0.6	0	Nil	0	0	14.3	0	3.6	0.2
Oreochromis niloticus	0	2.4	75.7	5.9	0	0	47.8	0	30.9	2.5
O. leucostictus	29.4	3.7	0	7.6	0	0	1.1	0	7.6	2.8
O. variabilis	33.8	33.5	0	11.6	0	0	0	0	8.5	13.5
Tilapia zillii	0	6.9	0	81.9	0	0	40.5	38.1	10.1	30.4
Haplochromines	7.3	303.9	17.1	284.9	7.7	7.7	33.9	98.0	16.5	188.7
Clarias gariepinus	0	0	0	12.0	0	0	0	0	0	3.6
Barbus altianalis	0	25.2	213.9	63.9	297.1	8.5	7.7	0	129.7	29.3
B. paludinosus	0	0	0	0.5	0	0	0	0	0	0.2
Labeo victorianus	0	0	0	0	13.6	19.3	4.2	0	4.5	5.8
Protopterus aethiopicus	27.9	0	0	0	0	0	0	0	7.0	0
Synodontis afrofischeri	0	0	0	0	0	0	135.9	153.5	34.0	18.6
S. victoriae	7.1	0	0	0	0	0	31.1	20.5	9.6	2.1
Marcusenius grahami	0	0	0	0	4.8	0	9.2	0	3.5	0
Mormyrus kannume	239.4	144.1	205.7	284.3	4.9.5	124.1	46.2	0	225.2	165.7
M. macrocephalus	0	0	0	0	0	0	20.5	0	5.1	0
Gnathonemus victoriae	0	0	0	0	0	0	1.6	151.3	0.4	15.1
G. longibarbis	0	0	0	0	0	0	2.8	18.5	0.7	1.9
Shilbe intermedius	0	0	0	0	0	0	23.5	0	5.9	0

NB: Localities associated with Transect 1 upstream include: Kikonko, Kunjaba, Makwanzi Is, Transect 2 downstream include: Naminya, Kisadha, Ofwono, Zaire, Mugalya, Kisoga, Transect 3 downstream include: Matumu, Kisoga A,B,C, Damba, Transect 4 downstream include: Kasanga, Kibuye, Sajjabi

Table 8.3. List of fish and their common names (English and Local) found during the surveys of the River Nile.

Scientific Name	Common English name	Local name
Bagrus docmac	Cat fish	Semutundu
Barbus altianalis	Barbel	Kisinja
Labeo victorianus		Ningu
Brycinus sadleri		Nsoga
Gnathonemus longibarbis		Kisoma
Gnathonemus victoriae		Kisoma / Bobo
Haplochromines		Nkejje
Labeo victorianus		Ningu
Lates niloticus	Nile perch	Mputa
Mormyrus kannume	Elephant snout fish	Kasulubana
Oreochromis leucostictus	Tilapia	Ngege
Oreochromis niloticus	Tilapia	Ngege
Oreochromis variabilis	Tilapia	Mbiru.
Synodontis afrofischeri	Catfish	Nkolongo
Synodontis victoriae	Catfish	Nkolongo
Tilapia zillii		Ngege

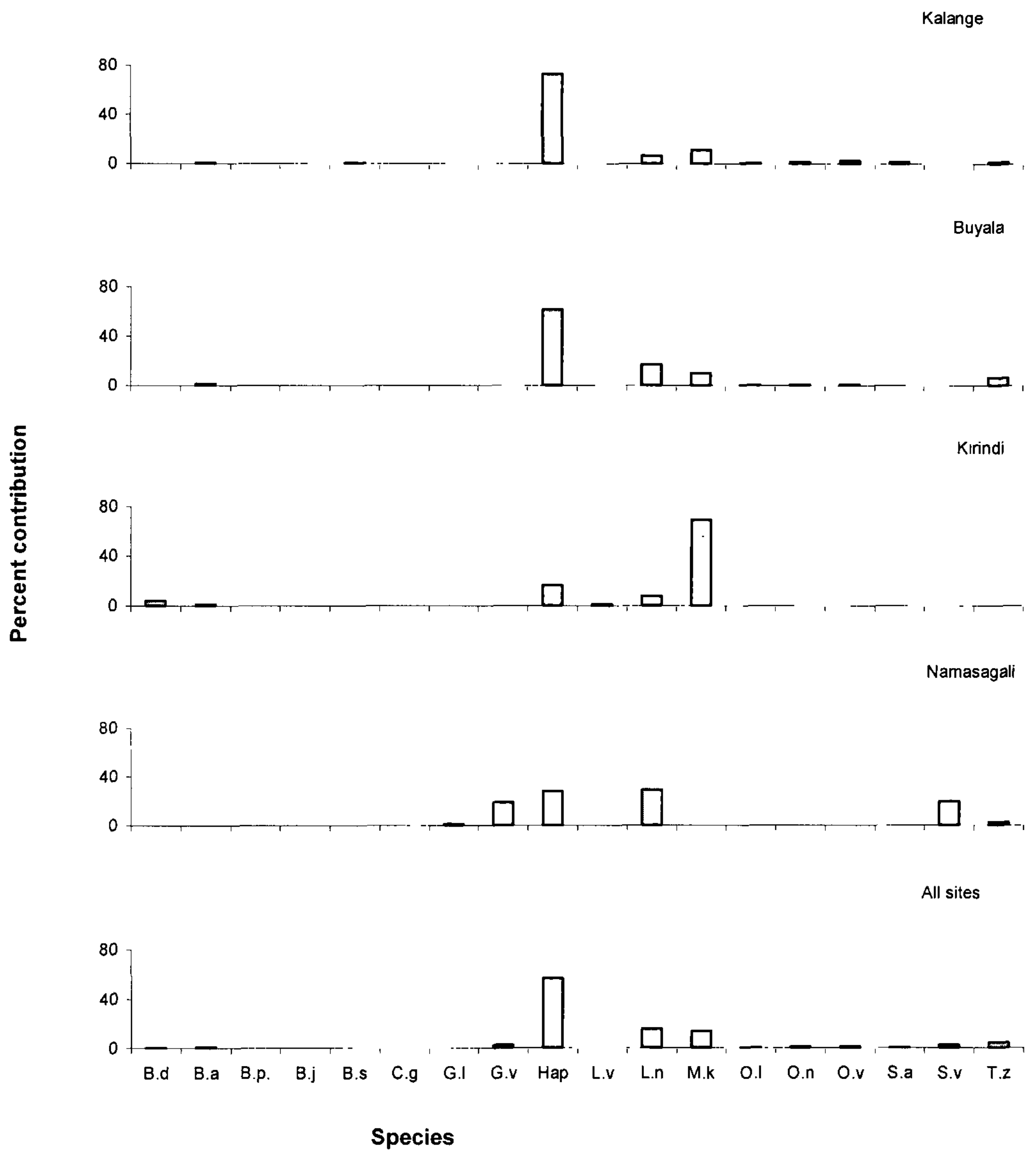


Figure 8.1 Relative abundance (numbers) of fish species caught in gill nets in April 06 along the Nile

B.j	*Brycinus jacksonii*	G.l	*Gnathonemus longiba*	O.n	*Oreochromis niloticus*
B.s	*Brycinus sadleri*	G.v	*Gnathonemus victoria*	O.l	*Oreochromis leucostictus*
B.a	*Barbus altianalis*	Haps	*Haplochromines*	O.v	*Oreochromis variabilis*
B.p	*Barbus palludinosus*	L.v	*Labeo victorianus*	S.a	*Synodontis afrofisheri*
B.d	*Bargrus docmac*	L.n	*Lates niloticus*	S.v	*Synodontis victoriae*
C.g	*Clarias gariepinus*	M.k	*Mormyrus kannume*	T.z	*Tilapia zillii*

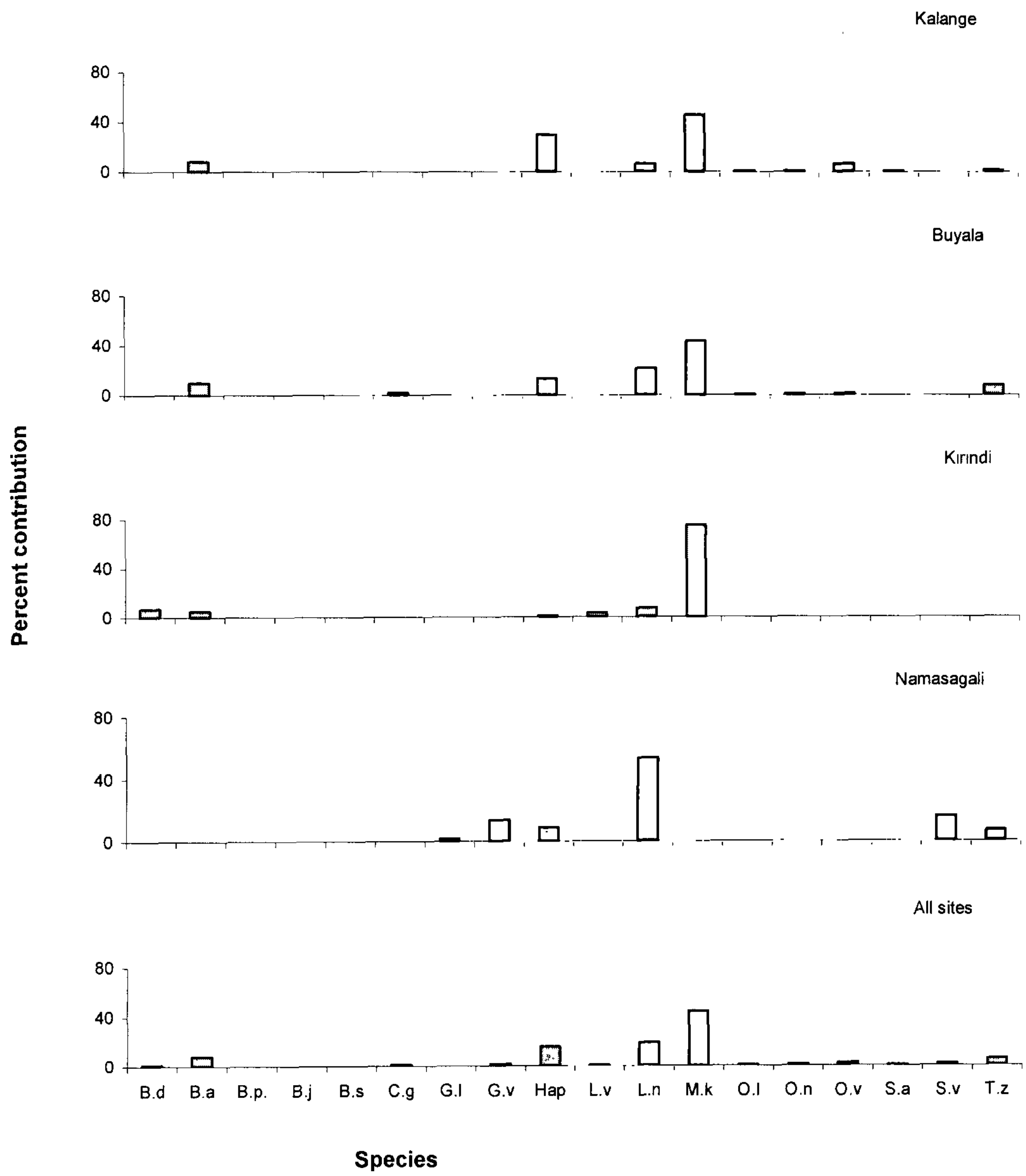


Figure 8.2 Relative abundance (weight) of fish species caught in gill nets in April 06 along the Nile

B.j	*Brycinus jacksonii*	G.l	*Gnathonemus longiba*	O.n	*Oreochromis niloticus*
B.s	*Brycinus sadleri*	G.v	*Gnathonemus victoria*	O.l	*Oreochromis leucostictus*
B.a	*Barbus altianalis*	Haps	*Haplochromines*	O.v	*Oreochromis variabilis*
B.p	*Barbus palludinosus*	L.v	*Labeo victorianus*	S.a	*Synodontis afrofisheri*
B.d	*Bargrus docmac*	L.n	*Lates niloticus*	S.v	*Synodontis victoriae*
C.g	*Clarias gariepinus*	M.k	*Mormyrus kannume*	T.z	*Tilapia zillii*

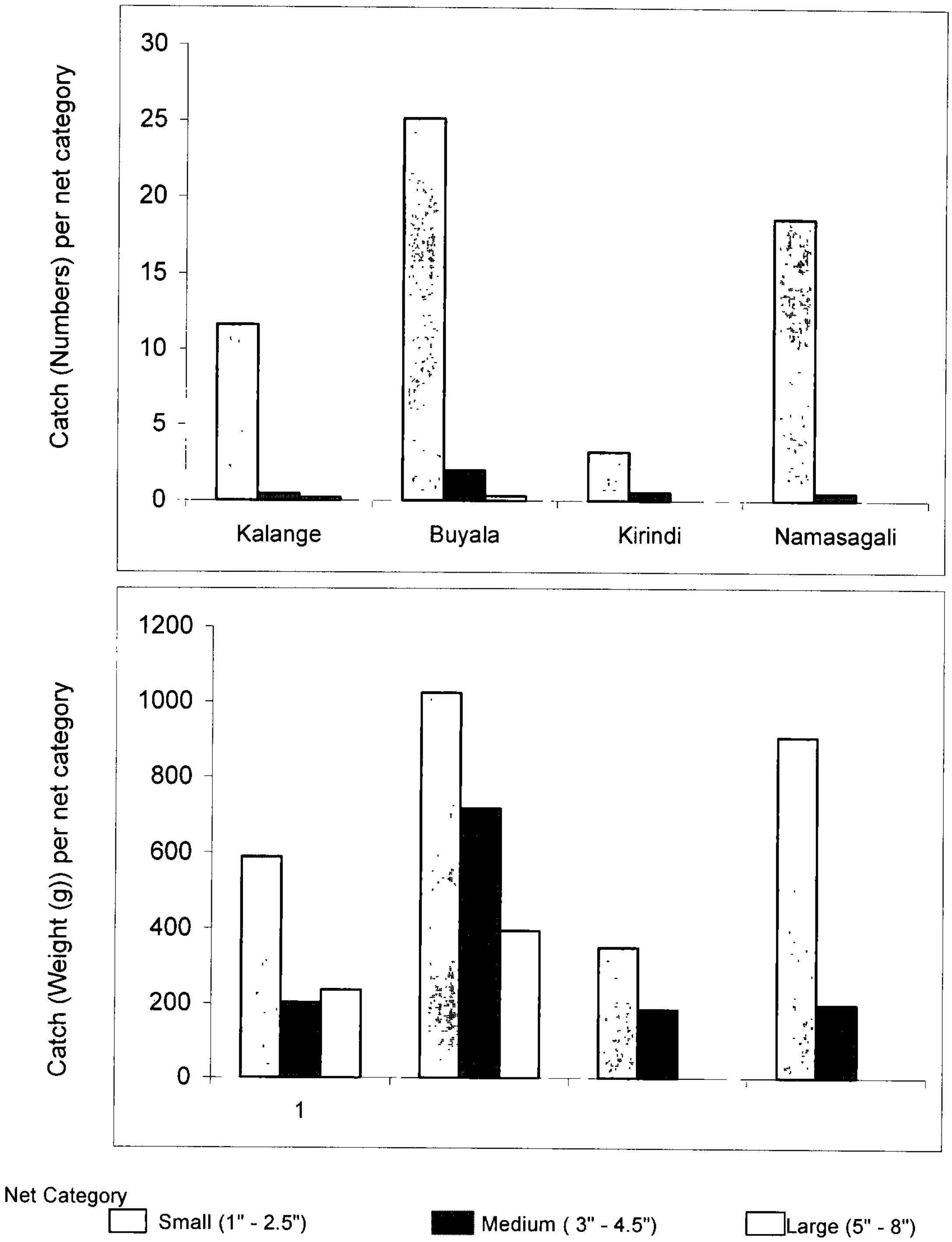


Figure 8.3 Mean catch per net category from sampled stations along River Nile - April 2006

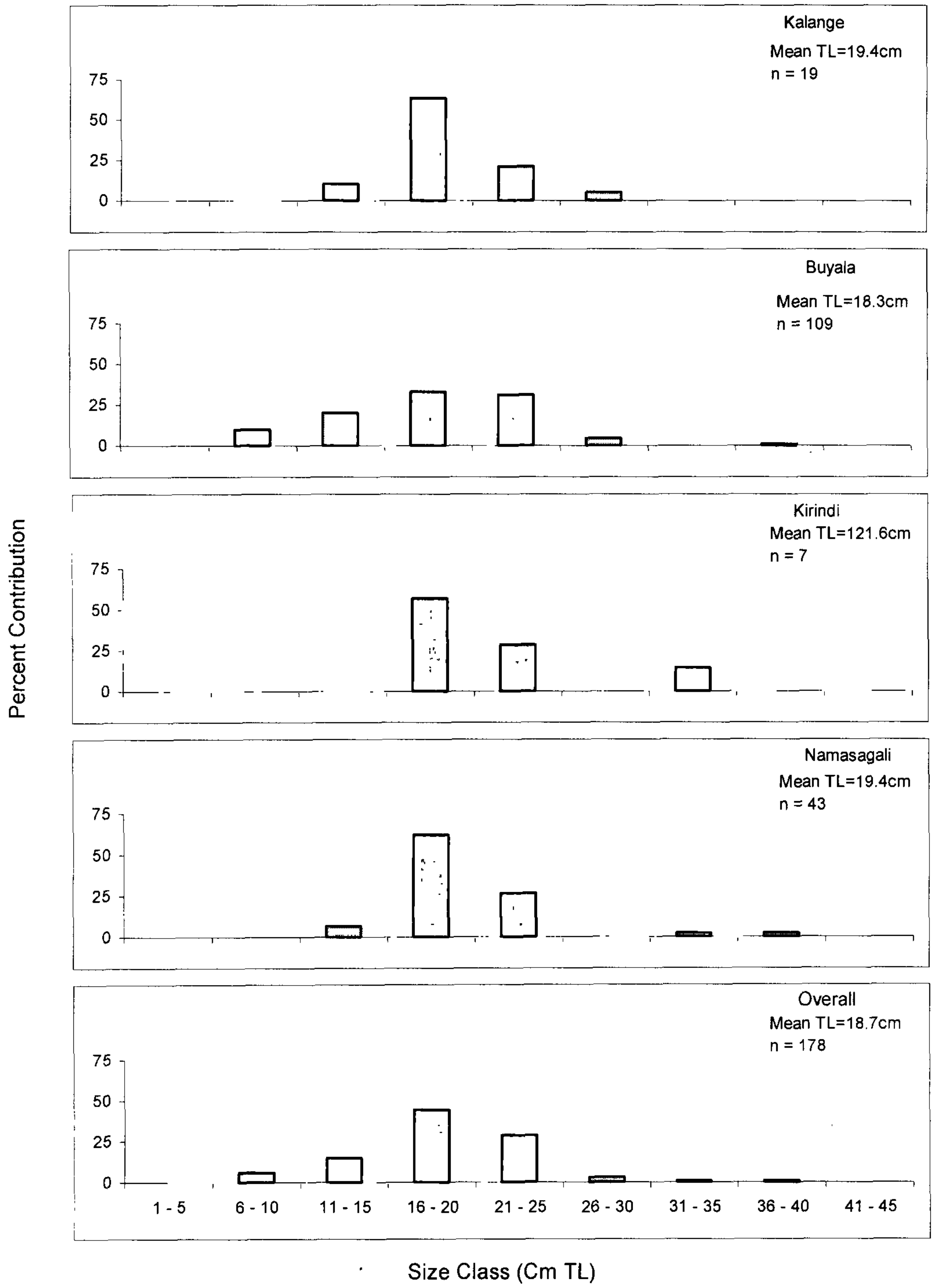


Figure 8.4 Size distribution of *Lates niloticus* caught in experimental gillnets at sampled stations along the Upper Victoria Nile April 2006

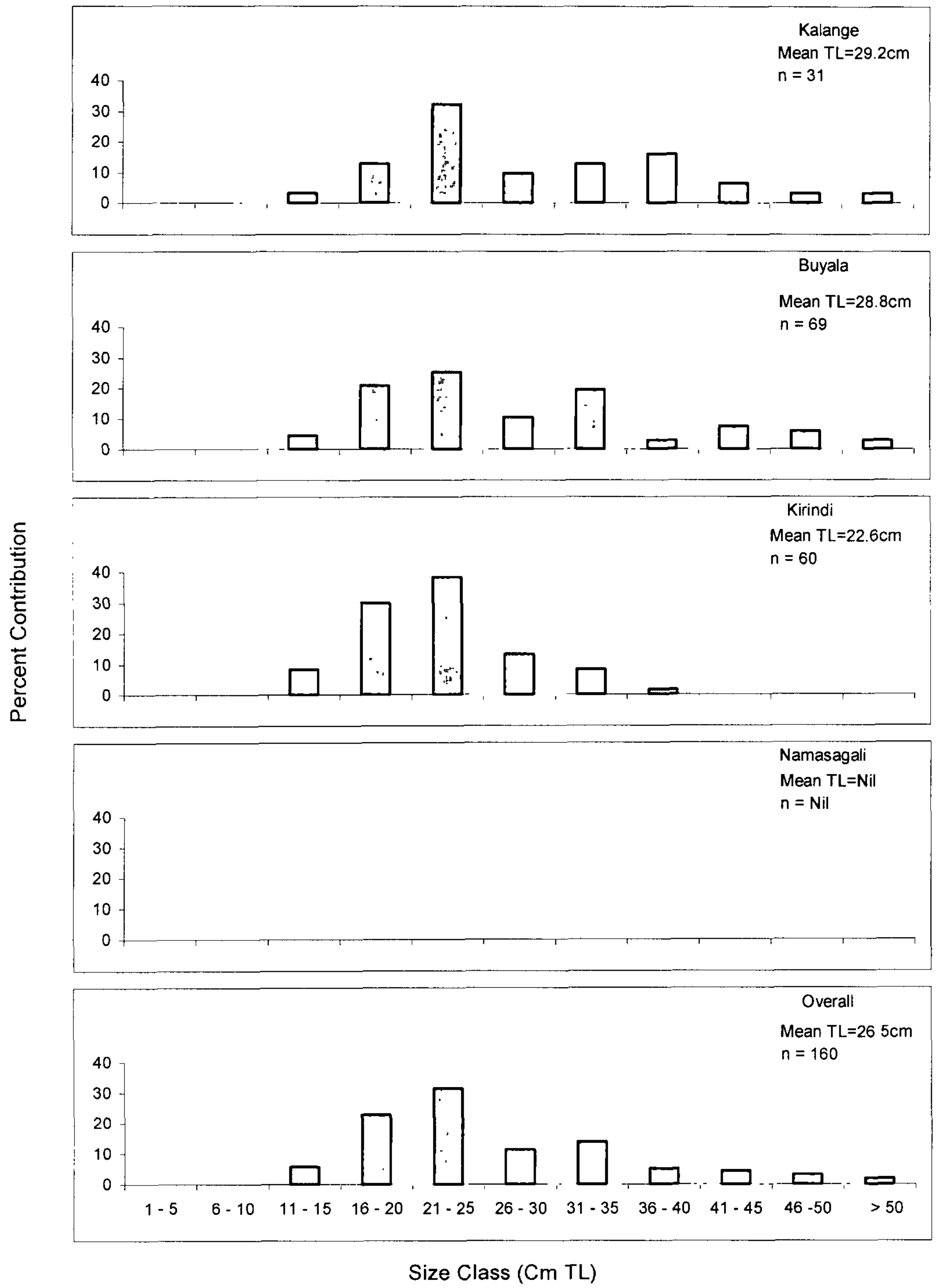


Figure 8.5 Size distribution of *Mormyrus kannume* caught in experimental gillnets at sampled stations along the Upper Victoria Nile April 2006

CHAPTER 9

9.0. Biology and Ecology of Fishes

9.1. Introduction

Fish are among the major components of aquatic ecosystems that may be adversely impacted by hydropower projects along rivers. Some of the ecological aspects of development that may affect fish are changes in water flow, characteristics of new water regimes and interruption in breeding for those fishes which are migratory. Changes in composition of food organisms may also affect the ecology of fishes. As riverine fishes are important in the socio-economic livelihood especially of the riparian communities, baseline information on the ecology of fish populations prior to development is very important. In this report, the biology and ecology of the fishes occurring between an upstream of the proposed project transect and 3 downstream transects was studied and compared with similar studies conducted in April 2000 in the same transects. Two main aspects have been evaluated – the feeding ecology and breeding (egg production).

9.2. Materials and methods

Stomach content analysis and fecundity were conducted as detailed in the report of the previous AESNP Survey of April 2000.

9.3. Results

9.3.1. The food and trophic ecology of the fishes

Six fish species were used as indicators of trophic ecology. They included *Mormyrus kannume* and *Lates niloticus* in most sites, *Synodontis afrofischeri* and *Gnathonemus victoriae* from Kalange and Namasagali transects; *Oreochromis variabilis* from Kalange and *T. zillii* from Kalange, Buyala and Namasagali

9.3.1a. *Mormyrus kannume*

In all the sites where it occurred most abundantly, Transect 1 to 3 (corresponding to Kalange, Buyala and Kirindi) respectively, *Mormyrus kannume* fed mostly on insects which included chironomids, Ephemeroptera, Trichoptera, and unidentified insect remains. Other prey items included *Rastrineobola argentea*, unidentified fish remains, molluscs and crabs. The relative importance of food items in the diet of *M. kannume* is shown in Fig. 9.1.

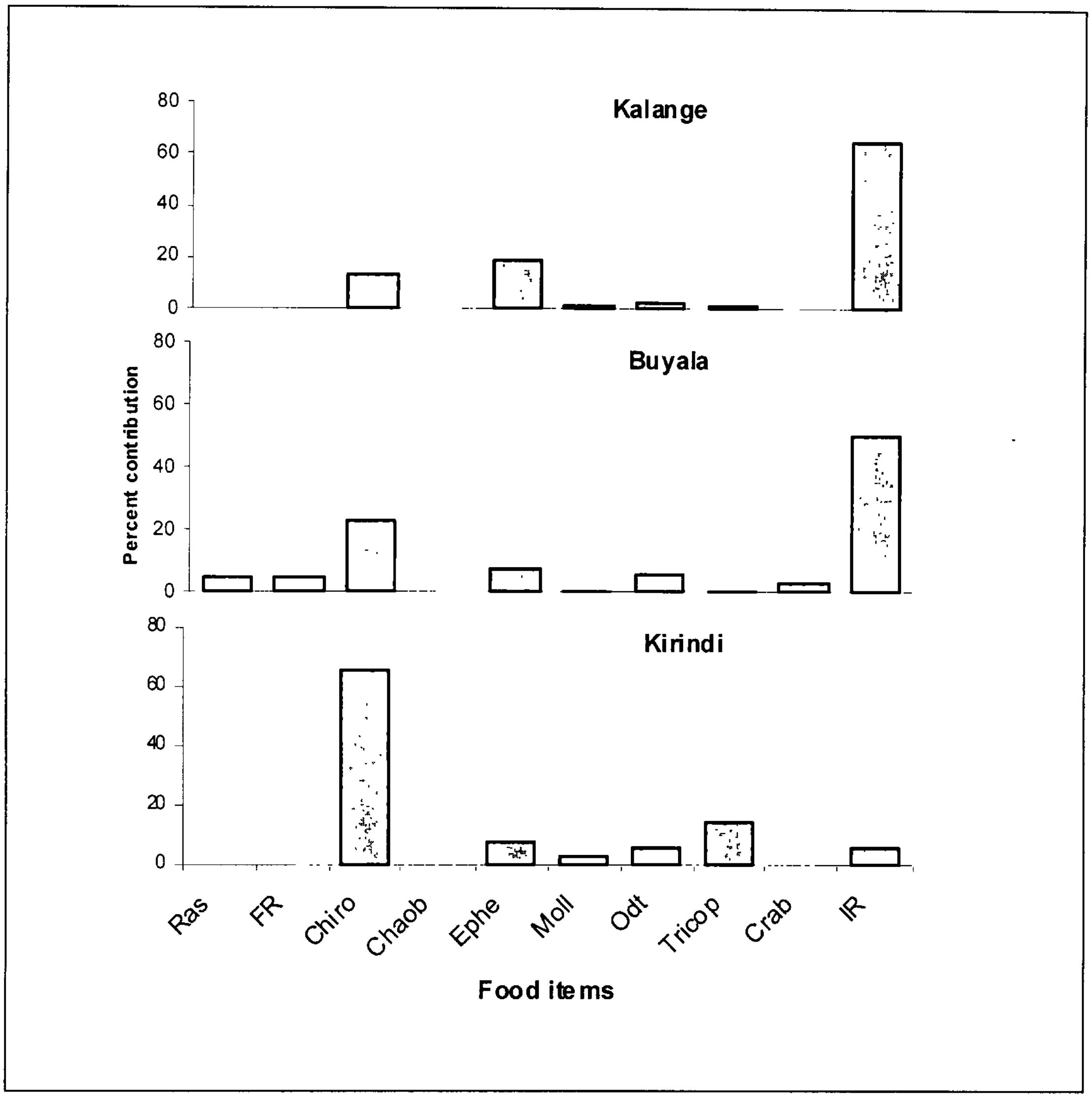


Fig. 9.1. The relative importance of food items in the diet of *Mormyrus kannume* caught at the 3 transects along the Victoria Nile

Ras = *Rastrineobola argentea*; FR = Fish remains; Chiro = chironomid; Chaob. = Chaoborid; Ephe. = Ephemeroptera; Moll. = Mollusc; Odt. = Odonata; Tricop. = Trichoptera; IR = Unidentifiable insect remains

9.3.1b. *Lates niloticus*

As in previous surveys, *Lates niloticus* had ingested mostly fish prey which was dominated by haplochromines, *Clarias* sp. and unidentified fish remains (Fig. 9.2). Other prey items included *Caridina nilotica.*

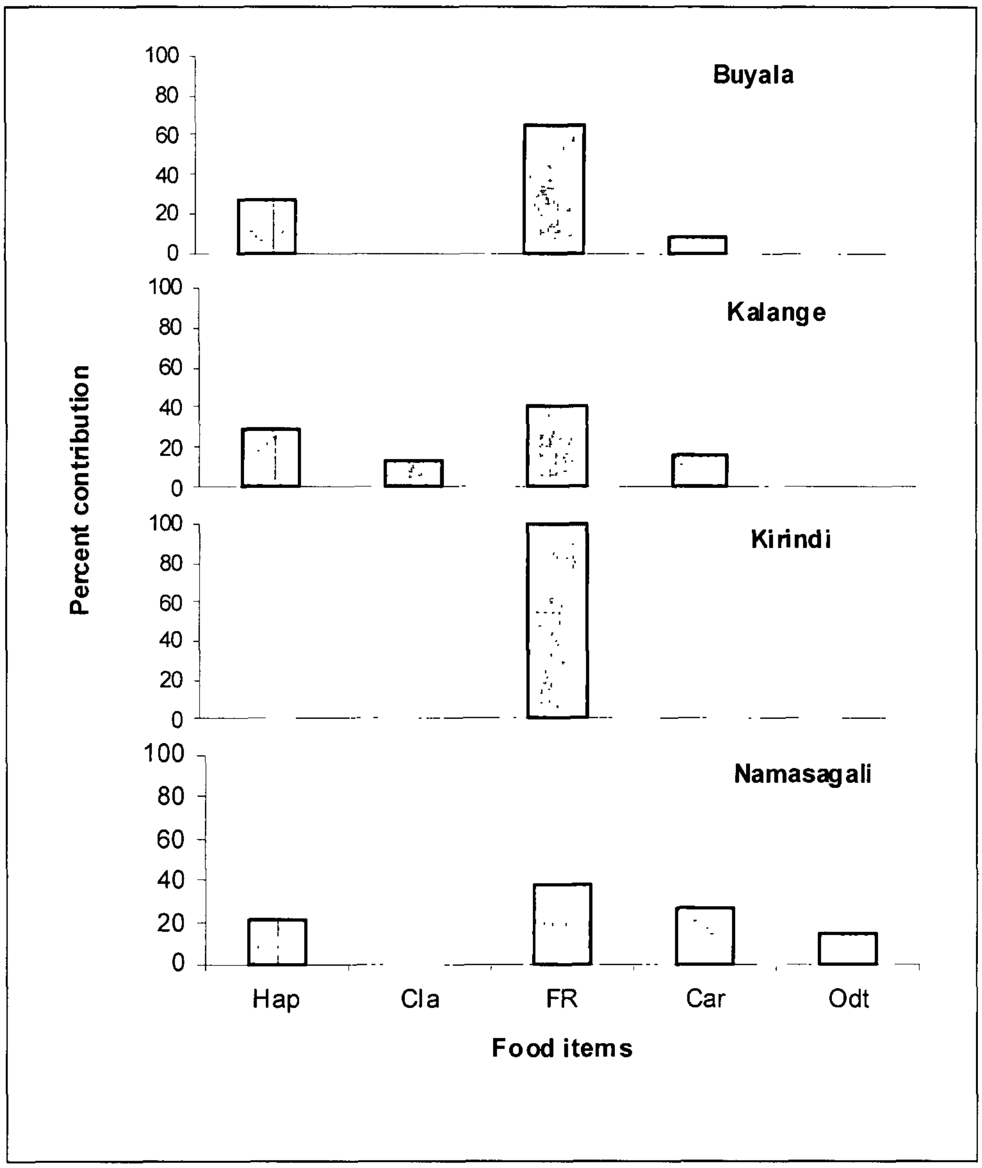


Fig. 9.2. The relative importance of food items in the diet of *Lates niloticus* caught at the four transects along the Victoria Nile

Hap. = haplochromines; Cla. = *Clarias* sp.; FR. = Unidentifiable fish remains; Car. = *Caridina nilotica*; Odt. = Odonata

9.3.2c. *Synodontis afrofischeri*

The main food of *Synodontis afrofischeri* during this survey was chironomids (35.7%), Odonata (32.1%), chaoborids (14.3%), unidentified insect remains, (14.0%), Ephemeroptera (3.6%) and molluscs (0.3%). This contrasted with results obtained in the April 2000 survey results in which the dominant food items were Isoptera.

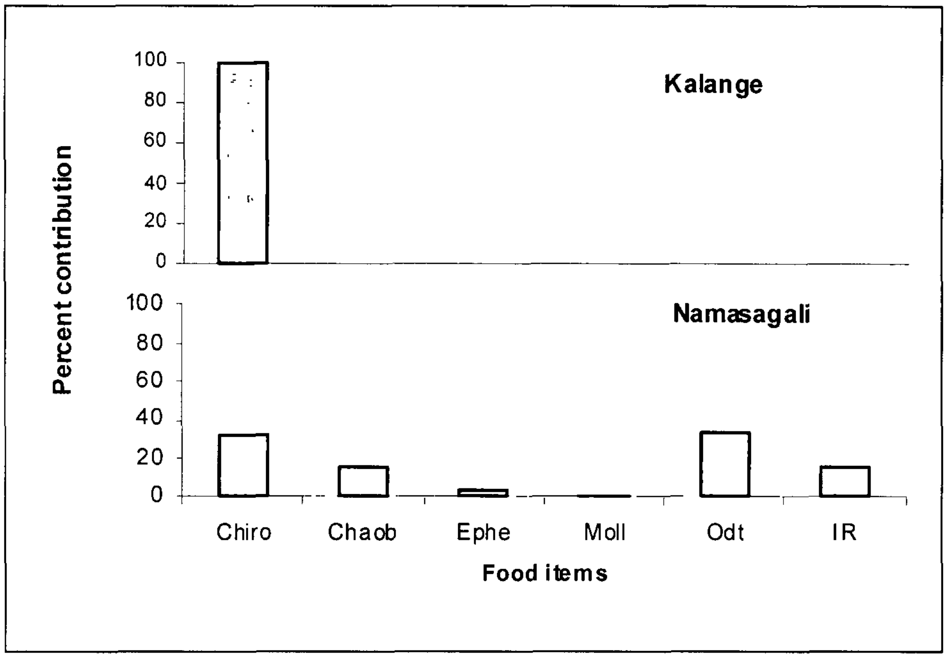


Fig. 9.3. The relative importance of food items in the diet of *Synodontis afrofischeri* caught at the two transects along the Victoria Nile.

9.3.2d. Food of other fish species

Among the tilapiines, only *Oreochromis variabilis* and *Tilapia zillii* had stomachs with food contents. In *O. variabilis*, the food items included algae (63.9%), detritus (32.4%) and high plant material (3.6%), while in *Tilapia zillii*, the dominant food item was algae (94.1) followed by high plant material (4.6%) and detritus (4.6%). There were no *O. niloticus* specimens with stomach contents.

Bagrus docmack fed predominantly on fish prey (60%) and Ephemeroptera (40%) while *Gnathonemus victoriae* fed exclusively on chironomids.

9.3.3. Fecundity (egg production)

Fecundity was only assessed in *Oreochromis niloticus* where only one ripe female was recorded with a fecundity of 4414 eggs. This was higher than in the survey of April 2000 where the only female specimen recorded had a fecundity of 1922 eggs. The mormyrids were not considered for fecundity studies because most of the ripe female had partially shed the eggs while in *Lates niloticus* there were no ripe female specimens recovered in the catches.

9.4. Discussion

Results of the food analysis indicate that *L. niloticus* and *B. docmack* were the main predatory fishes in the sites surveyed although in Buyala *M. kannume* was found to have included *R. argentea* and unidentifiable fish remains in its diet. However, insects especially chironomids were the main food items ingested by all the fish species recorded in the catches. Other food items included molluscs, *Caridina* and crabs. High plant material was an important food item for *T. zillii* and *O. variabilis*. Thus vegetation dominated habitats are important in the food web of the Upper Victoria Nile probably because, in addition to being a food item for the tilapiines, they are also an important habitat for other organisms especially insects, which are an important food item for most of the fish species recorded in the catch.

Higher densities of breeding adults of mormyrids were encountered as in the previous sampling of April 2000.This seems to be correlated with the onset of breeding triggered by the onset of the rain season. Despite the large number of *Lates niloticus* recorded from the experimental gillnets and *O. niloticus* purchased from the commercial fishers, only 1 specimen of *O. niloticus* had ripe gonads and no breeding specimen was recorded for *L. niloticus* For *L. niloticus* this observed trend may be due to absence of adult specimens (>50 cm TL) which usually have ripe gonads while for *O. niloticus* it was not yet peak breeding

CHAPTER 10

10.0. The Fishery Catch Survey

10.1. Background

Fish and fish products in Uganda are very important as a source of food, income, export earnings and employment. The higher diversity of fish species also attracts global attention in evolutionary studies. The fishery sector is directly employs more than 350,000 people and indirectly over 1.2 million people. Fish is the cheapest source of animal protein in Uganda. In 2005, it is estimated that fish exports earned Uganda US $ 142 million up from US $ 103 million in 2004, making it almost the first most important non-traditional export commodity. Despite the importance of the fishery industry to the people that live along the Victoria Nile, the amount of fish caught from the river is not known. The existing fishery is basically subsistence and the fishing is mainly done using cast nets, hooks (long line and angling) and to a lesser extent gill nets.

Tapping the hydropower potential of Victoria Nile like any other developmental project on a natural resource has to comply with legal provisions governing projects of this nature in Uganda (NEMA, 1996). Environmental Impact Assessment (EIA) for the proposed development has to be undertaken to evaluate among other issues, fishery related aspects relevant to the development. Their report is therefore an update of EIA findings based on a field commercial fish catches study of the same project area and/or period covered during the 2000 surveys as a first study during the pre-construction phase.

10.2. Materials and Methods

A fish catch survey of the first quarter (corresponding to AESNP second quarter period 2000) of the study was conducted during March 2006 at four transects (one upstream and three downstream of the proposed hydro electric power site at Dumbbell island. Within each transect the names of major fish landing sites which were accessible were sampled along with the records of the number of active boats at each landing site. The types of full time jobs supported by the fishery were recorded by gender at the time of sampling.

For each sampled boat the following information/records were made:

Date of sampling, boat type, season, number of days the fisher goes out fishing per week, whether day or night catch, type of propulsion, number of crew per boat, gear type, size and number per boat, types of species caught per gear, gear size and fishing method, total weight of individual fish species per gear, gear size fishing method and the total length of each species were measured (the form used is attached). The fishers

provided information on the price (Shs/kg) of different fish species at the sampled landing sites.
The procedure used for estimation of fish catch was outlined in the first quarter report 2000 (AESNP, 2000) and was again followed during April 2006.

10.3 Results

10.3.1 Fishing effort at landing sites sampled

The active boats operating in the transects and those sampled in the April 2000 and April 2006 are shown in Table 10.1. Out of the 51 active boats at the landing sites in the 4 transects, 37 (73%) were sampled compared to (46) 92% of the 50 active canoes sampled during the second quarter of 2000 surveys. The active canoes comprised, 57% Ssese compared to 12%, 39% compared to 50% dug out canoes and 4% compared to 38% parachute in a second quarter of 2000 surveys. It is important to note that Ssese and parachute are all planked canoes but parachutes have flat bottom while Ssese canoes, have the bottom plunks that meet at an angle. In the present sampling, these different types have been distinguished. For the sampled canoes, 67% compared to 13% were Ssese, 30% compared to 54% were dug out and 3% compared to 33% were parachute.

10.3.2 Fulltime jobs supported by the fishery

Boat builders increased from 6 men to 12 men (Table 10.1). Namasagali (transect four) and Buyala (transect two) recorded 5 men each compared to 2 men and 3 men in the similar quarter of 2000 survey. Kalange (transect one) recorded 2 men compared to 1 man and Kirindi 1 man compared to none in the similar quarter of 2000 survey. Though not directly investigated in this survey the possibility of migration of these boat builders within the four transects should be considered.

There was a noted decrease of (33%) of food vendors from 9 in April 2000 to 6 in April 2006. The men and women were one and 8 respectively (April 2000) compared to one man and 5 women in April 2006, a reduction of 37.5% in female vendors. There were no net repairers in April 2006 while one man was operating at Namasagali in April 2000. Men cleaning the fish landing sites were at Namasagali (one in April 2000 and two in April 2006).

89 fishers operated at the sampled fish landing sites in April 2000 compared to 128 in April 2006, an increase of 43.8%. Fish traders were 22 in April 2000 compared to 47 in April 2006, an increase of 114%. Men fish traders were 7 in April 2000 and 25 in April 2006 while females were 15 (April 2000) and 22 (April 2006).

Chairpersons of fish landing sites increased from one (April 2000) to three in April 2006. in April 2000, the only one Chairperson was at Namasagali while in April 2006 two were recorded at each at Kalange and Kirindi unlike in April 2000, where four fisheries staff were recorded. In April 2006, only one at Kalange was in place. Only Namasagali had two Askalis at the fish landing site (April 2000) compared to one in April 2006.

10.3.3 Importance of commercial and local food fish species being caught in transect 1- 4

Based on percentage composition by weight of different fish species caught by different gears (Tables 10.2-10.4) *Oreochromis niloticus* remained the most dominant 75.8% compared to 81%, in transect 1, *Mormyrus kannume* (32.6%) also remained dominant compared to (29.8%), in transect two, *Rastrineobola argentea* (91.9%) was dominant compared to *Lates niloticus* (63%) and transect three *Barbus altianalis* (38.5%) compared to *Bagrus docmak* (100%) in the second quarter of 2000 survey. Over all the four transects (Table 10.5) *R. argentea* (62%) contributed highest percentage by weight compared to *O. niloticus* (53.2%) in the similar quarter of 2000 survey. Unlike in the second quarter of 2000, where *O.niloticus* was the most dominant in all transects except transect 3, in this quarter it was only dominant in only transect four Namasagali. Higher catches of *O.niloticus* were from hook operations unlike in the second quarter of 2000 where Cast nets higher. *O. variabilis* like in the second quarter of 2000 remained restricted to transect one Kalange. Like in the second quarter of 2000 *C. gariepinus* was only recorded in transect four Namasagali. *Protopterus aethiopicus* which had been encountered in the second quarter of 2000 was missing in the catches during this quarter. Haplochromine fish species also appeared in the catches but had not been recorded in the second quarter of 2000.

A total of 12 different fish taxa were recorded along the Victoria Nile compared to 10 fish taxa during second quarter of 2000. Noted absent in the second quarter was *P. aethiopicus* while haplochromines and *R. argentea* were recorded in this quarter but were absent in the second quarter of 2000. Most importantly *R. argentea* contributed the highest percentage by weight in this quarter.

10.3.4 Size structure of major commercial fish species

The size structure of various major fish species encountered are shown in Figs 10.1 – 10.3. The major fish species were encountered in transects one and four where there were reasonable numbers (≥30 specimens) for frequency analysis. The size range of *T. zillii* from castnet catches (transect 1 at Kalange) was 12 - 31 cm TL (mode 20–21 cm TL) compared to 18 - 31 cm TL (mode 24-27 cm TL) at the same transect for the second quarter of 2000 (Fig.10.1)

A Kalange transect one, there were few specimen of *O. niloticus* (19) for frequency analysis from Cast nets compared to (14) in the second quarter of 2000. However, these had a size range of 15 -33 cm TL compared to 16 – 49 cm TL in the second quarter of 2000. This slight shift in the range could be explained by the shift in mesh size from 4" and 5" in the second quarter of 2000 to 3" in this quarter.

There were very few (25) *L. niloticus* specimen from cast net catches at Kalange. However, these had a size range of 21-35 cm TL compared to a size range of 22-37 cm in second quarter of 2000. Like in the second quarter of 2000 they were all immature.

At Namasagali (transect four) the *O.niloticus* commercial catches from gill nets. The size frequency distribution is shown in Fig. 10.2. The mode was at 29-30 cm TL compared to 33-36 cm TL and range was 25-36 cm TL compared to 27-48 cm TL in second quarter of 2000. All fish were mature.

M. kannume commercial gillnets catches in transect one – (Kalange) for the this quarter had a bimodal of 40-41 and 44-45 compared to 38-39 cm TL in the second quarter of 2000 and size range was 28-67 cm TL in this quarter compared to size range of 34-57cm TL in the second quarter of 2000 (Fig. 10.3) The mesh size of nets varied slightly (4" – 5") in second quarter of 2000 compared to 3.5" – 5") in this quarter (Table 10.6)

Rastrineobola argentea was, like in the AESNP fourth quarter report of 2000, recorded at transect two and was harvested by the 2mm mesh size mosquito net applying one lamp compared with a 3 mm mesh size scoop net of fourth quarter 2000. The mesh size harvested mainly juvenile fish of size range 14 mm – 32 mm SL with a mode at 22 mm SL (Fig. 10.4)

There was no length frequency analysis in this quarter for catches from Angling and Longline in transect four at Namasagali because the specimens were too few for such analysis compared to second quarter of 2000 where *O. niloticus* from longline and angling in transect four at Namasagali both had similar mode (25-26 cm TL). However size of Angling hooks and long line hooks changed from 6-14 to 10-12 and 7-12 to only 7 in second quarters of 2000.

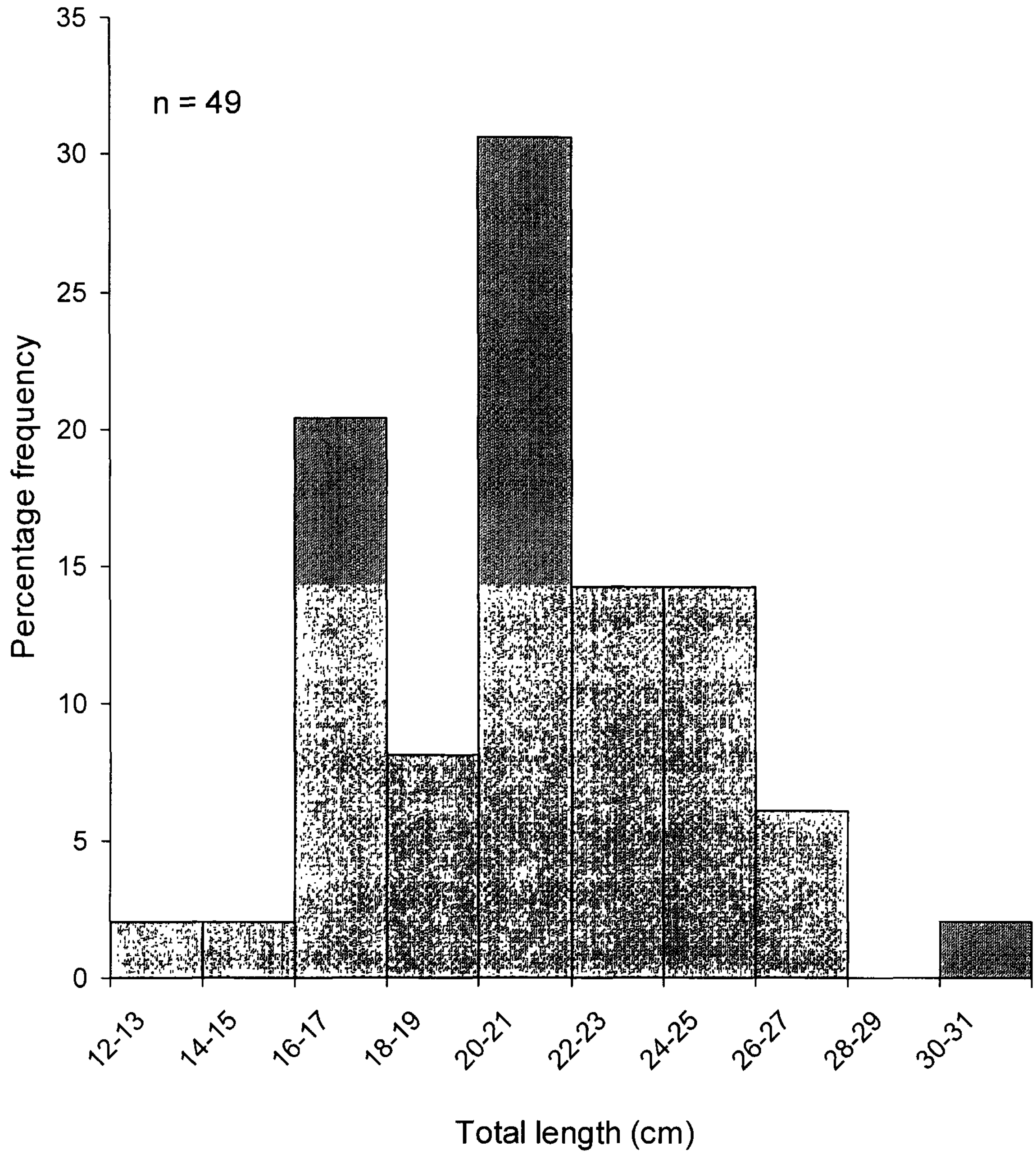


Fig. 10.1. Length frequency distribution of *Tilapia zillii* from commercial catches of cast nets transect one (Kalange-Makwanzi-upstream of Dumbbell Island) -2 cm intervals

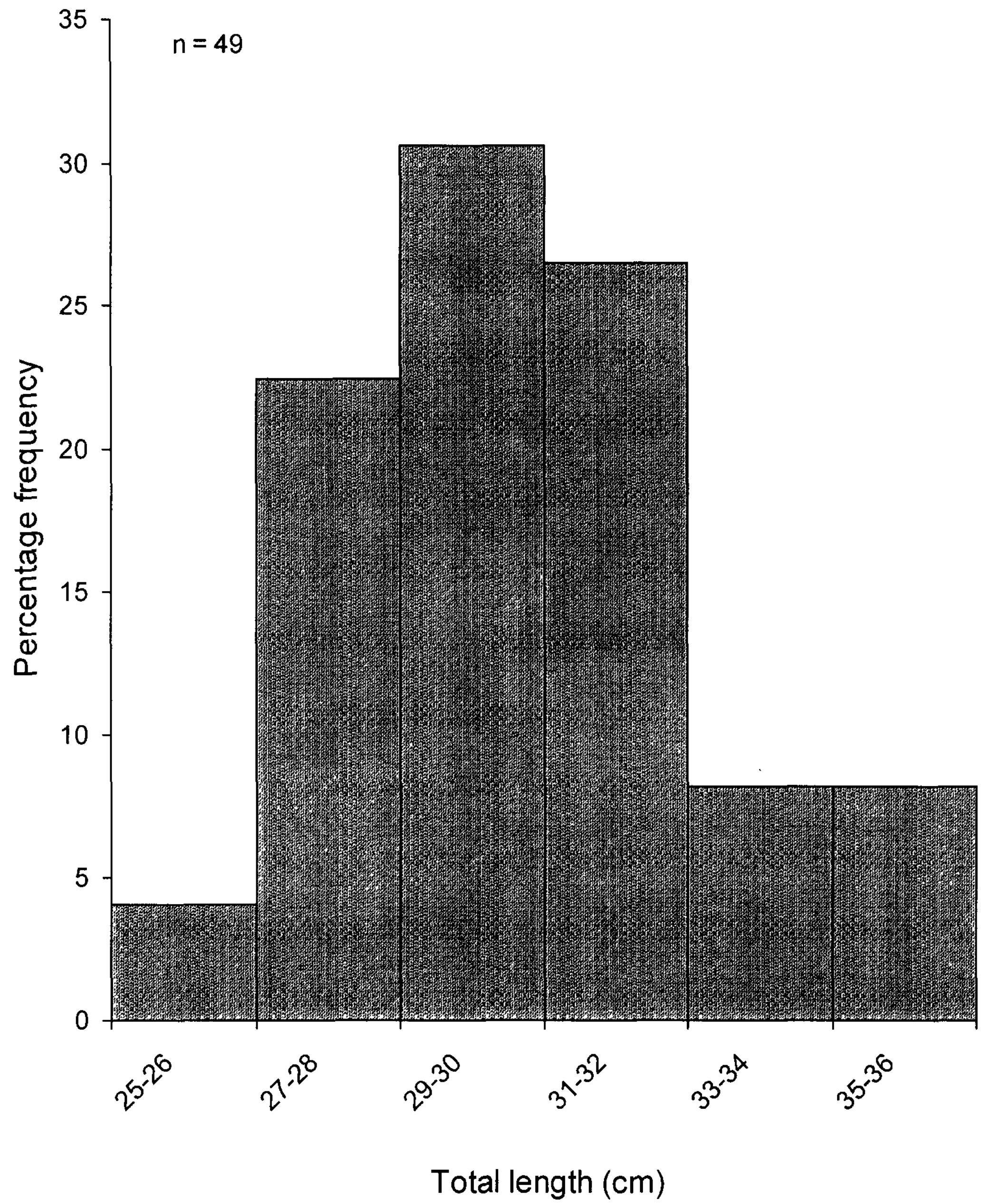


Fig. 10.2. Length frequency distribution of *Oreochromis niloticus* from commercial catches of gill nets transect four (Namasagali -downstream of Dumbbell Island) 2 cm intervals

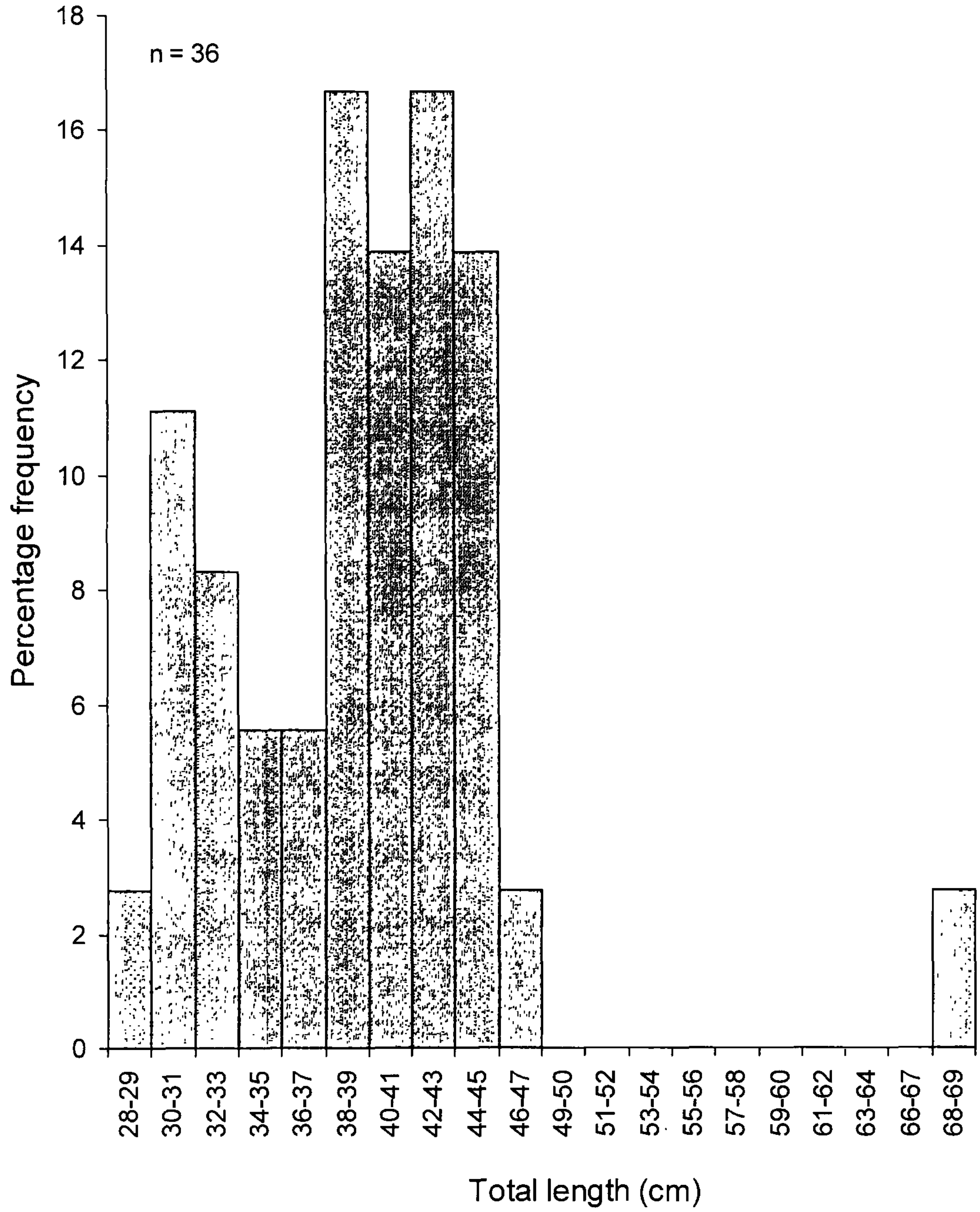


Fig. 10.3. Length frequency distribution of *Mormyrus kannume* from commercial catches of gill nets transect four (Namasagali – downstream of Dumbbell Island) 2 cm interval.

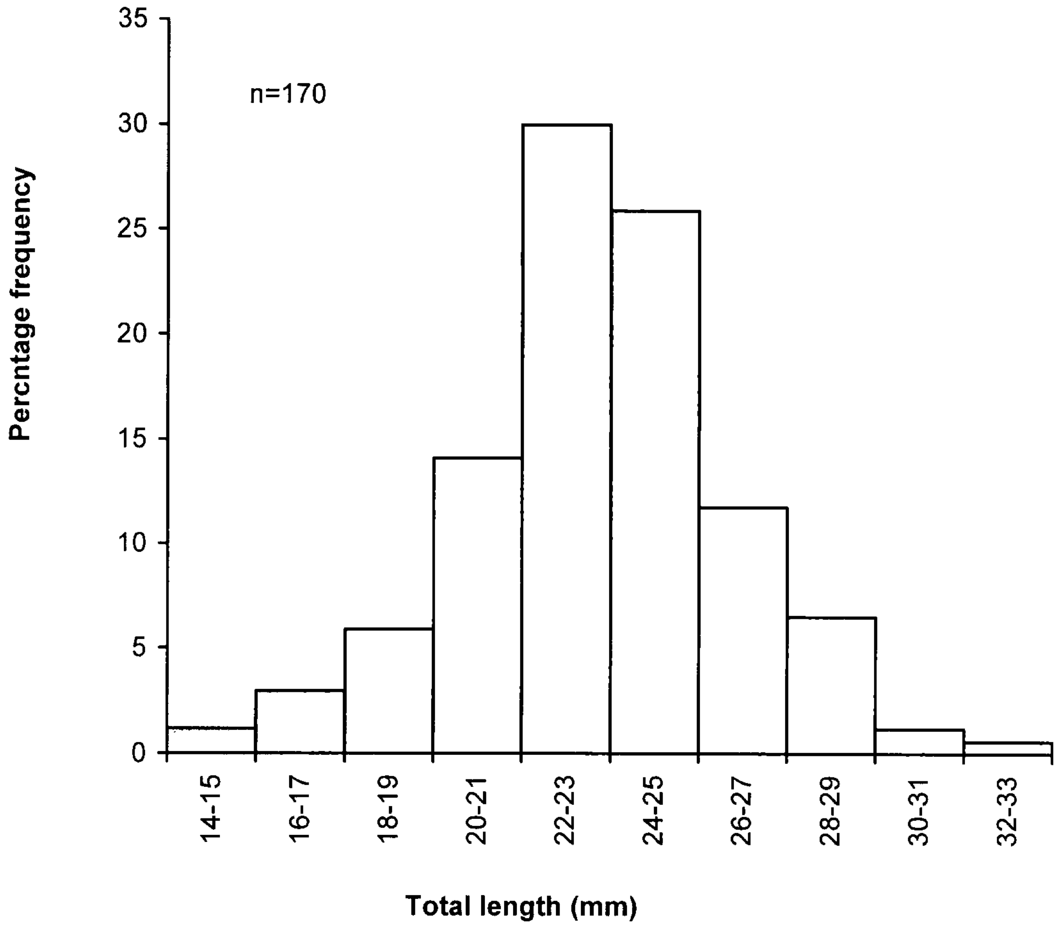


Fig. 10.4. Mukene length frequency distribution in (mm).

10.3.5. Estimates of total yield

10.3.6. Fish catch estimates

The composition of fish catch, average fishing days per week, average gear per canoe and fishing methods and gear sizes are shown in Table 10.6. Like in the second quarter of 2000, there was variation in the average number of gear per canoe but the size of gears did not change significantly. In this quarter a new gear the seine net (mosquito net) of mesh size 1 mm targeting *R. argentea* was recorded in transect two Buyala.

10.3.7. Catch per unit of effort (CPUE)

The highest catch (kg) per canoe along transect 1-4 was from mosquito net catches 300 kg per canoe Buyala-Kikubamutwe (Transect 1), followed by gill nets at 15.6 kg/canoe and 14.3kg/canoe at Namasagali-Bunyamira (Transect 4) and Kalange-Makwanzi respectively. The least catches (0.4 kg/canoe) were recorded from longline at transect two Buyala-Kikubamutwe. Noted absent were catches from longline at transect one Kalange –Makwanzi which had contributed the highest catch per canoe during the second quarter of 2000 followed by gillnet catches at (14.7kg/boat) and 13.5 kg/canoe in castnet catches at Kalange – Makwanzi in transect one (Table 10.7).

The total estimated monthly fish yield was 16816 kg compared to 7,966.4kg in the second quarter of 2000 (Table 10.10). The increase by 66% is explained by the high catch rates of *R. argentea* recorded in transect two Buyala-Kibubamutwe, even though the catchability of the different fishing methods are not comparable.

10.3.8. Estimates for total commercial value of catch

The average cost prices of individual fish species obtained from fishers are shown in Table 10.11 for each transect. There was a general increase in prices of fish across the four transects but notable was for *L. niloticus*, *O. niloticus* and *B. docmak* that doubled in price wherever they were encountered and *M. kannume* that increased more than three times in price at transect one Kalange Makwanzi of the second quarter of 2000.

The estimated monthly fish value obtained was 12.1 million Ugandan shillings compared to 4.02 million Uganda shillings obtained in second quarter of 2000.

10.3.9. Non-commercial uses of fish.

As reported in the second quarter of 2000, there was no change of non-commercial uses of fish during April 2006.

10.3.10. Sport fishing

No sport fishing was observed in both this quarter and similar quarter of 2000.

10.4. Discussion

The overall number of active canoes at the landings in the four transects did not change significantly (51 active canoes and 50 active canoes in this survey and that of 2000 respectively compared to 90 in the first quarter of 2000) (Table 10.1). However there was an increase in transect 3 downstream (Matumu-Kirindi) where the number doubled from four to nine. This like in the second quarter 2000 makes fishers switch from fishing to land tillage in preparation for crop planting. The increase in the number of active canoes at Kirindi could be explained by migration of fishers within transects manifested by a reduction in active canoes in Namasagali – Bunyamira (25-20), Buyala-Kikubamutwe (13-9) and Kalange-Makwanzi (9-6).

There was an overall reduction in food vending activities across the four transects as shown in the reduction in the number of food vendors from 8 (all women) to 6 (5 women and 1 man) and complete absence of food vendors in transect 2 (Buyala) and transect 3 (Kirindi). Food vending was dominated by women while fishing, boat building/repairing, fisheries staff, and chairpersons were dominated by men (Table 10.1). Absence of food vendors relates to the fishers not being permanently in the transects and thus participating in other activities like crop cultivation. No net repair was recorded at Namasagali compared to the second quarter of 2000 due to the continued reduction from 25 and 20 active boats in the second quarter 2006 and second quarter 2000 respectively. Despite the a slight increase in the number of active canoes across the four transects, the number of fishers and fish traders increased mainly due to the observed general increase in fish prices per Kg (Table 10.11).

The number of species caught by fishers along the Upper Victoria Nile increased slightly from 10 in second quarter 2000 to 12 fish taxa in second quarter 2006 respectively because haplochromines and *R. argentea* not previously recorded were encountered in this quarter. The percentage contribution of the haplochromines to the overall catches was negligible (>0.1%) compared to that of *R. argentea* which contributed (62%) overall and 91.9% in transect 2 Buyala-Kikubamutwe. It should be noted that *R. argentea* was only being fished in transect 2 (Buyala-Kikubamutwe) and information was recorded from one canoe out of the total two that fish for it in transect two. *P. aethiopicus* which had been recorded in the second quarter of 2000 did not appear in the catches during second quarter 2006.

At Kalange (Transect one), cast net fishers during first quarter 2006 were using mesh size 3" compared to mixed mesh sizes 4" – 5" in the second quarter of 2000. However, the size range of *O. niloticus* caught was 15-35 cm TL compared to 16-49 cm TL in the second quarter of 2000. This is explained by the corresponding shift above in mesh sizes used.

The size of *M. kannume* in commercial catches at Kalange (Transect one) varied with a bimodal 40-41 cm TL and 44-45 cm TL compared to mode 38-39 cm TL in, range 28-67 cm TL compared to 34-57 in second quarter of 2000. This was mainly attributed to the changes in the minimum mesh size 3" in this quarter from 4" in the second quarter of 2000 (Table 10.6.).

Changes in the average number of fishing gears was due to some fishers buying additional gear while others may have discarded old ones but the gear sizes did not substantially change as they are the sizes normally used to target particular fish species using a specific fishing method. The parameters used in fish catch estimates are shown in Tables 10.8 – 10.9

The total monthly catch estimates in this quarter was double (16815.9 kg) that of the second quarter of 2000 where as the value was three times (12.1m shillings) that recorded in the second quarter despite an almost no increase in the number of canoes (51) in this quarter and (50) in the second quarter of 2000. Correspondingly the number of fishers and fish traders also increased and were 128 and 47 respectively in this quarter compared to 89 and 27 respectively in the second quarter of 2000. The increase in monthly catches is mainly attributed to the introduction of *R. argentea* fishery in transect two Buyala to Kikubamutwe which recorded the highest catch rate (300Kg/day/canoe). The number of fishers and fish traders increased probably due to both the increase in catches and especially in price per kg of fish caught at almost all the transects. The increase in the observed monthly catches and prices explains the three-fold increase in value.

10.5. Summary

- A total of 37 canoes outs of 51 active canoes were sampled in the four transects compared to 46 sampled canoes out of 50 active ones in the second quarter of 2000.
- The active canoes comprised the Ssese type (57%), dugout (39%) and parachutes (4%) where the sampled canoes comprised Ssese (67%), dugout (30%) and parachutes (3%) compared to active canoes, Ssese (12%), dugout (50%) and parachutes (38%) and sampled canoes; Ssese (13%), Dugout (54%) and parachutes (33%) in the second quarter of 2000.
- Full time jobs supported by the fishery incuded food vending and boat building.
- Food vendors were 6 people compared to 12 in the second quarter of 2000. Women made up 83% of the labour force compared to 77% in the second quarter of 2000. At Namasagali two men cleaned the landing compared to one in second quarter of 2000.
- Boat builders in all the four transects were 12 compared to 6 builders in the second quarter of 2000, chairmen of fishing landings remained three like in the second quarter of 2000 and the number of fisheries staff reduced from two in second quarter 2000 compared to one in first quarter of 2006.
- Fishers in this quarter were 128 compared to 89 in the second quarter of 2000 and fish traders were 47 (47% women compared to 60% in the second quarter of 2000) compared to 25 observed in the second quarter of 2000.
- The major fishing gears/methods were angling (40.5%), Gill nets (31.0%), long line (16.7%), Cast nets (9.5%) and Mosquito net (2.4%) of the sampled canoes.

In the second quarter of 2000, of the sampled canoes, Angling and long line contributed 34.8% each of the sampled canoes, gill nets (21.7%) and cast nets (8.7%).

- The major commercial fishery along the Victoria Nile transects in order of importance ware *R. argentea* (62%), *O. niloticus* (11.5%) *M. kannume* (6.1%), *L. niloticus* (5.8%), *B. docmak* (5.4) and *B. altianalis* (4.9%) in the first of 2006. In the second quarter of 2000 *O. niloticus* contribution was (53.0%), *M. kannume* (13.6%) *L.niloticus* (13.5%) and *B. altianalis* (5.7%).
- The importance of fish species in commercial catches along the Victoria Nile changed slightly to include *R. argentea* as the most import fishery and *B.docmak* which became less important in the fishery was 5.4% compared to 2.4% in the second quarter of 2000.
- The highest CPUE was in transect two (300 kg per canoe) compared to transect one (15.3 Kg/canoe) in second quarter of 2000.
- The total monthly yield estimates from the 4 transects was 16816 kg compared to 7969.4kg in second quarter of 2000 and the estimated monthly fish value was 12.09 million Uganda shillings compared to 4.02 million in the second quarter of 2000.
- As was the case in the second quarter of 2000, there was no sport fishing.

10.6. Conclusion

The estimated monthly catches doubled and the value increased by three times those of the second quarter of 2000, mainly due to the increase in fish prices and capture of *R. argentea* that recorded the highest catch rate per canoe per day (300 kg). Correspondingly the same two factors led to an increase in the number of fishers (89 to 128) and fish traders (27 to 47). The highest monthly yield estimates were got in transect two (16815.9 kg valued at 9.8M) and transect four (2042kg valued at 1.74M) and the least was transect three 669 Kg valued at 0.43 compared to 3637.7 kg valued at 1.81M, in transect four and 3421.7kg valued at 1.72M in transect one and the least was in transect three 308.0 Kg valued at 0.09M of the four transects along Victoria Nile in the second quarter of 2000. Transect four (Namasagali) had the highest fishing effort (20 canoes) as was the case in the second quarter of 2000 but the number had reduced by five canoes (20%).

However the highest CPUE (catch kg per canoe) was in transect two at 300 kg per canoe compared to transect one at 16.7 kg per canoe in the second quarter of 2000. The gears and fishing methods in order of importance were angling (40.5%), followed by gill nets (31.0%), and long line 16.7% for the fishing canoes sampled. The *R. argentea* was the overall most dominant species (62.0%) compared to *O. niloticus* (53.2%) in the second quarter of 2000. A total of 12 fish species were recorded compared to 10 in the second quarter of 2000. However, *P.aethiopicus* was not encountered. The highest number of fish species (8) were in transect one followed by transect 2 and 4 each with 6 species.

Table 10.1 The composition of fish catch survey information of April 2006 compared with second quarter April 2000 survey (in brackets) at the four sampling transects of the upper Victoria Nile. D= Dugout: S=Ssese: Pa=Parachute

Parameters	Transect 1 Upstream Kalange to Makwanzi		Transect 2 Downstream Buyala to Kikubamutwe		Transect 3 Downstream Matumu to Kirindi		Transect 4 Downstream Namasagali to Bunyamira	
Major landing sites								
Active canoes	9S(6 Pa, 6S)		13S (8Pa, 1D)		7S, 1Pa, 1D (2Pa, 2D)		19D, 1Pa (22D, 3Pa)	
Sampled canoes	9S (6 Pa, 6S)		9S (6Pa, 1D)		7S, 1Pa, 1D (2Pa)		10D (24D, 1Pa)	
Jobs supported by the fishery	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
Boat builders/repair	2 (1)		5 (3)		1 (-)		5 (2)	
Food vendor		4 (4)	- (1)	- (4)			1	1
Net Repairer							- (1)	
Cleaner fish landing							2 (1)	
Fishers	57 (22)		26 (9)		5 (12)		40 (46)	
Fish traders	11 (3)	12 (7)	5 (3)	8 (7)	1 (1)	2 (1)	8	
Chairperson	1				1		1 (1)	
Fisheries staff	1 (1)		- (1)				- (2)	
Askali landing site (securicor)							1 (2)	

NB: Localities associated with all the transects in all the Tables are: Transect 1 upstream include: Kikonko, Kunjaba, Makwanzi Is, Transect 2 downstream include: Naminya, Kisadha, Ofwono, Zaire, Mugalya, Kisoga, Transect 3 downstream include: Matumu, Kisoga A,B,C, Damba, Transect 4 downstream include: Kasanga, Kibuye, Sajjabi

Table 10.2. Records of the commercial and local fish species caught and their percentage composition by weigh (kg) in individual gears compared with second quarter 2000 (in brackets) at the four sampling stations of the upper Victoria Nile

Parameters	Transect 1 Upstream Kalange to Makwanzi	Transect 2 Downstream Buyala to Kikubamutwe	Transect 3 Downstream Matumu to Kirindi	Transect 4 Downstream Namasagali to Bunyamira
Composition in gillnets				
O. niloticus	3.2 (18.0)			78.2 (69.8)
O. leucostictus	- (0.6)			- (1.8)
O. variabilis	3.0 (4.4)			
L. niloticus	7.5 (8.2)	15.6 (39.0)	31.6	
M. kannume	69.5 (64.6)	33.6 (61.0)	68.4	- (2.0)
B. altianalis	15.3 (4.0)			15.4 (26.3)
B. docmak	- (0.3)	- (49.8)		
T. zillii	- (1.5			2.7
C. gariepinus				3.7

Table 10.3. Records of the commercial and local fish species caught and their percentage composition by weight (kg) in cast nets and hooks compared with second quarter 2000 (in brackets) at the four sampling stations of the upper Victoria Nile

Parameters	Transect 1 Upstream Kalange to Makwanzi	Transect 2 Downstream Buyala to Kikubamutwe	Transect 3 Downstream Matumu to Kirindi	Transect 4 Downstream Namasagali to Bunyamira
Castnets:				
O. niloticus	16.5 (27.1)			50.9
O .leucostictus	2.0 (0.5)			44.8
O. variabilis	8.5 (26.6)			
T. zillii	42.3 (31.0)			
L. niloticus	24.6 (8.9)			4.2
B. altianalis	15.3 (2.0)			
Haplochromines	0.3			
M. kannume	5.8			
Longline				
O. niloticus	(3.9)			
L. niloticus	(45.1)	(30.7)	15.2	100 (98.1)
M. kannume	(5.7)			
B. altianalis	(19.3)		43.1	
B. docmak		100 (69.3)	41.7	
P. aethiopicus	(6.0)			
C. gariepinus	5.3			1.9

Table10.4 Records of the commercial and local fish species caught and their percentage composition by weight (kg) in angling catches compared with second quarter 2000 (in brackets) at the four sampling stations of the upper Victoria Nile

Parameters	Transect 1 Upstream Kalange to Makwanzi	Transect 2 Downstream Buyala to Kikubamutwe	Transect 3 Downstream Matumu to Kirindi	Transect 4 Downstream Namasagali to Bunyamira
Angling				
O. niloticus	75.6 (76.6)	2.8		84.9 (77.2)
O. variabilis	- (9.7)			
T. zillii	2.8 (7.7)	0.8		
L. niloticus	13.2 (13.9)	19.5 (88.0)	69.2	15.1 (22.5)
M. kannume	8.4	7.2		
B. altianalis		5.0	30.8	- (0.3)
B. docmak		64.1 (12.0)	- (100.0)	

Table 10.5. Overall percentage composition by weight (kg) compared with second quarter 2000 (in brackets) at the four sampling stations of the upper Victoria Nile

Parameters	Transect 1 Upstream Kalange to Makwanzi	Transect 2 Downstream Buyala to Kikubamutwe	Transect 3 Downstream Matumu to Kirindi	Transect 4 Downstream Namasagali to Bunyamira	
O. niloticus	22.4 (26.8)	0.2		75.8 (81.0)	11.5 (53.2)
O. leucostictus	0.8 (0.4)			2.3	0.1 (1.4)
O. variabilis	4.6 (10.0)				0.7 (4.3)
T. zillii	17.8 (7.7)			2.0	3.0 (3.3)
L. niloticus	15.3 (14.7)	1.5 (63.0)	25.0	8.1 (8.8)	5.8 (13.5)
M. kannume	32.6 (29.8)	1.2 (15.1)	4.1	(0.5)	6.1 (13.6)
B. altianalis	6.3 (5.1)	0.3	38.8	11.4 (6.7)	4.9 (5.7)
B. docmak	- (0.1)	4.9 (22.0)	32.4 (100.0)		5.4 (2.4)
P. aethiopicus	- (3.7			(6.7)	(1.9)
C. gariepinus	- (1.8)			2.7	0.3 (0.8)
R. argentea		91.9			62.0
Haplochromines	0.1				

Table 10.6. The composition of fish catch survey fishing gears, fishing methods and size of gear compared with second quarter 2000 (in brackets)at the four sampling stations of the Upper Victoria Nile

Parameters	Transect 1 Upstream Kalange to Makwanzi	Transect 2 Downstream Buyala to Kikubamutwe	Transect 3 Downstream Matumu to Kirindi	Transect 4 Downstream Namasagali to Bunyamira
Av. gear per boat				
Gillnets	5.2 (6.6)	3.5 (2)	2 (-)	6.2 (4.3)
Castnets	1 (1)			- (1)
Angling (Hooks)	2 (2.3)	4.8 (2.8)	5.8 (-)	4.3 (5.1)
Longline (Hooks)	- (210)	40 (38.5)	68.5 (15)	29 (18.4)
Mosquito net		1 (-)		
Size of gear				
Gillnets	3.5"-5 (4"-5")	- (3")		5", 6" (4.5" ,6")
Castnets	3" (4/5'-4.5" – 4.5/5")		3" (-)	- (4")
Angling (Hooks)	10-15 (10-14)	7,8 (12,8)	7,8 (7)	10-12 (6,11,12,14)
Longline (Hooks)	- (8)	- (8)		7 (7,9,10,11,12)
Mosquito net		1mm (-)		

Table 10.7. The catch per unit of effort (kg) per boat, gear or fishing method compared with second quarter 2000 (in brackets) at the four sampling stations of the Upper Victoria Nile

Parameters	Transect 1 Upstream Kalange to Makwanzi	Transect 2 Downstream Buyala to Kikubamutwe	Transect 3 Downstream Matumu to Kirindi	Transect 4 Downstream Namasagali to Bunyamira
Catch per unit of effort per boat				
Gillnets	14.3 (14.7)	6.7 (4.1)	1.9 (-)	15.6 (12.4)
Castnets	8.6 (13.5)			- (8.3)
Longline	- (24.4)	0.4 (1.9)	10.0 (2.7)	2.5 (5.8)
Angling	7.1 (8.6)	12.2 (2.2)	3.4 (-)	5.5 (9.4)
Mosquito net		300 (-)		
Per gear				
Gillnets	1.2 (2.5)	1.1 (2.1)	1.0 (-)	1.2 (2.9)
Castnets	7.3 (13.5)			- (8.3)
Longline	- (0.12)	0.01 (0.05)	0.1 (0.23)	0.04 (0.3)
Angling	1.4 (3.7)	0.7 (0.2)	0.2	0.8 (1.8)
Mosquito net		300 (-)		

Table 10.8. Estimates of the total yield (kg) per day compared with second quarter 2000 (in brackets) for sampled boats at the four sampling stations of the Upper Victoria Nile

Parameters	Transect 1 Upstream Kalange to Makwanzi	Transect 2 Downstream Buyala to Kikubamutwe	Transect 3 Downstream Matumu to Kirindi	Transect 4 Downstream Namasagali to Bunyamira
Total number of active boats at landing	9 (12.0)	13 (9.0)	9.0 (4.0)	20.0 (25.0)
Boats sampled	12 (9.0)	9 (7.0)	9.0 (9.0)	10.0 (25.0)
Average days fished/week	5.2 (6.1)	7.0 (7.0)	5.2 (7.0)	5.0 (4.6)
Yield estimates of species per day (kg)				
O. niloticus	8.3 (44.0)	0.5		38.7 (160.2)
O. leucostictus	0.3 (0.7)			
O. variabilis	1.7 (16.5)			(4.6)
T. zillii	6.6 (12.6)			1.0
L. niloticus	5.7 (24.2)	4.8 (10.5)	8.0	4.2
M. kannume	12.2 (48.9)	4.0 (2.5)	1.3	(17.4)
B. altianalis	2.4 (8.5)		12.4	5.8 (1.0)
B. docmak	(0.2)	15.9 (3.7)	10.4 (5.5)	(13.3)
P. aethiopicus	(6.0)			(1.2)
C. gariepinus	(2.9)			1.4
R. argentea		300		
Haplochromines	0.1			
Total weight (kg) landed per day	37.2 (164.5)	326.4 (16.7)	32.1 (5.5)	51.1 (197.7)

Table 10.9. Estimates of total yield kg/month compared second quarter 2000 (in brackets) at the four sampling stations of the upper Victoria Nile

Parameters	Transect 1 Upstream Kalange to Makwanzi	Transect 2 Downstream Buyala to Kikubamutwe	Transect 3 Downstream Matumu to Kirindi	Transect 4 Downstream Namasagali to Bunyamira
Total yield (kg/week), kg/month				
O. niloticus	202.5 (915.2)	20.2 (-)		15448 (2947.7)
O. leucostictus	7.2 (14.6)			- (84.6)
O. variabilis	41.7 (343.2)			
T. zillii	160.9 (262.1)	6.1 (-)		40 (-)
L. niloticus	138.4 (503.4)	192.1 (378.0)	167.1 (-)	166 (320.2)
M. kannume	295.1 (1017.1)	161.8 (89.6)	27.2 (-)	- (18.4)
B. altianalis	57.1 (176.8)	40.4 (-)	258 (-)	232 (244.7)
B. docmak	- (4.2)	643.1 (134.4)	217.2 (308.0)	
P. aethiopicus	- (124.8)			- (22.1)
C. gariepinus	- (60.3)			56 (-)
R. argentea		12133.3 (-)		
Haplochromines	1.2 (-)			
Total	**904 (3421.7)**	**13200.4 (602.0)**	**669.5 (308.0)**	**2042 (3637.7)**

Table 10.10. Estimates of total cost per fish species per month and estimates of total value in millions of Uganda shillings at the four sampling stations of the Upper Victoria Nile

Parameters	Transect 1Upstream Kalange to Makwanzi		Transect 2 Downstream Buyala to Kikubamutwe		Transect 3 Downstream Matumu to Kirindi		Transect 4 Downstream Namasagali to Bunyamira	
	Sh/kg	Millions	Sh/kg	Millions	Sh/kg	Millions	Sh/kg	Millions
O.niloticus	750 (743)	0.15 (0.68)	500 (-)	0.01 (-)			100 (500)	1.55 (1.47)
O.leucostictus	500 (750)	0.004 (0.01)			1000 (-)	0.22 (-)	- (300)	- (0.03)
O.variabilis	550 (660)	0.02 (0.23)						
T.zillii	550 (600)	0.09 (0.16)					500 (-)	0.02 (-)
L.niloticus	900 (500)	0.12 (0.25)	2250 (700)	0.43 (0.27)	1250 (-)	0.21 (-)	1000 (350)	0.17 (0.11)
M.kannume	786 (220)	0.23 (0.22)	667 (600)	0.11 (0.05)			- (225)	- (0.004)
B.altianalis	800 (500)	0.05 (0.09)	1500 (-)	0.06 (-)			- (500)	- (0.12)
B.docmak	- (767)	- (0.003)	2000 (1100)	1.29 (0.15)	1000 (700)	0.22 (0.09)		
P.aethiopicus	- (220)	- (0.03)					- (200)	- (0.004)
C.gariepinus	- (875	- (0.05)					1400 (-)	0.08 (-)
R. argentea			**600 (-)**	**7.3 (-)**				
Haplochromines	**0.05 (-)**							
Total		**0.67 (1.72)**		**9.2 (0.47**		**0.43 (0.09)**		**1.74 (1.81)**

CHAPTER 11

11.0. Bilharzia, other Disease vectors and Status of Sanitation

11.1. Introduction

The study of bilharzia and snail vectors as well as other disease vectors such as *Simulium sp* and the effect of the extent of water quality to humans who use it for bathing, drinking and cooking, fishing, swimming is essential in baseline information and changes that may occur during and after dam construction. Bilharziasis (Schistosomiasis) is spread by two major snail vectors, *Biomphilaria spp* and *Bulinus sp.* The former is a vector of *Schistosoma mansoni* while the latter is a vector of *Schistosoma hematobium.* River blindness, one of the very dangerous disease for riparian communities along polluted rivers is spread by *Simulium* larvae. This report provides preliminary information on the prevalence and intensity of waterborne diseases mainly schistosomiasis and river blindness, and the sanitation status among the riparian communities along the Upper Victoria Nile.

11.2. Materials and Methods

11.2.1. Sampling for Bilharzia (schistosomiasis) snails

The snails were sampled by making 3 transects on both banks of the river at selected sites. Each transect measured one square metre. The snails were collected by hand picking from rocks and by use of a grab for the river bottom. These were the only viable methods due to the presence of rocks at the site, which made the conventional scooping method unsuitable. The vector snail samples were then placed in test tubes and water was added before they were exposed to sunlight for 2-4 hours to shed them for cercaria.

11.2.2. Sampling stool for parasitological analysis of Bilharzia in humans

Stool samples were obtained from the residents both male and females present at the landing sites, were involved. Consent was obtained from the residents and the local leaders were informed. High-risk water-human contact activities were determined as Fishing, Bathing/swimming, washing clothes, fetching water and playing.

The Kato-Katz stool analysis technique was used, whereby 41.7 mg of human faecal material was collected from each of the 15 people per selected site, giving a total of 60 samples from the people. Intensity of infection from these samples was determined by placing the faecal material on a slide with the aid of a template and a cellophane cover slip dipped in malachite green. Samples were examined under a compound microscope for purposes of estimating the eggs per gram load (EPG).

11.2.3. Prevalence of schistosomiasis by different water users

Prevalence of schistosomiasis was evaluated for the following water contact activities: fishing, fetching water, bathing and swimming, playing and washing by taking sample populations of 14, 11, 10, 10, and 15 people, respectively covering the four transects.

11.2.4. Sampling for faecal coliforms

Samples were taken from one site from each of the 4 transects along the river for the purpose of testing for faecal coliforms. The sites were Kalange(Transect 1), Kikubamutwe (Transect 2), Kirindi (Transect 3) and Namasagali (Transect 4) at shallow fast moving waters and deep water points. Equipment was sterilised using methylated spirit. The water was filtered, a pad prepared and culture media (Mackonky's broth solution) was applied to the pad and incubated for 20-22 hours in line with the testing method using DelAgua Testing kit.

11.2.5. Sampling for *Simulium* (Blackfly) larvae

Samples of crabs and vegetation in fast moving waters of the river were collected and checked for *Simulium* larvae at the four transects.

11.3. Results

11.3.1. Bilharzia snails abundance and distribution

The non-vector snails were more abundant than the vector snails at three sites except Namasagali (Fig. 11.1). Of the vector snails, only two were infectious i.e. shed cercaria. One, a *Biomphalaria* was from Kalange and the other was *Bulinus* from Kikubamutwe (Transect 2). Though the number of infected vector snails were few, they may be quite significant in the spread of disease. Of the two vector snail species, *Biomphalaria sp.* was more abundant at Kalenge and Kirindi sites (Fig.11.1). The prevalence land is indicative of a higher risk of *Schistosoma mansoni* than *Schistosoma haematobium.* Kalange had the highest number of vector snails while Namasagali had the lowest. At all sites, the vector snails were encountered and thus their number, distribution and abundance could be a source of transmission. Shedding of cerceria by the *Bulinus sp* is indicative of transmission of *S. haematobium* that has not yet been clinically detected in Uganda and therefore merits further follow up.

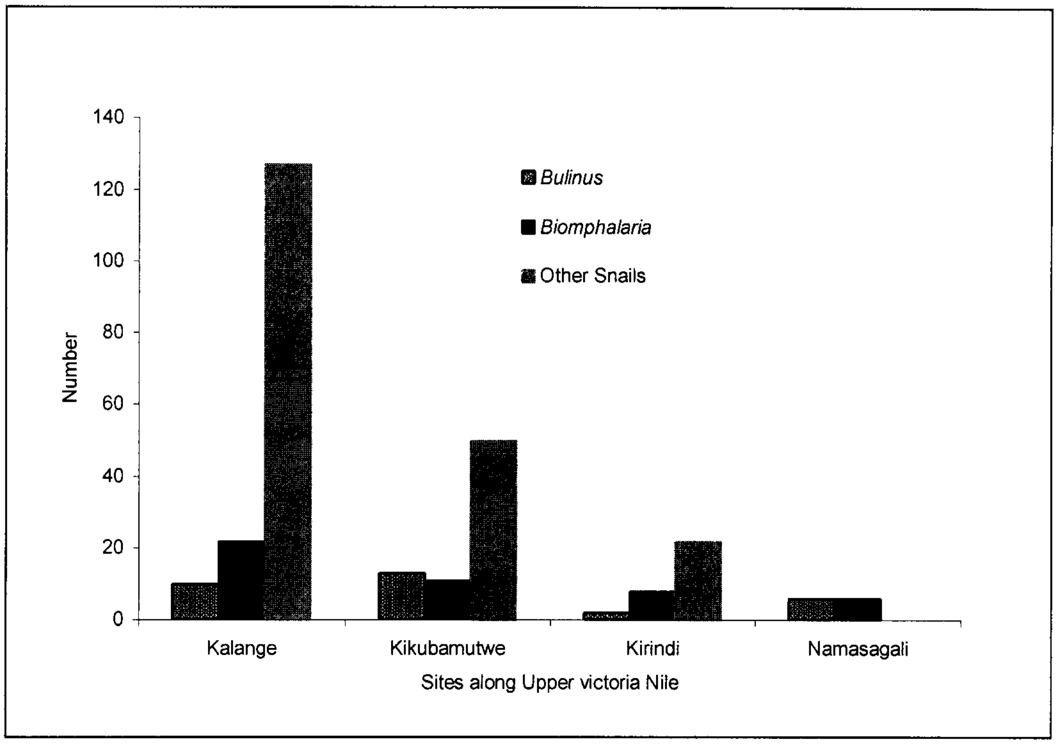


Fig. 11.1. Abundance and distribution of bilharzias vector (*Bulinus* and *Biomphalaria*) snails and non-vector (*Bellamya, Melanoides, Lymnaea* and bivalves) molluscs along the Upper Victoria Nile

11.3.2. Parasitological analysis of bilharzias in humans

Of the 60 samples collected from a population of 265 people, 50 % of the sampled population were infected with Schistosomiasis (Table 11.1).

Table 11.1 Sample population and samples collected at the sites along Upper Victoria Nile for prevalence of Schistosomiasis

Village	Site	Popn. at site	Samples collected	Positives
Buwenda	Kalange	65	15 (23%)	8
Kikubamutwe	Nankwanga	60	15 (25%)	7
Kirindi	Bukwaya	70	15 (21%)	7
Namasagali	Kabanga	70	15(21%)	8
Total		**265**	**60 (22.6%)**	**30**

Infection with schistosomiasis was highest (53%) in both Kalange and Namasagali (Fig. 11.2). It is especially significant in Kalange area when you find that there is presently an active deworming programme using mass chemotherapy with paraziquantal. This is indicative of a high rate of re-infection.

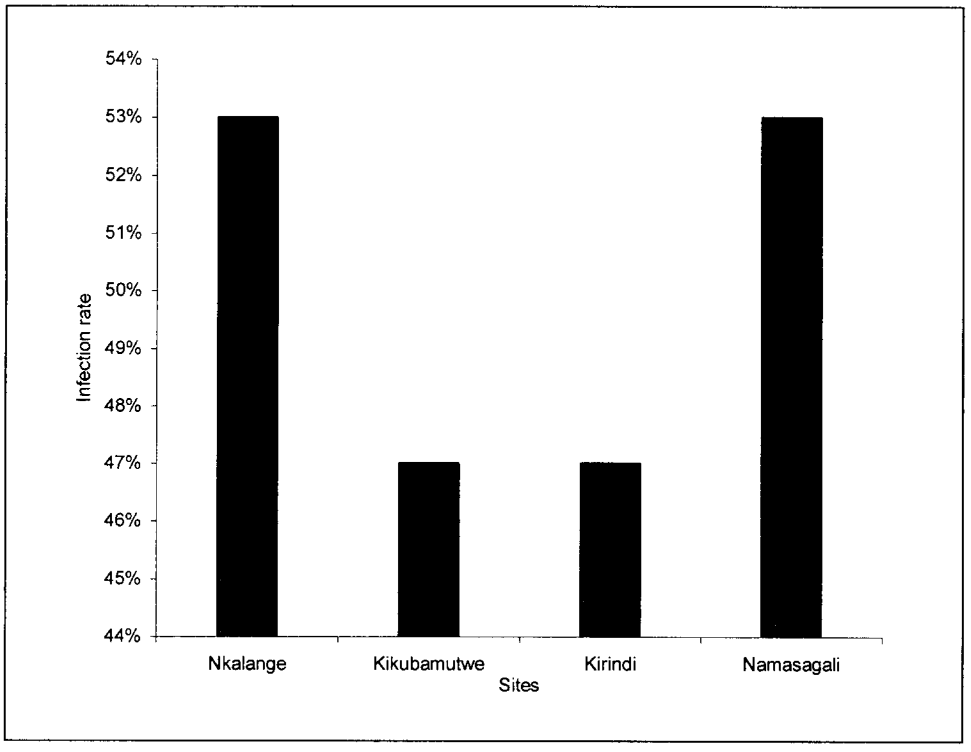


Fig. 11.2. The infection rate of schistosomiasis at four sites along the Upper Victoria Nile

11.3.3. Intensity of infection by schistosomiasis

Kalange and Namasagali have moderate to heavy intensity while Kirindi and Kikubamutwe have light to moderate intensity (Table 11.2). Thus, a concerted effort is needed to promote chemotherapy and environmental sanitation measures to reduce parasite loads and transmission in the riparian villages on Upper Victoria Nile

Table 11.2. Intensity of schistosomiasis infection

Site	Samples	Positive No.	Light intensity	Moderate intensity	Heavy intensity
Kalange	15	8 (53%)	1 (6.7%)	5 (33.3%)	2 (13.3%)
Kikubamutwe	15	7 (47%)	2 (13.3%)	4 (26.7%)	1 (6.7%)
Kirindi	15	7 (47%)	4 (26.7%)	2 (13.3%)	1 (6.7%)
Namasagali	15	8 (53%)	2 (13.3%)	4 (26.7%)	2 (13.3%)
Total	**60**	**30 (50%)**	**9 (15%)**	**15 (25%)**	**6 (10%)**

11.3.4. Prevalence of schistosomiasis by different water users

The major predisposing activities for Schistosomiasis infection were fishing and swimming/ bathing (Fig. 11.3). These activities therefore will form the focus of subsequent the health interventions.

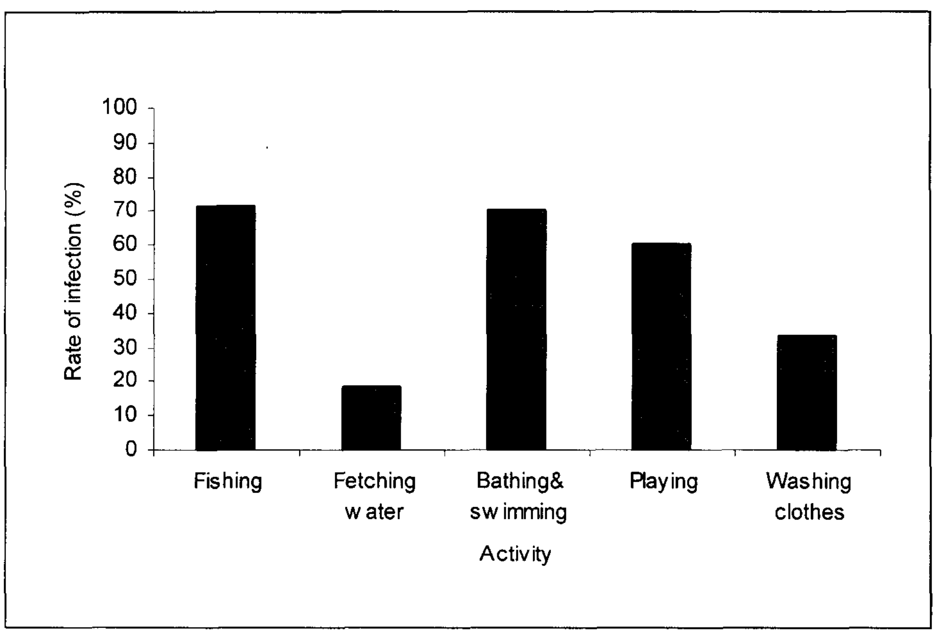


Fig. 11.3. Prevalence of schistosomiasis by water contact activities

11.3.4. Faecal coliforms contamination

The micro-organisms of medical importance were predominantly *Salmonella* and *Shigellosis*. Contamination was higher at the shallow human and water contact points than in the deeper water (Table 11.3). All sites were far above the acceptable limit of 5 colonies per 100 mls of water. Ten colonies and above are indicative of urgent need for health interventions to reduce the threat of disease. Contamination at Kalange was exceptionally high, although that recorded at Namasagali was also of high risk of contamination. Mass health education, home improvement campaigns and mass chemotherapy should be undertaken at the sites to mitigate the effects of disease transmission.

Table 11.3. Feacal coliforms colonies at the inshore and deep points of the transects on Upper Victoria Nile

Transect	Kalange		Kibubamutwe		Kirindi		Namasagali	
Station	Inshore	Deep	Inshore	Deep	Inshore	Deep	Inshore	Deep
No of colonies/100 ml of water	200	40	50	10	60	20	80	20

11.3.5. *Simulium (*Blackfly) larvae survey

Medically important species of *Simulium* flies mostly live in sheltered areas of the river/stream in fast moving waters. Vegetation collected showed no signs of medically important *Simulium* larvae. A total of 55 crabs which were collected did not have any *Simulum* larvae. However, invertebrate survey carried out during this study found some *Simulium* larvae (21 ind. m^{-2}) under plant roots at the eastern and western banks of the Kalenge-Naminya transect.

11.4. Discussion

Results from this survey, the first one of its kind show that the sanitation environment of the riparian communities along the Upper Victoria Nile is poor as indicated by faecal coliform load of over ten colonies per 100 ml of water at all sites. The acceptable limit of coliform load for good sanitation is 5 colonies per 100 mls of water (Barrel *et al.*, 2000). Ten colonies and above are indicative of urgent need for health interventions to reduce the threat of disease. Risk and prevalence of schistosomiasis were noted especially for people predisposed to water by fishing and bathing/swimming activities. River blindness seemed not to be a threat at present along the Upper Victoria Nile.

Therefore, there is a need to sensitize the communities about health hazards through mass health education, home improvement campaigns and mass chemotherapy at the sites to mitigate the effects of disease transmission. The origin of high levels of faecal coliforms (*Salmonella*) contamination should be further monitored.

CHAPTER 12

12.0. Fisheries Socio-economics Findings

12.1. Objectives of the survey

The main objective of the survey was to provide baseline fisheries socio-economic information on activities in the project site.

12.2. Survey sites and tools

The survey was focused on the areas previously sampled during AESNP EIA 2000. Participatory Rural Appraisal tools including transect walks, focus group discussions and key informant interviews were used. Additional socio-economics information captured in meeting notes is not included in this report.

12.3. Populations and activities at sampled sites

The major economic activity prevailing in the sampled sites is predominantly agriculture with some smallholder fishing activity. Although fishing is largely carried out on a subsistence level, the activity essentially supports many livelihoods as far as basic needs such as food, health income are concerned. Some of the species harvested are Nile perch (*Lates Niloticus*), Tilapia (*Oreochromis niloticus*), *Bagrus* (Semutundu), *Mormyrus* (Kasulu), and *Barbus* (Kisinja). Other economic activities include; charcoal burning, poultry farming, bars/restaurants and grocery shops. Livestock farming (cows, goats and sheep) is also practiced.

Beach Management Units (BMUs) around landing sites are not yet fully established.
On average the fishers' earn of between Ush 10,000-30,000, an equivalent of US $ 5.5-16.2 per week per fisher. However, majorities of them do not save. Only 9.5% had bank accounts in various locations, which indicates that they attach little value to their future income sources.

12.4 Fishing assets owned

Most of the fishers (89%) owned fishing assets while a few rented. Amongst the assets owned include; boats, oars, hook and gillnets.

13.0. References

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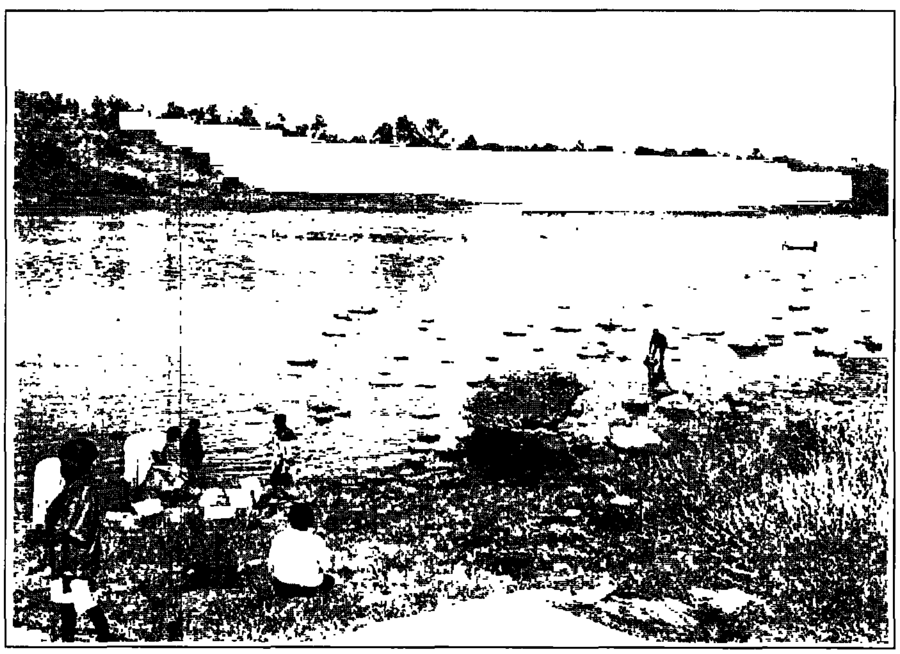
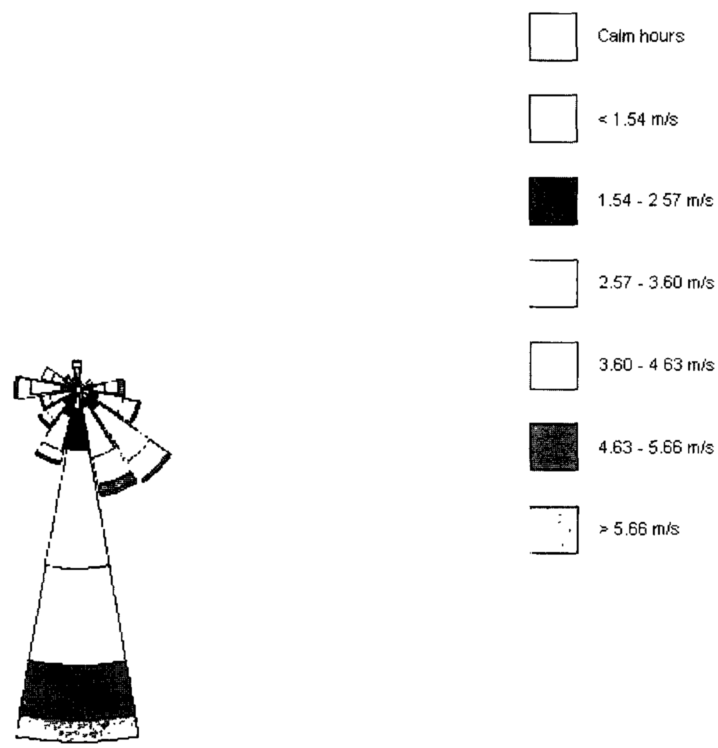
ANNEX A

A scoop-net on River Nile. This gear is used for fishing the small pelagic cyprinid Mukene (*Rastrineobola argentea*).



Washing in the Nile River. One of the ways communities along the river get infected by water-borne diseases especially bilharzias a common disease on the Nile.

Sun-drying the catch. Mukene caught from Kibubamutwe were very small immature fishes. The BIC pen lid shown is 57 mm long.



Source: Jinja Meteorological Station

Project Name: **BUJAGALI HYDROPOWER FACILITY EIA**	Date: MARCH, 2001	G0503_H_31	**Figure C.1**
Prepared for: **AES NILE POWER**	**WIND ROSE DIAGRAM FOR JINJA** **JULY 1999 TO JUNE 2000**		

BURNSIDE

Appendix C.2
Climatic Data

(Source: Appendix C.2 - AESNP Hydropower Facility

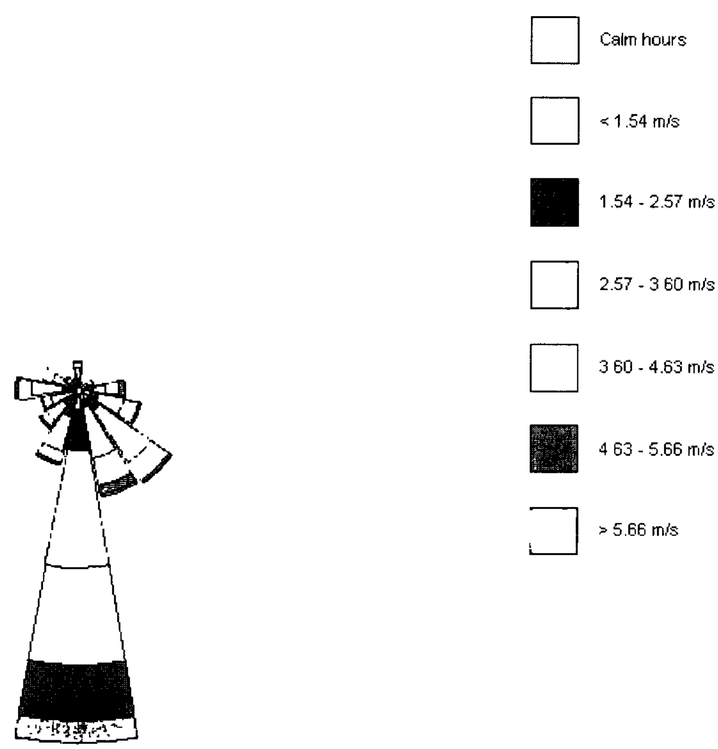
EIA, March 2001)

APPENDIX C.2
WIND DATA

Table C.1 Relative Frequency Distribution of Wind Speed and Direction at Jinja Kimaka Meteorological Station for Period January 1999 to June 2000

Speed m/s Direction	≤1.54	1.54 to 2.75	2.75 to 3.60	3.60 to 4.63	4.63 to 5.66	>5.66	Total %
0	0.137	0.685	0.959	0.479	0.068	0.068	2.397
22.5	0.000	0.000	0.274	0.137	0.000	0.068	0.479
45	0.000	0.000	0.274	0.000	0.000	0.000	0.274
67.5	0.137	0.000	1.027	0.000	0.000	0.000	1.164
90	0.342	0.685	1.164	1.301	0.616	0.068	4.178
112.5	0.685	0.959	2.466	1.370	0.205	0.137	5.822
135	0.753	1.370	5.959	2.123	0.274	0.137	10.616
157.5	0.685	0.685	4.932	2.740	0.890	0.274	10.205
180	1.644	3.836	11.301	9.178	5.342	2.123	33.425
202.5	0.685	1.644	3.425	1.027	0.411	0.000	7.192
225	0.685	0.822	1.918	0.685	0.205	0.068	4.384
247.5	0.205	0.205	2.192	0.753	0.137	0.068	3.562
270	0.616	0.753	2.877	1.301	0.274	0.000	5.822
292.5	0.548	0.342	1.507	0.959	0.000	0.000	3.356
315	0.068	0.411	0.616	0.274	0.068	0.000	1.438
337.5	0.274	0.068	0.548	0.000	0.000	0.000	0.890
Total %	7.466	12.466	41.438	22.329	8.493	3.014	95.205
Calms							4.795
Missing							0.000
Total %							100.000

Source: Department of Meteorology, Uganda



Source: Jinja Meteorological Station

Project Name: **BUJAGALI HYDROPOWER FACILITY EIA**	Date: MARCH, 2001	G0503_H_31	**Figure C.1**
Prepared for: **AES NILE POWER**	**WIND ROSE DIAGRAM FOR JINJA** **JULY 1999 TO JUNE 2000**		

BURNSIDE

Appendix C.3
Terrestrial Ecological Assessment Report

Bujagali Hydropower Project: Terrestrial Ecological Assessment (Plants, Birds and Mammals)

May 2006

Client: RJ Burnside International Ltd

Prepared by: Makerere University Institute of Environment and Natural Resources

Prof. Derek Pomeroy, Robert Kityo, Paul Ssegawa

FAUNA & FLORA – REPORT

Executive Summary

As the previously extensive forest has been cleared over the past few decades, all but a few forest trees remaining, the predominant land use is now subsistence farming. Such agro ecosystems can support quite a high diversity of native flora and fauna, especially where, as in these areas at present, agricultural practices are largely small-scale and relatively traditional. Thus we did not expect many rare or threatened species, and this was confirmed by our findings.

The only major change between 1998 and 2006 has been the fencing of part of the west bank, and the subsequent rapid growth of thickets. Both here, and at other sites (including the Forest Reserve) a number of young trees are growing, so that the potential for natural forest regeneration seems quite good. Once the dam is closed, it would be possible to imagine the lake surrounded by forest, and with several forest island, supporting some tourist activities and breeding sites for water birds, as well as a sanctuary for native mammals. With good management, the degraded Forest reserves could likewise regenerate into an attractive feature on either bank, with forested islands between. As elsewhere, some sustainable uses of these forests could occur, once regeneration is well underway.

Overall more species of plants have been recorded in all sites compared to the results in 1998.

Some of the islands in the project area (e.g. Dumbbell, Namizi and Bujagali), will probably be completely submerged following the dam construction. Although largely cultivated these islands still supported a lot of species characteristic of forests, especially in the uncultivated areas and particularly the peripheries.

The invasive exotics, *Broussonetia papyrifera* and *Lantana camara* are quite abundant in most of the areas visited these could be controlled through a sustained regime of clearing to encourage native species to regenerate.

Exclusion of human activities, particularly farming on river banks, and enrichment planting with *Albizia grandebraceatata*, *Albizia coriria, Milicia excelsa* and *Ficus* spp. will protect the river banks from erosion. Encouragement of natural regeneration of indigenous mid and late successional species such as *Ficus ovata, Warburgia ugandensis, Albizia grandebractiata, Celtis africana* especially in the Kalagala forest reserve will enhance the aesthetic value of these forests and contribute to tourism.

Numbers of species of birds were generally higher in 2006, partly because of the presence of Palearctic migrants, but probably also because the wet season increases the food supply for many species.

Of the various sites surveyed in 2006, the Forest Reserves had the most species. Of sites in the dam area, east and west banks had similar total numbers of species, as well as species of various specialities. No *globally-threatened* species were recorded, but several species of regional interest were present. However, their populations within the Bujagali are a negligible proportion of the population of the species as a whole, so that construction of the dam will not affect them significantly.

The surviving mammalian diversity is largely comprised of small sized mammals including Rodents, Bats and Monkeys since all larger species are long gone from the area.

We have not recorded many species of conservation concern in the area however a few merit mention: -

i. *Milicia excelsa* (Mvule) is categorized as Low Risk/ Near threatened by the IUCN (2000).

ii. Other restricted range species include *Ficus cordata and Ficus ottonifolia,* which have been recorded in only one floral region out of the four that occur in Uganda.

iii. Of the species of mammals recorded to still occur in the area only the African Spot Necked Otter *Lutra maculicollis* is listed by IUCN as vulnerable. Although the species is faced with a diversity of threats, it however remains widespread in many of Uganda's large fresh water bodies of which the Victoria Nile is only a small part.

The major conclusions from these surveys are that: -

- Regeneration in the fenced areas on the west bank has been remarkable, and shows interesting potential for natural reaforestation.
- The islands, and to some extent the two reserves of the 'Kalagala offset' retain significant numbers of native trees, which, with appropriate management, could also lead to natural reaforestation. In both cases, this would have considerable visual appeal (important to ecotourists) and have conservation benefits too.
- The east bank areas between Bujagali and Namizi remain essentially the same as in 1998.

BUJAGALI ESIA – FLORA and FAUNA

1 INTRODUCTION

1.1 Site description

Fieldwork at the sites concerned in the Bujagali ESIA took place between 15 and 26th March 2006. In this section, we have three parts – site descriptions, the vegetation structure and human use. These are followed by detailed accounts of the plants, birds and mammals of these areas and, finally a brief overview. Here we consider the main features of the six surveyed areas, as a background to their flora and fauna. The area as a whole has a high human population, especially on the east bank, so that the landscapes are predominantly determined by human activity, past and present. Less than 40 years ago, however, the banks of the Nile river were extensively forested, then the source of the disease known as river blindness, transmitted by *Simulium* flies, was eradicated, and people progressively cut down almost all of the forest, although a few forest trees remain within the farmland, and many more on some of the islands.

1.1.1 THE EAST BANK OF THE HYDRO AREA contains two of the sites that were surveyed in 1998, and which have been revisited in 2006. One is adjacent to Bujagali Falls (but mainly in the farmland outside the developed tourist area) and the other opposite Dumbbell Island. This area was not fenced in March 2006.

Namizi – this area, which is quite intensively used for smallholder/subsistence farming is relatively flat but slopes gently towards the river. A few houses have recently been built by richer members of the community; some are not lived in permanently. Native trees are preserved and common with the farmlands.

Bujagali village – the tourist area. We mainly surveyed the area outside the various camps, which however are still considerably affected by tourists, such as the riders of 'all-terrain vehicles', which are noisy and probably damage the tracts. Trees are again common. Between the occasional new houses, many people in these areas remain very poor.

1.1.2 THE FENCED AREA OF THE WEST BANK also contains two sites (the more northerly one embracing both Kikubamutwe and Malindi). These were surveyed for birds, mammals and plants in 2006, but only the northerly one was a bird site in 1998.

Kikubamutwe – the area just inside the fence, marking the main entrance to the fenced area – slopes gently down to the river, where the bank is relatively low. Since the people left the area in 2002, few signs of their presence remain, but there are a few banana plants and some mango and jackfruit trees. Most trees, however, seem to have been cut before the area was evacuated. Of those that remain, there are a few large ones which are certainly important for birds. The most striking feature is extensive, dense bush, composed largely of *Lantana camara* but with a high abundance of Paper mulberry, as described in Section 2. Scattered through the area are some open places, apparently derived from murram pits, and the roads are also wide, providing a contrasting habitat to the bush.

North of Naminya. This area, within the fence, is similar in many respects to the dam site, but there are more open areas, and as the track follows the perimeter fence, it was easy to observe the adjacent mixed farmland too. *Imperata* grass is now flourishing in an area of more than a hectare that had been recently burnt.

1.1.3 THE FOREST RESERVES or Kalagala-Itanda offset. These may well have been intact forests at the time of gazettement, but are degraded now. There is some dispute as to whether the islands belong to one or other of these reserves, or neither, it is reputed that one of the rafting companies has acquired the largest island.

Nile BankForest Reserve, on the east bank, some 15 km north of Dumbbell Island, is marked by an NFA signpost but consists to a very large extent of maize. It is alleged that the NFA authorities allowed the local communities to plant annual crops for one more growing season and thereafter will be planted with Pinus. However, no houses have been built in the area, suggesting that people accept that it is a reserve. The area is predominantly flat, sloping gently towards the river until within some 30-40 metres of the river bank, when it falls steeply, these slopes are partly cultivated too.

The few remaining trees form a clump of perhaps a hectare at the picnic site (used by rafters at the downstream end of their journey) and under the care of a very helpful lady, Ms Sarah. Elsewhere in the area we surveyed, which is within a few hundred metres of the picnic site, there are also some scattered trees.

Although within the surveyed crop area, maize is dominant, other crops included beans and tomatoes, and there were a few pawpaw trees.

Kalagala Forest Reserve, opposite Itanda on the west bank, retains a small clump of large tees, and a number of smaller trees are scattered along the area between the road and the river. The area is quite attractive and is well-used by local people for washing clothes – and by small boys for swimming. This reserve extends inland for approximately 300 m, where the absence of houses suggests that people are aware of its existence; if it were to be allowed to regenerate, they would lose their fields but not their homes.

1.2 Vegetation Structure

The number of trees, thickets, amount of ground cover and such-like features are a simple way of describing the landscape. This vegetation structure is also important to birds and mammals, many of which use trees, for example.

Information on vegetation structure was obtained as follows. Ten points were selected at random within the overall area; usually these were along paths, but offset to one side to exclude the path and its edges. Vegetation was recorded as the estimated percentage cover (i.e. the amount of ground covered, as seen from above) in four height zones – 0-1, 1-3, 3-8 and more than 8 metres in height. Vegetation was classified as native or non-native (crops and other introduced plants), and woody (trees and shrubs) or non-woody, (such as beans or grasses). The estimates were made by looking at the area within ten metres of the point where the observer stood, and dividing it into four nominal quadrants; the maximum cover in any one layer is therefore 25%, in any one quadrant. This method is of course approximate, but as seen in Figure B1 there are obvious differences between the six sites.

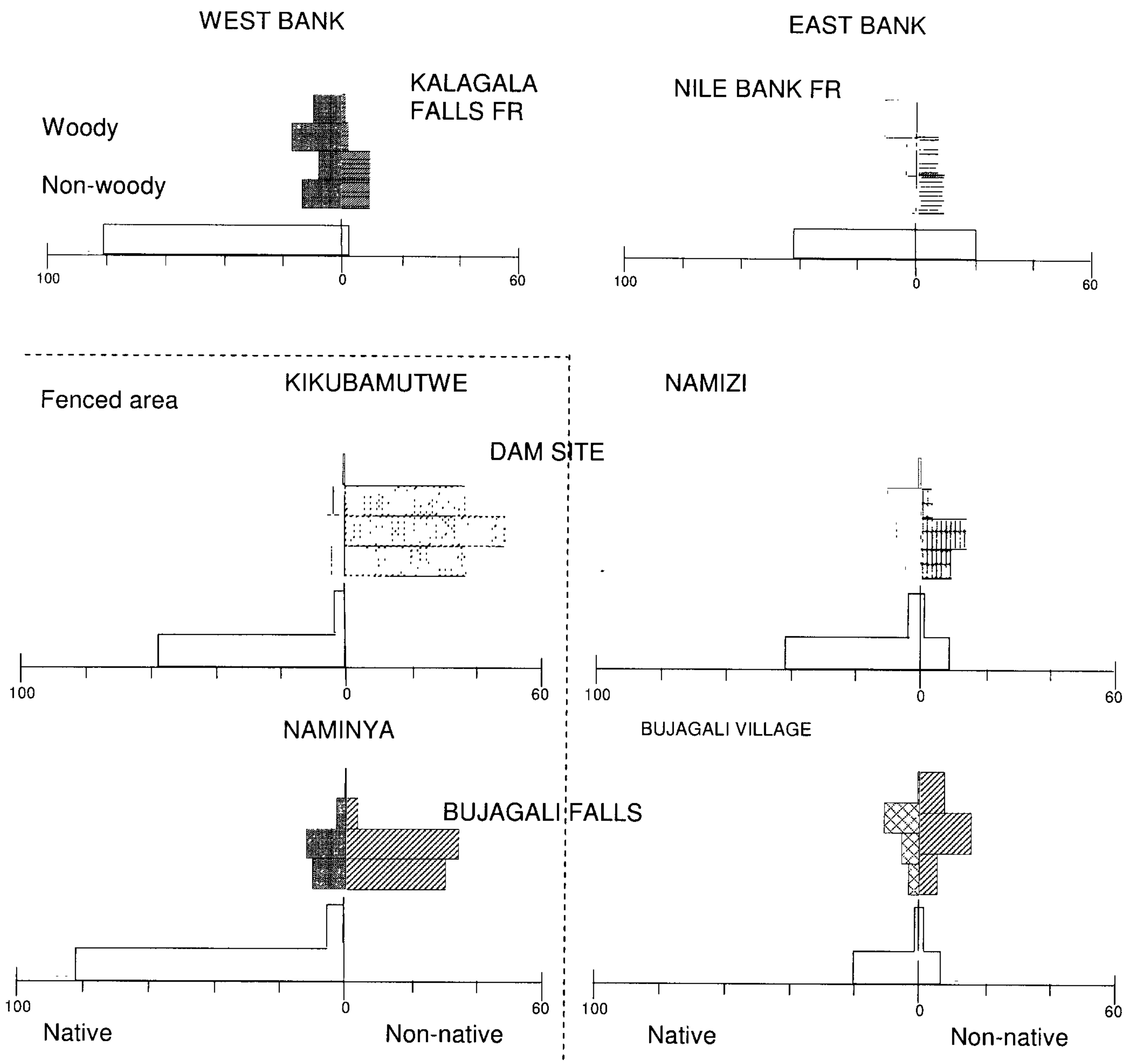


Figure B1. Estimated % vegetation cover, by vegetation type, at six survey sites. For each site, native vegetation is shown on the left, and woody vegetation above. See text for details.

The most widespread land use in the area as a whole is *smallholder farming* (Bolwig *et al* 2004), and the east bank sites at Namizi and and Bujagali Village are fairly typical of this type. There are mature trees, some in clumps but mostly scattered, with an average canopy cover above 3 metres of about 15%, of which more than half is formed by native species. Trees are important as feeding, nesting and roosting sites for birds, and are also important for some bats and other mammals.

Planting of crops was actively going on – even on a Sunday! – So there were considerable areas of bare ground, which would become covered as the crops grow. A third of the ground was covered by native species – mostly 'weeds' in the fallow areas and grass elsewhere. These are important areas for smaller mammals, and a variety of birds.

On the west bank, two sites within the *fenced area* show extensive and often dense growths of *Lantana* and Paper Mulbery (see Figure A1 and plant section). Native trees and shrubs in these areas were less than half those on the east bank; it seems likely that, before they left, people cut down most of the useful trees for timber and other purposes. Outside the thickets, the cover of native grasses and other plants was generally dense.

In the two *Forest Reserves*, we surveyed those areas where native trees remain, and the nearby areas with crops. Kalagala Falls FR retains more trees than Nile Bank FR, most of which has been converted to maize. The tree cover at Kalagala was the highest of any site, and included a clump of mature pines which, however, are having their bark removed, perhaps for tinder.

1.3 Human Activities

Birds and other fauna are affected by human activity, usually negatively. We observed the extent of cultivation, the amount of fallow land, whether there were signs of recent-cutting or fire, and whether livestock were grazing in the area; finally we noted how many people were moving in the area, each of these being scored from zero to five. The results are summarised in Table A1.

Table A1. Human activities and disturbances at the six sites

	Fenced area		Smallholder farms		Forest Reserve	
	Kikubamutwe	Naminya	Namizi	Bujagali	Kalagala	Nile Bank
Cultivation	0	0	4	4	3	4
Fallow	5	5	2	1	1	1
Tree-cutting[a]	1	0	0	0	2	1
Fire	0	2[b]	0	0	0	0
Grazing[c]	0	0	2	1	2	1
People[d]	1[e]	0[e]	5	4	5	3

Notes: a Whole trees, branches and charcoal-making
b several hectares had been burnt recently
c mainly by cattle and goats
d an indication of the numbers of people moving through the area, actively cultivating etc.
e inside fenced area

2 FLORA COMPOSITION AND DESCRIPTION OF VEGETATION TYPES

2.1 Introduction

According to Langdale-Brown *et al.* (1964), the project area was originally characterized by species in the genera *Celtis* and *Chrysophyllum* as the climax (primary forest) tree species. The early successional stages are usually dominated by *Albizia* spp with *Teclea nobilis, Celtis africana* and *Antiaris toxicaria* while the mid-successional stage is predominantly *Bosqueia, Funtumia, Celtis*, with *Teclea nobilis* as the dominant understorey species.

The WS Atkins International 2001 report indicated that most of the project area including the Islands contained little native vegetation due to intensive agricultural activities. The Kalagala offset is still relatively intact because it is mainly a forest reserve with a few islands with limited human activities that can impact greatly on the vegetation. However, the Nile Bank Forest Reserve is largely planted with maize and there are some scattered tree species mainly *Maesopsis eminii* and *Antiaris toxicaria* but the river banks are still relatively intact with *Celtis* and *Holoptelea grandis* dominating.

This report presents a floristic assessment of the various sites within the project area including the Kalagala offset. It also gives a comparative overview with the previous vegetation survey as reported in the WS Atkins report 2001.

2.2 Methods

The field surveys were conducted between 15th and 26th of March 2006. Randomly located quadrats of 10 X 10 m were placed in representative habitat types at ten study sites (the six 'riverbank' sites discussed in Section 1.1, plus four 'island' sites: Itanda/Kalagala island, Namizi Island, Bujagali Islands and Dumbbell Island). The habitat types included gardens for the sites with intense agricultural activities, bushes, fallow land and forested areas especially along the riverbanks and islands. These were used to record trees over 10 cm diameter at breast height (dbh). Nested plots of 2 X 2 m were also used to assess the herbaceous vegetation (i.e. forbs and grasses). This was expected to give a good measure of the relative abundance of each species in a given study site. Inventory sampling was also done so as to produce a near complete species list for every site. Voucher specimens were collected for those species that could not be identified in the field and were brought to Makerere University Herbarium (MHU) for identification. Botanical nomenclature follows Polhill et al. (1954).

2.21 Data analysis

A compilation of the species at site level was done indicating the individual abundances at different sites using the semi-quantitative DAFOR scale (Dominant, Abundant, Frequent, Occasional, Rare). The number of times a species appeared in the quadrats gave a good indication of its abundance in a particular study area. A total of 137 quadrats of 10 X 10 m were used in the entire assessment.

Cluster analysis was used to group sites according to their respective species assemblage compositions to determine the degree of similarity among them. This was based on the presence/absence data. Cluster analysis is a technique that sorts objects (such as samplings units) into groups or clusters based upon their overall resemblance to one another (Ludwig & Reynolds, 1988). There are several cluster analysis algorithms, including single-linkage, average linkage and complete linkage, all having different ways in which clusters are formed (Johnson & Wichern, 1992); and although most cluster analyses give similar results, several algorithms should be explored and the results compared. Clusters can then be determined from one of the cluster analysis methods based on the underlying 'ecological knowledge of the data' (Ludwig & Reynolds, 1988).

Overall, 298 species were recorded in binary (presence or absence) format for the 10 sites investigated. To determine similarity of sites, the 298 X 10 array was used to calculate Sorensen's coefficient (S) (Ludwig & Reynolds, 1988) for each pair (A and B), where S = a/(a+b+c), and ***a*** is the number of species sites A and B have in common, ***b*** is the number of species present in site A but absent in site B, and ***c*** as the number of species present in site B but absent from site A. The S values range from near 0 (for a site pair dissimilarity) to near 1 (site pair similarity).

To place sites into meaningful groups, the S values for all combinations of site pairs were summarized into a 10 x 10 array or similarity matrix. An agglomerative clustering technique (weighted centroid) provided in the Multivariate Statistical Package (MVSP) of Kovach (1999) was used to produce a dendrogram containing all 10 sites. A minimum S of 0.1 was used for defining clusters. Other measures of similarity and also measures of distance between sites were attempted along with several different methods of clustering (single-linkage and complete-linkage techniques). All techniques yielded similar results, with the S and weighted centroid clustering being most meaningful ecologically.

2.3 Results and Discussion

2.31 Floristics

There were 298 species, belonging to 215 genera and 75 plant families. The most dominant plant family was Fabaceae with 40 species followed by Euphorbiaceae, Poaceae, Moraceae and Asteraceae with 27, 24, 21 and 15 species respectively (see Appendix P1). The most abundant genus was Ficus with 16 species followed by Phyllanthus with five species only. The trees species constituted 30.5% (91 species) of the total, followed by forbs with 30.2% (90 species) and shrubs, 18.5% (55 species.). The commonest tree species recorded included *Markhamia lutea, Albizia grandibracteata, Broussonetia papyrifera, Maesopsis eminii* and *Milicia excelsa.* These occurred in at least 8 of the sites surveyed (Appendix P1). There were 20 exotic (non-native) species recorded of which *Broussonetia papyrifera* (Paper mulberry) and *Lantana camara* were the commonest.

The presence of *Maesopsis eminii* and *Albizia grandibracteata* was alluded to by Langdale-Brown *et al.* (1964) as being characteristic of the project area. However, the presence of the invasive Paper mulberry and *Lantana camara* in high abundances reflects the absence of tree cover, because these species are light demanders and can only proliferate under conditions of canopy openness especially in abandoned fields or farmland and in this case the fenced off areas at Kikubamutwe and Naminya sites. However, it was also observed, especially at Kikubamutwe and Namizi, that seedlings and saplings of *Albizia* were growing. This regeneration was even more pronounced at Kikubamutwe where saplings of *Albizia* were struggling through the rather dense Paper mulberry and *Lantana camara*. Langdale-Brown *et al.* (1964) argued that *Albizia* species represent early successional stages, which are eventually followed by *Celtis* and *Chrysophyllum* as the late successional species. Therefore, if succession is allowed to occur, *Lantana camara* and Paper mulberry could eventually be eliminated as the indigenous tree species grow and provide tree cover particularly in the fenced areas.

2.32 Species richness at the various sites

The Kalagala area registered the highest observed species richness of 104 species followed by Kikubamutwe and the Itanda/Kalagala Island with 101 and 91 species respectively (Figure P1). The species richness at Kalagala area, which is the most species-rich, is about a third of the total plant species recorded. This further shows the differences in floristic compositions at different sites and varying habitat type conditions caused mainly by human activities.

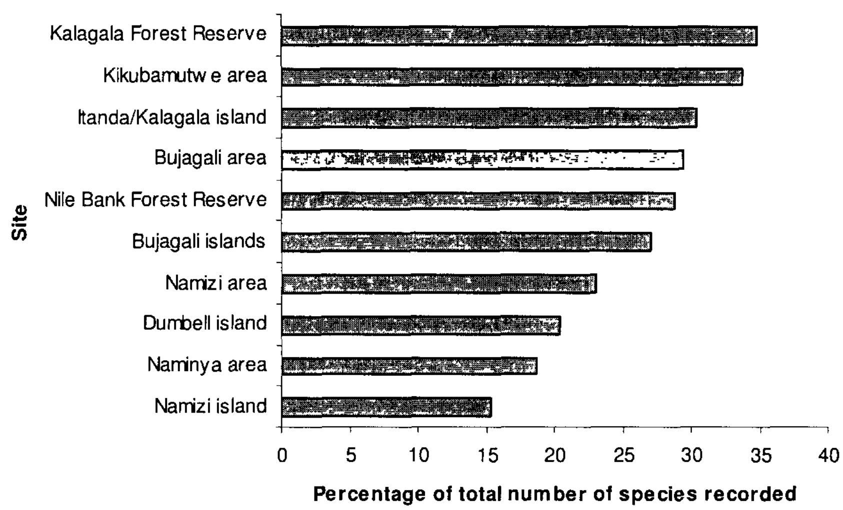


Figure P1: Observed species richness at various sites

The Naminya area and Namizi Island registered the least numbers of species with 56 and 46 respectively. This is due to the intense agricultural activities. Most of the natural vegetation has been cleared for agriculture and only a few scattered trees remain standing. The main crops grown include *Ipomoea batatus* (sweet potato), *Manhot esculentus* (cassava), *Musa sapientum* (banana), maize and beans. Weeds of agriculture such as *Bidens pilosa, Euphorbia heteropylla,* and *Commelina benghalensis* dominate the herbaceous vegetation

The richness registered at the Kalagala site can be attributed to the fact that the area is a forest reserve with a certain level of protection from encroachment. The riverbanks also represent a rich flora characteristic of typical semi deciduous forest dominated by *Celtis, Ficus* and *Holoptelea* trees with typical shrubs and herbaceous vegetation.

2.33 Site vegetation descriptions

- *Bujagali area*

This is a predominantly agricultural area with *Coffea robusta* (coffee), *Musa sapientum* (banana) and *Zea mays* (maize) as the main crops. There are scattered trees of mainly *Artocarpus heterophyllus* (Jack fruit tree), *Broussonetia payrifera* (Paper mulberry), *Lantana camara, Markhamia lutea* and occasionally *Milicia excelsa.* The riverbanks are dominated by *Lantana camara* and *Broussonetia papyrifera.* The herbaceous vegetation is predominantly *Commelina africana, Bidens pilosa,* and *Ageratum conyzoides.*

- *Kalagala Forest Reserve*

The Kalagala site is a forest reserve with some large, tall trees and thick natural vegetation along the riverbank. The dominant trees and shrubs include *Albizia coriaria, Ficus ovata, Maesopsis eminii, Antiaris toxicaria, Vernonia amygdalina, Ficus vallis-chaudae, Holoptelea grandis,* and lianas such as *Urera trinervis* and *Loeseneriella africana.* The herbaceous vegetation is typical of forest species including *Desmodium velutinum, Hibiscus* sp. and *Pycreus polystachyos.*

- *Nile Bank Forest Reserve*

Most of the Nile Bank Forest reserve is planted with maize but the local people have been asked to harvest their crops and leave at the end of the next growing season to pave way for replanting with Pinus. However, there are scattered trees of mainly *Milicia excelsa, Maesopsis eminii, Antiaris toxicaria* and *Ficus ovata.* The river banks are dominated by *Celtis wightii, Ficus ovata, Holoptelea grandis* and the exotic Paper mulberry and *Lantana camara.*

- *Namizi area*

This is an area that is largely farmland. It is characterized by gardens of Coffee, Banana, maize and sweet potato with scattered homesteads. There are scattered trees of *Markhamia lutea, Ficus exasperata,* and *Ficus mucuso.* The dominant shrubs include *Vernonia amygdalina* and *Flueggea virosa.* There are weeds of agriculture dominating in farmland and these include *Digitaria abyssinica, Achyranthes aspera, Bidens pilosa, Sorghum arundinaceum* and *Sida rhombifolia.* The riverbanks are dominated by Broussonetia papyrufera and Lantana camara. Some *Albizia* spp and *Milicia excelsa* were regenerating. However, it was observed during the survey that some riverine vegetation had been cleared away for farming.

- *Naminya site*

A large section of this site was fenced off and has come to be largely dominated by the invasive exotics, *Broussonetia papyrifera* and *Lantana camara*. Other trees recorded in this area included *Markhamia lutea, Spathodea campanulata, Albizia grandibracteata, Albizia coriaria* and *Artocarpus heterophyllus*. The dominant shrubs included *Flueggea virosa* and *Vernonia amygdalina*. The herbaceous vegetation was dominated by *Bidens pilosa, Digitaria abyssinica, Conyza floribunda, Dyschoriste radicans* and *Imperata cylindrica*. The cultivated area mainly consisted of scattered trees of Ficus, *Maesopsis eminii*, *Cassia spectabilis*, and *Coffea robusta*. Some seedlings and saplings of mainly Albizia and *Maesopsis eminii* were observed particularly in the fenced area. The presence of these species may point to an early successional process that is reported by Langdale-Brown *et al.* (1964).

- *Kikubamutwe area*

A large section of this area is fenced and is predominantly Paper mulberry and *Lantana camara*. *Albizia* spp, *Artocarpus heterophyllus* and a typical pioneer tree species, *Trema orientalis* is fairly common. The herbaceous vegetation was dominated by *Bidens pilosa, Digitaria abyssinica, Conyza floribunda,* and *Dyschoriste radicans*. Seedlings and saplings of Ficus, Albizia and *Maesopsis eminii* were also observed in this area.

- *Itanda/Kalagala Island*

A large section of this island is planted with vegetables i.e. *Lycopersicum* sp. (tomatoes) and *Solanum* spp. Some scattered trees of *Broussonetia papyrifera, Coffea robusta* and *Musa paradisiaca* were also observed. The dominant indigenous trees on this island include *Markhamia lutea, Maesopsis eminii, Milicia excelsa, Spathodea campanulata, Antiaris toxicaria, Alchornea cordifolia, Chaetacme aristata, Cola gigantea, Albizia glaberrima, Holoptelea grandis, Sterculia dawei, Albizia gummifera* and *Pseudospondias microcarpa*. The more pristine areas are mainly on the island periphery which is less accessible or is dominated by rock, and these form habitats akin to forest.

- *Namizi Island*

This island had the least number of observed species. A large section of it is cultivated and the dominant species include *Broussonetia papyrifera*, Albizia, Ficus, *Morinda lucida* and *Antiaris toxicaria*. The herbaceous vegetation was dominated by *Bidens pilosa, Digitaria abyssinica, Conyza floribunda, Dyschoriste radicans,* and *Euphorbia hirta*.

- *Bujagali Islands*

These are relatively more species rich with a lot of flora characteristic of forest habitat. The islands have been cultivated for production of vegetables but the inaccessible areas, rocky shoreline and steep sections have been avoided and carry a lot of species. The characteristic species include *Capparis erythrocarpos, Maytenus heterophylla, Tapura fischeri, Alchornea cordifolia, Argomuellera macrophylla, Drypetes gerrardii, Albizia coriaria, Albizia grandibracteata, Artocarpus heterophyllus, Broussonetia papyrifera* and *Lantana camara*.

- *Dumbbell Island*

The exposed island periphery is dominated by *Broussonetia papyrifera* and *Lantana camara* although the immediate inner areas have natural vegetation. They are rich in species that are relics of typical forest. The characteristic species include *Tapura fischeri, Alchornea cordifolia, Argomuellera macrophylla, Drypetes gerrardii, Albizia coriaria, Albizia grandibracteata, Artocarpus heterophyllus, Manilkara obovata, Cola gigantea, Sterculia dawei, Chaetacme aristata, Urera trinervis* and *Lantana camara*. The edges of the island are dominated by the invasive species.

2.34 Site similarity

Species presence or absence was scored in the 10 sites and provided the basis for cluster analysis which, provided evidence of likeness of species assemblages among the 10 sites of the project area (Figure P2).

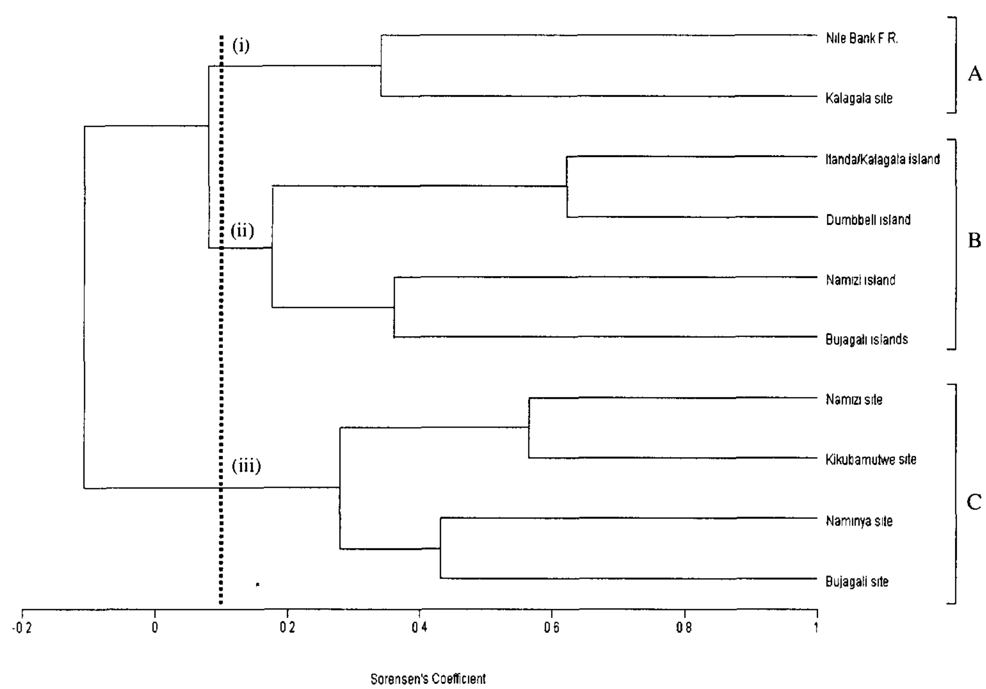


Figure P2. Cluster analysis of 10 sites of the project area based upon the presence or absence of 298 plant species. Site groupings (A, B & C) were defined using the Sorensen's coefficient of 0.1 (dashed line).

Dumbbell Island and Itanda/Kalagala Island sites had the highest Sorensen's similarity index (S) of 0.623 followed by Kikubamutwe and Namizi sites clustering with 0.565 (Table P1). Other sites clustered at lower values, and using a minimum S of 0.1 for defining clusters, the analysis produced three distinct groups of sites A, B, and C as shown in Figure P2.

Table P1. Similarity matrix (similarities expressed by the Sorensen's similarity index) of sample sites of the project area investigates. The highest values are shown in bold.

Group 1	Group 2	Similarity index (S)
Dumbbell island	Itanda/Kalagala island	**0.623**
Kikubamutwe site	Namizi site	**0.565**
Bujagali site	Naminya site	0.431
Bujagali islands	Namizi island	0.359
Kalagala site	Nile Bank FR	0.34

The cluster analysis in Figure P2 shows that Nile Bank FR and Kalagala FR are similar in terms of presence or absence of species. In cluster B, Dumbbell Island and Itanda/Kalagala Island have a higher similarity compared to the Namizi Island and Bujagali Islands pair. It is also evident in cluster C that the Namizi and Kikubamutwe sites had a higher similarity than the Naminya and Bujagali sites.

Thus the cluster analysis produced three distinct groups - Cluster A consisted of those sites which still had a lot of natural vegetation on them for example the riverbanks of Nile Bank FR and Kalagala FR which had forest patches with relatively intact natural vegetation. They also had a relatively high species richness compared to other sites in the project area. Cluster B consisted of the islands in the project area, some of which will probably be completely submerged during the dam construction phase. Although there was a lot of cultivation on these islands they supported a lot of species characteristic of forests, especially in the uncultivated areas and particularly the peripheries. The invasive exotics, *Broussonetia papyrifera* and *Lantana camara* were also quite abundant on these islands. Cluster C represented those sites that have been exposed to intense agriculture over the years. The most widespread species included mainly crops such as banana, maize and coffee. Other species that were characteristic of these areas were *Artocarpus heterophyllus* (Jack fruit tree), which is for provision of edible fruit, *Markhamia lutea* which is used in construction of houses, handles for hoes etc. The invasive exotics, *Broussonetia papyrifera* and *Lantana camara* were common in these areas especially in the seedlings growth stage. These sites had relatively low species richness since they are intensely cultivated. The weeds of agriculture such as *Bidens pilosa, Euphorbia heterophylla, Euphorbia hirta, Digitaria abyssinica* are abundant in the herbaceous vegetation.

2.4 Species of conservation concern

Milicia excelsa (Mvule) is categorized as Low Risk/ Near threatened by the IUCN (2000). Other restricted range species include *Ficus cordata and Ficus ottonifolia.* These have been recorded in only one floral region out of the four that occur in Uganda.

2.5 Management options for the Invasive exotic species

Within the project area, *Lantana camara* and *Broussonetia papyrifera* are notorious exotic invasive species. They can be described as plants that have a high rate of increase in uncrowded or otherwise favourable environments (i.e. the early stages of succession), with a manifestation of rapid growth and the production of large quantities of easily dispersed seeds, rapid germination, etc. (Whitmore, 1991; 1998). Their invasiveness may be attributed to the complex interaction between a species' reproductive biology, the local habitat, management, landscape characteristics and the established local flora.

However, it has been observed in Budongo forest reserve (Western Uganda) that the paper mulberry has been restricted to forest edges and is unable to proliferate under shade conditions. It is anticipated that as the late successional trees such Celtis, and Albizia (Langdale-Brown *et al.*, 1964) colonise the area, *Broussonetia papyrifera* and *Lantana camara* will be considerably reduced. However, to enhance regeneration with indigenous species, mechanical removal at regular intervals can help reduce their effect on the landscape and enhance natural regeneration of native species.

2.6 A comparative overview with the previous vegetation survey

About 39% (47) of the species recorded in the previous survey (see WS Atkins 2001 Report) were not recorded in the present survey. This is probably due to the fact that our survey was short, but many of the areas reported in the previous survey are agricultural and therefore became less important after people were re-settled from the west bank area by AES Nile Power, or compensation was paid for crops on the east bank and the Bujagali and Dumbbell Islands.. It is also probable that the high human population in these areas, coupled with the subsistence farming, leads to continued cutting of trees for fuel-wood, construction and clearing of land for agriculture. On the other hand, we found 178 additional species. This may be partly due to the rains that no doubt break the dormancy of seed for plants that may not necessarily be apparent in a dry season, especially the ephemerals. Together with a higher sampling effort, and more sites surveyed, this yielded a bigger species list.

In the fenced areas, particularly at Kikubamutwe, the invasive Paper mulberry and *Lantana camara* have continued to proliferate. However, indigenous species especially *Albizia* spp., *Maesopsis eminii* and *Sapium ellipticum* are regenerating, with many in the seedlings and sapling stages, even within the thick *Lantana camara* and *Broussonetia papyrifera* bushes. Therefore, with time, colonization will result into late successional species displacing the light demanding invasives.

2.8 Conclusions

There is a considerably higher species richness in the respective areas surveyed compared to the 1998 botanical survey Kalagala offset increased numbers but nevethertheless all sites including those done in 1998 recorded more species). The species assemblages vary considerably among the agriculturally affected sites, the islands and the forest reserves as can be seen in Figure P2 due to differences in intensity of land use activities particularly for agriculture and forestry and, to some extent, accessibility of the islands. *Milicia excelsa* (Mvule) is categorised as Low Risk/Near Threatened by the IUCN (2000), however, it is widespread and with stable populations in all sites (see Appendix P1). Although natural regeneration with indigenous trees will be achieved eventually, especially in the fenced areas, controlling of the populations of Lantana and Paper mulberry would further enhance the natural regeneration process. Exclusion of human activities, particularly farming on river banks, and enrichment planting with *Albizia*, *Milicia excelsa* and *Ficus* spp. will protect the river banks from erosion. Replanting with indigenous mid and late successional species such as *Ficus ovata, Warburgia ugandensis, Albizia grandebractiata, Celtis africana* especially in the Kalagala forest reserve will enhance the aesthetic value of these forests and contribute to tourism.

The sites in cluster A, represent areas under the management of the NFA and therefore will theoretically be managed following the management options of NFA. Cluster B sites, which are essentially the island sites wil be submerged and most of the vegetation will be lost. Some halophytic species such as those in the genus Ficus may survive in parts of the islands that may remain not totally submerged and could therefore still serve as important resources for some birds and mammals that would roost on them or feed on their fruits. Cluster C represents sites that are largely under subsisitence agriculture with few economically important tree species, besides their food crops. It is our understanding that the local people cultivating along the riverbanks in the project area were already compensated and therefore should have stopped cultivating here. If cultivation is to be completely stopped we foresee the area regenerating with indigenous trees although in some areas enrichment planting may be necessary to enhance the regeneration.

3 LAND BIRDS

3.1 Introduction

A summary of the data, from both 1998 and 2006, is given in Appendix B1, which is arranged to compare the two years and to facilitate comparison between the various 2006 sites. In interpreting the differences between 1998 and 2006, two things are important. Firstly, the 1998 visits were in August, a comparatively dry time, whereas there had been widespread rains before the 2006 visits. Secondly, migrant birds, especially those from the Palearctic region (which is mainly Europe and northern Asia), would only just be beginning to arrive in August, the time of the 1998 surveys, but most will not have left by March, the month of the 2006 counts.

3.2 Methods

In both years, bird species were counted for one hour, several times at each site; a method known as Timed Species Counts or TSCs. TSCs are a method of rapid surveys which have been widely used in East Africa (Freeman *et al* 2004). During each one-hour count, bird species are listed in the order in which they are seen, or heard. The time is also noted at 10-minute intervals so that scores can be allocated, thus: 6 for species recorded in the first ten minutes, 5 for those recorded in minutes 11-20, and so on to 1 for those only recorded in the final ten minutes.

A commoner species will more often be recorded in the first ten minutes than a rare one, which will also be recorded in fewer counts. For this report we have used simple mean values of these TSC scores.

Various studies of birds in Uganda have classified birds according to their migratory and conservation status (if threatened, they are said to be Red-Listed; IUCN, 2000) and habitat requirement (see, for example, Bolwig *et al* 2004). The categories we have used are listed in Table B1.

Table B1. Bird descriptors. No globally-threatened species were observed. The species' preferred habitats and migratory status are also indicated in Table B1 and Appendix B1.

Threat categories	R-NT	regionally near threatened
	R-RR	species of regional responsibility
Habitat/habits	FF	forest specialist
	F	forest generalist
	F	forest visitors
	W	waterbird
	w	Bird often found near water
	G	species characteristic of grassland
	Ae	species which are predominantly aerial
Migrants	P	Palearctic migrants
	A	Afrotropical migrants, migrating with Africa

Birds at the sites adjacent to Dumbbell Island (Dam East and West) were each counted four times; those at the other sites (seeTable B2) were each counted three times (in 1998, only 3 sites were surveyed, with a total of five counts at each site). Fieldwork was undertaken between 15 and 26th March 2006. The area had received sufficient rain for plants to be actively growing, and many species of birds were beginning to nest, thereby increasing their conspicuousness.

3.3 Key results

These are given in Table B2, for each site in each year. In addition to the categories of birds listed in Table B4, we include Raptors (birds of prey), since these are 'top predators' and can be useful indicators of ecosystem health (Sergia *et al* 2005). The total numbers of species recorded at each site are given too.

The total numbers of species are often taken as a measure of diversity. Numbers were generally higher in 2006, partly because of the presence of Palearctic migrants, but probably also because the wet season increases the food supply for many species.

At the bottom of Table B2, we show the numbers of species recorded at each site in each year. However, some sites had more counts than others, so we also show the numbers after just thee counts ($\sum 3$), the minimum number at any site. Of the various sites surveyed in 2006, the Forest Reserves had the most species. Of sites in the dam area, east and west banks had similar total numbers of species, as well as species of various specialities. No *globally-threatened* species were recorded, but several species of regional interest were present. However, their populations within the Bujagali are a negligible proportion of the population of the species as a whole, so that construction of the dam will not affect them significantly.

There area supports many species that need trees, and which live near water, and the development of the dam could benefit these, especially if the growing of trees is encouraged. Numbers of aerial feeders, grassland specialists and migrants wee comparatively low.

3.4 Changes from 1998 to 2006

This comparison concerns the three sites counted in both years, and which are boxed in Table B2 and Appendix B1.

More species of birds were recorded in 2006, when there had been some rain. As Table B2 shows, birds associated with water, as well as migrants, were considerably more common in 2006.

The more detailed results given in Appendix B1 show that, for the three sites counted in both years, 108 species were recorded (out of 140 for all sites in both years). Of these, 61 were found in both years, whilst 16 were only recorded in 1998 and 31 only in 2006. The increase in species numbers between years, from 77 to 92, can as already indicated be largely attributed to there being virtually no migrants in 1998, whilst the rather higher scores for many species in 2006 are partly a result of wetter weather increasing the birds' activity levels. The fencing of part of the west bank, leading to the formation of dense thickets (section 1) has also allowed some species, new to the area, to be added to the list. Examples are the Little Greenbul and Snowy-headed Robin Chat. Thus, overall, the differences between the two years are easily explained in terms of seasons and the new enclosure.

Table B2. Summary results of bird counts at six sites: data are number of species. The sites in the shaded area for 2006 correspond to those surveyed in 1998. As seen in Appendix B1, some species fall into more than one category (e.g. they could be Palaearctic migrants that need trees – PF) whilst other belongs to none of the categories in this table. All contribute to the species totals at the foot of the table.

		1998				**2006**					
		Kikubamutwe	**Namizi**	**Bujagali**		**Naminya**	**Kikubamutwe**	**Namizi**	**Bujagali**	**Kalagala**	**Itanda**
Number of counts		5	5	5		3	4	4	3	3	3
HABITAT TYPE[a]		F	F	F		R	R	F	F	FR	FR
SPECIES OF CONSERVATION CONCERN	R-NT[d]	1	1	0		0	0	0	0	0	1
	R-RR	2	3	3		3	4	3	2	4	3
RAPTORS		3	4	3		7	9	6	5	6	7
HABITAT SPECIALISTS	FF	0	0	0		0	0	0	0	1[e]	0
	F	7	7	7		4	14	13	11	11	7
	f	18	24	26		19	23	28	19	25	18
	WW	4	4	3		2	3	3	2	3	5
	W	8	7	9		15	14	12	6	10	15
	G	1	1	1		4	2	2	2	6	5
	Ae	3	3	3		3	4	7	3	4	6
MIGRANTS	P	1	0	2		5	9	8	4	6	8
	A	1	3	4		2	3	5	1	3	3
TOTAL SPECIES RECORDED	All	50	48	49		54	56	70	46	65	55
	$\sum 3$[b]	38	37	41		54	40	56	46	65	55

Notes a F = small-scale farms, R = fenced (regenerating) areas, FR = Forest Reserves
b Species total after 3 counts
c Bujagali Falls
d Categories are listed in Table B1.

Twelve species, including African Hobby and Great Blue Turacco, were recorded only from one or both of the Forest Reserves, despite their highly degraded state, suggesting, as with both plants and mammals, that these areas have some potential interest.

4 WATERBIRDS

During our visits, between 15th and 26th March, opportunistic observations were made on waterbirds at various points along the river from Bujagali Falls to the Kalagala area. Of particular interest were birds that were found breeding.

4.1 Breeding records

Greater Cormorants *Phalacrocorax carbo* were breeding on two islands at Kyabirwa, with a total of about 30 nests, some with young. A further 30 or so nests were in use on small islands at the upstream end of the Itanda Falls. Both Sacred Ibis *Threskiornis aethiopicus* and Cattle Egrets *Bubulcus ibis* were resting in the same trees as the cormorants, but although they would be expected to be nesting in March (Brown & Britton 1980) they seemed not to be doing so. Several nests of the African Fish Eagle *Haliaeetus vocifer* were seen; there are at least five pairs in the area. The African Open-billed Stork *Anastromus lamelligerus* has been known to nest along this stretch of the Nile (pers obs) but they were not seen nesting this year.

A pair of the Regionally Vulnerable Rock Pratincoles *Glareola nuchalis* were seen near Dumbbell Island; they are almost certain to nest locally.

4.2 Other records

Greater Cormorants, Sacred Ibis and Cattle Egrets were also common all the way along the river.

The African Darter *Anhinga rufa* was quite common. This species is Regionally Vulnerable, largely because it gets caught (unintentionally) in fishermen's' nets, and drowns. It may survive here because of the fast current in many places, where nets cannot be set.

In addition to Greaters, Long-tailed Cormorants *Phalacrocorax africanus* were numerous all along the river. Several each of Little Egret *Egretta garzetta* and Yellow-billed Stork *Mycteria ibis* were also seen; but we saw only a single Common Squacco Heron *Ardeola ralloides*. Several Common Sandpipers *Actitis hypoleucos* were noticed, presumably shortly before their departure (probably to Siberia).

4.3 Not seen

Curiously, we saw no Pied Kingfishers *Ceryle rudis* (other than two nearer to Jinja); they were common in 1998 and are indeed common throughout Uganda; however, they are known to make seasonal movements (Carswell *et al*, 2005).

4.4 Conclusion

The presence of so many fish-eating birds shows that there are currently plenty of small fish along this stretch of the Nile (even the Fish Eagle does not usually take fish above about one kilogram, and most are less than half of that (Brown et al, 1982). If the dam at Bujagali goes ahead as planned, thus creating a naturalistic lake, and trees on the islands are allowed to regenerate, we see no serious harm to waterbirds, especially if fishing is properly managed, with some no-go areas for fishermen to allow successful breeding. Downstream, reforestation of the Kalagala-Itanda offset will similarly provide much-needed nesting sites.

5 MAMMALS

5.1 Introduction

The WS Atkins International 2001 report indicated that most of the project area including the Islands contained little native vegetation due to intensive agricultural activities. The Jinja and Kagoma 1: 50,000 topographic sheets show the riverine areas from Njeru and Bujagali to as far north as Kalagala to have been forested until at least 1968. Reports from interviews with the local people have also suggested that forest clearing for cultivation and settlement in these areas happened between about 1975 to the 1980s for example in the Namizi area.

In the WS Atkins 2001 report although mammals were not specifically surveyed for, mention is made of several mammal species (the Red tailed Monkeys, Mole rats, Spot necked Otters, Straw coloured Fruit Bats, Hippopotami and Bush pigs) either as occurring in the area at the time or in previous times.

5.2 Methods

As a group, mammals were not evaluated for the Project area in the previous studies although some incidental information was gathered on six species of mammals. The present study has attempted to document in some more detail the diversity of mammals present and past in a number of areas in and around the Project area. Owing to the nature of the environment in the project area and its surroundings, it is very unlikely that larger mammals will still survive here except for a few hardy and very adaptable ones that can survive in human impacted environments. Smaller mammals on the other hand particularly those species that are not tied to very narrow ecological requirements could still survive in fairly high densities and diversity.

Trapping to assess the presence of small mammals and bats was done in the fenced area of the proposed dam site (Naminya/Kikubamutwe) and at Bujagali. These two areas are fairly representative of the surviving vegetation stands around the project area. It is expected therefore that any species of small mammals recorded in these two areas, could within limits, be expected to occur in the other nearby areas as well. A mixture of Sherman and snap traps in a line transect were used to trap and document presence and diversity of terrestrial small mammals. The line transect was preferred because it permits traversing a variety of habitat types given a short time of surveying. Mist nets were used for capturing and documenting bats, supplemented by observation of species in roosts, foraging or otherwise and signs such as skeletal material found in various locations, and scats also gave evidence of presence of one species or the other in the places investigated. In all areas visited interviews were also conducted with the local people to document the presence of any larger mammals both present now and in previous times.

The field surveys were conducted between 15 – 26th of March 2006. The nomenclature followed in this report is that of Wilson and Reeder (1993), also used in Davies & Vanden Berghe (1994).

5.3 Mammal species recorded for the project area and its surroundings

Overall eight groups of mammals (Table M1) have been recorded from the area. As would be expected the small mammals (mostly the rodents) comprise the largest proportion of the mammals recorded in the area. The results presented here are probably not a fair representation of the other two groups of small mammals (Insectivora and Chiroptera). Near complete lists of these can only be compiled following long repeated field seasons of surveying in the areas. Many more species of these would be expected in an area such surveyed for this work.

Table M1. Summary of mammal diversity in the study area

Taxonomic group	Total number of species recorded from these field surveys and of historical records from interviews with local people	Total recorded as present in March 2006
Artiodactyla (Antelopes)	5	0
Carnivora (Carnivores)	6	3
Insectivora (Insectivorous mammals)	1	1
Megachiroptera (Fruit Bats)	3	3
Microchiroptera (Insect Bats)	3	3
Primates (Monkeys)	3	2
Proboscidea (Elephants)	1	0
Rodentia (Rats, Mice Squirrels & allies)	20	20

All larger species of mammals would find it rather difficult to survive in habitats with a heavy human presence and therefore have largely disappeared.

5.4 The immediate impact area

A total of 42 species of mammals have been recorded from both interviews on what mammals used to be in these areas and actual field surveys to document presence of those that were present at the time of these surveys in the area here described as the immediate impact area (comprising of the Dam site –Kikubamutwe and Malindi, Naminya, Bujagali and Namizi although this area also includes some of the islands, they are separately discussed in a different section) of the proposed project. Ten of these species (*in Appendix M1) have long been lost from the area largely due to conversion of the formerly forested areas. The larger mammals have all been lost from this area leaving only smaller mammals that are adapting to, and surviving in, the much-changed environment. There is a likelihood though that the species list of mammals in the area could be higher than recorded here if more effort were to be invested in surveying for them.

The trapping results in the dam Site and Bujagali (Table M2) although based on a small sampling effort (90 trap-nights in the Dam Site and 45 trap-nights at Bujagali); they nevertheless present an initial indication of relative abundance of the species of small mammals recorded. Additional trapping would probably turn up more species than were recorded since several other species that would be expected in this geographical range were not recorded from these efforts.

Table M2. Relative abundance of the small mammals trapped in two of the locations.

Species	Trap rate (%)	
	Dam site	Bujagali
Mastomys hildebrandtii	6.7	8.9
Lophuromys sikapusi	10.0	11.1
Lophuromys flavopunctatus	6.7	11.0
Aethomys kaiseri	5.0	0.0
Lemniscomys striatus	6.7	15.0
Otomys tropicalis	1.7	5.0
Dasymys incomtus	1.7	2.2
Mus minutoides	5.0	4.4
Overall trap success	43.3	51.1

In both locations *M. hildebrandtii, L. sikapusi, L. flavopunctatus,* and *L, striatus*, all species of largely moist savanna type habitats, were fairly common while the rest of the species were captured in much smaller numbers.

The importance of the presence and abundance of small mammals lies in the fact that they are consumers and are also food to other animals. They therefore play vital ecological roles and their extirpation from an area would impact on the other species that are dependant on them either for food or dispersal.

The Straw-coloured Fruit Bats (*Eidolon helvum*) were reported by WS Atkins 2001 to roost on one of the Bujagali Islands in thousands. These bats were not found on the islands at the time of the 2006 surveys, although skeletal material from them was found on the islands. It was reported however from interviews with the local people cultivating on the islands that they return to the islands at different times of the year.

Although from a distance the islands (such as the Bujagali islands visited) appear forested, cultivation that is supposed to have been stopped on them continues with extensive gardens of a variety of vegetables. Therefore most of the vegetation has been cleared to give way to the growing of these crops. The only remaining fair sized trees are on the periphery of the islands. The farmers have largely depleted the tree stand inland on the islands under cultivation, reducing them as a vital resource for bats. If cultivation continues at the same rate as observed at the time of doing these surveys it is unlikely that the bats will continue to use these islands much longer.

5.5 The Kalagala-Itanda Offset Area

The Kalagala – Itanda offset was proposed as an area to be protected in perpetuity, as compensation for the reduction in river/rapids habitats and tourism values that would arise from the construction of the Bujagali Dam (Government of Uganda 2001). By 2001 both the Kalagala Falls (KFFR) and Nile Bank Forest Reserves (NBFR) were already deforested by the local people for cultivation and already an urgent need for action to stop further damage to these reserves was recommended. KFFR was

considered to have greater immediate potential for tourism development than NBFR because it was in a less degraded state at that time.
At the time of conducting the present survey (March 2006), the Nile Bank and Kalagala Falls FRs only remain forest reserves by name as most of the natural vegetation that formerly characterized them is largely depleted, particularly in the case of Nile Bank Forest reserve. This latter is now mostly covered in gardens of maize and tomatoes but part is also getting replanted with pines. The Kalagala Falls forest reserve (KFFR) on the other hand, although quite depleted as a forest, nevertheless still has some large trees surviving. The Itanda/Kalagala Islands on the other hand have a fair amount of natural vegetation still surviving, despite being impacted by the local people, who are clearing them to grow crops of tomatoes, greens, yams, pineapples, maize and bananas among others. The human pressures on the islands notwithstanding, several species of mammals were recorded present on these islands (Appendix M1).

If the Nile Bank and Kalagala Forest Reserves were to be restored, it is unlikely that they would be naturally repopulated by the larger mammals that once ranged in these areas, since their populations have long been lost from the areas outside the main Mabira forest Block. A suitable mitigation scenario would be to reintroduce such species as used to occur in the areas from elsewhere.

As a refuge for mammals, the two forest reserves in this area (Kalagala Falls & Nile Bank) are not very important anymore in the state they are today. If rehabilitated and restored, for example by re-vegetation with native species, initially populations of species of small mammals that no doubt still survive in some of these areas will recover. Re-introduction of larger mammal species, if compatible with tourism development and local farming activities, could then be done to restore some of the larger mammals that used to exist in these forests.

5.6 Bujagali, Kalagala/Itanda and Dumbbell islands

At the present time the Bujagali Islands are under intense agriculture, being used for growing the variety of crops mentioned already elsewhere in this report. A lot of the vegetation on the islands has been cleared, leaving a small peripheral ring along the edge of each island. The other islands on the other hand, although being cultivated still have a fair stand of vegetation. Appendix M1 lists the mammal species recorded for these islands. Dumbbell and Itanda/Kalagala Islands still have populations of Red tailed Monkeys in addition to which the latter also has two species of Porcupine (The Crested and Brush tailed Porcupine). Besides these the rest of the mammalian diversity recorded comprised of small mammals.

5.7 Conclusions

From interviews with the local people in the different areas visited the west and east banks of the Nile were forested to varying degrees up to about the 1980s. Settlement in, and clearance of forest was reported to date from about the late 1950s although no additional supporting evidence has been found for this. Given that the forested areas along the Nile in the project area would have been similar to that of Mabira Forest, it could be safe to assume that the mammalian composition would have been the same throughout the whole range. Several species of larger mammals were reported to have

existed in the areas visited (marked * Appendix M1) in some cases as recently as the 1980s for the Bushbucks, Elephants to 1962, and Hippos into the 1970s.
Of the species recorded to still occur in the area only the African Spot Necked Otter *Lutra maculicollis* is listed by IUCN as vulnerable (Appendix M1). The main threats to Spot-necked Otters are considered to be siltation due to erosion near the source of rivers, cultivation of bank side habitats, indiscriminate bushfires, competition for fish and hunting. The use of new nylon fishing nets has also been reported as causing the death of otters, which become tangled in them and drown. The local fisherman may also kill otters as a threat to their fish stocks - probably wrongly, as otters only take small fish and are not very numerous anyway[1].

Although faced with such a diversity of threats, this species is however still widespread in many of Uganda's large fresh water bodies of which the Victoria Nile only happens to be a small part. It is not likely either that damming the Nile will result in significant negative impacts on its survival.

6 GENERAL CONCLUSIONS

The areas described in this report have, on the whole, a high human population, especially on the east bank, so the landscapes are predominantly determined by human activity, past and present. Less than 40 years ago, however, the banks of the Nile were extensively forested. After the vector of the disease known as river blindness (the *Simulium* fly) was eradicated from the area, people progressively cut down almost all of the riverbank forest, although a few forest trees remain within the farmland, and many more on some of the islands. There is no doubt therefore that prior to this site being identified for the Hydropower project development, it had been grossly altered through anthropogenic impacts, thus lowering its value for biodiversity protection and conservation. However, several species that can survive in human impacted habits (largely agro ecosystems) are still found in these areas.

It is already evident in the fenced off area that following removal of human activities there is great potential for regeneration. In the long term this could result in vegetation similar to the original condition.

Resettlement of people and human activities from some of the areas along the Nile in the Project area, such as on some of the islands, the river banks, the fenced-off dam area and the Kalagala Offset area, could achieve several benefits:

i. Restoring the forested habitats and attracting a richer fauna that may still be able to cross the agro ecosystems

ii. Restoration of vegetation along the riverbanks that would counter increased soil erosion due to agriculture.

iii. Creation of an alternative habitat that could benefit ecotourism and that would mitigate for the loss of some rapids upstream.

iv. Restore large trees that are needed for roosting by birds and bats and nesting by larger birds such as the African Fish Eagle.

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[1] http://www.amblonyx.com/otter/maculicollis/otter_conserve.htm & [illegible]

For these and other reasons we consider the "Kalagala Offset" plan as a very positive mitigation measure. However the Nile Bank Forest Reserve that is already being replanted with exotic trees (pines) might also benefit from encouraging native trees to regenerate although this is going to depend on the management policy that NFA have for this reserve.

The only significant natural habitat conversion we envisage in the project area will result from the damming of the Nile and the resultant backwater that will flood areas of the riverbanks and islands from Dumbbell to Bujagali.

Performance Standard 6 of the International Finance Corporation spells out issues pertaining to biodiversity conservation and sustainable resource management in project development areas. As noted above there will be some negative effects on the natural environment, habitats and constituent flora and fauna which can be mitigated by ecological restoration in areas noted above.

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APPENDICES

Appendix P1. Plant species found in areas likely to be affected by the Bujagali Hydropower scheme and the Kalagala area.

Key to abbreviations:
Buj = Bujagali area; Buj Islands = Bujagali Islands; Dumbl Island = Dumbbell Island; Kiku = Kikubamutwe area; Nmy = Naminya area; Nmz Island = Mamizi Island; Nmz = Namizi area; Ita/Kala Island = Itanda/Kalagala Island; Kala FR = Kalagala Forest Reserve; N. Bank FR = Nile Bank Forest Reserve.

T = Tree; G = Grass; L = Liana/Climber; Ra = Rambler; Cr = Creeper; F = Forb; S = Shrub

* - signifies exotic (non-native) species

√ - signifies presence of a species

[a] - Abundance categories include: **D** – Dominant, **A** - Abundant, **F** – Frequent, **O** – Occasional, **R** – Rare. A species is considered **Dominant** if it occurs in at least eight of the sites investigated, and **Rare** if it occurs in only one site of all those investigated.

					Immediate Impact zone							Itanda/Kalagala offset		
Family	**Species**	**Habit**	**Abundance**	**Previous survey [a]**	**Buj**	**Buj Islands**	**Dumbl Island**	**Kiku**	**Nmy**	**Nmz Island**	**Nmz**	**Ita/Kala Island**	**Kala FR**	**N. Bank FR**
Fabaceae	*Acacia kirkii*	T	R	√										√
Fabaceae	*Acacia polyacantha*	T	R											√
Euphorbiaceae	*Acalypha bipartita*	S	O										√	√
Euphorbiaceae	*Acalypha neptunica*	S	F			√	√			√		√		√
Euphorbiaceae	*Acalypha ornata*	F	R	√									√	
Acanthaceae	*Achyranthes aspera*	F	F	√	√			√			√		√	√
Passifloraceae	*Adenia bequaertii*	L	A			√	√	√		√		√	√	
Passifloraceae	*Adenia tricostata*	L	R			√								
Amaranthaceae	*Aerva lanata*	F	R					√						
Acanthaceae	*Ageratum conyzoides*	F	O		√			√			√			
Fabaceae	*Albizia coriaria*	T	F	√	√	√							√	√
Fabaceae	*Albizia glaberrima*	T	F							√		√	√	√
Fabaceae	*Albizia grandibracteata*	T	D	√	√	√		√	√	√	√		√	√
Fabaceae	*Albizia gummifera*	T	O		√			√						√
Fabaceae	*Albizia zygia*	T	F			√		√					√	√

					Immediate Impact zone							Itanda/Kalagala offset		
Family	Species	Habit	Abundance	Previous survey [a]	Buj	Buj Islands	Dumbl Island	Kiku	Nmy	Nmz Island	Nmz	Ita/Kala Island	Kala FR	N. Bank FR
Euphorbiaceae	*Alchornea cordifolia*	T	F	√		√	√			√		√	√	
Sapindaceae	*Allophylus macrobotrys*	T	R		√									
Sapindaceae	*Allophylus sp.*	T	O									√	√	
Aloeaceae	*Aloe sp.*	F	R										√	
Apocynaceae	*Alstonia boonei*	T	R											√
Amaranthaceae	*Amaranthus spinosus*	F	O		√						√			
Commelinaceae	*Aneilema spekei*	F	O				√					√		
Moraceae	*Antiaris toxicaria*	T	A	√	√		√		√			√	√	√
Euphorbiaceae	*Antidesma membranaceum*	T	R										√	
Euphorbiaceae	*Argomuellera macrophylla*	S	F			√	√					√	√	√
Aristolochiaceae	*Aristolochia elegans*	F	R			√								
Annonaceae	*Artabotrys monteiroae*	L	R			√								
Annonaceae	*Artabotrys velutinus*	L	O				√					√	√	
Moraceae	*Artocarpus heterophyllus*	T	A	√	√	√		√	√		√			√
Asteraceae	*Aspilia africana*	F	O							√	√	√		
Acanthaceae	*Asystasia gangetica*	F	O	√				√					√	
Acanthaceae	*Asystasia schimperi*	F	F		√			√	√		√		√	
Fabaceae	*Baikiaea insignis*	T	R											√
Basellaceae	*Basella alba*	F	F	√		√	√					√	√	
Fabaceae	*Bauhinia variegata**	T	R	√	√									
Asteraceae	*Bidens pilosa*	F	D	√	√	√		√	√	√	√	√	√	√
Sapindaceae	*Blighia unijugata*	T	O			√							√	√
Poaceae	*Brachiaria decumbens*	G	R										√	
Euphorbiaceae	*Bridelia micrantha*	T	O	√	√		√					√		
Moraceae	*Broussonetia papyrifera**	T	D	√	√	√		√	√	√	√	√		√
Burseraceae	*Canarium scweinfurthii*	T	R	√				√						
Fabaceae	*Canavalia virosa*	L	F				√	√		√		√	√	
Capparaceae	*Capparis erythrocarpos*	S	F			√	√						√	√
Solanaceae	*Capsicum frutescens**	F	O		√			√						
Sapindaceae	*Cardiospermum corindum*	L	R		√									
Sapindaceae	*Cardiospermum halicacabum*	L	R			√								
Caricaceae	*Carica papaya**	T	A		√	√	√			√	√			√
Fabaceae	*Cassia bicapsularis*	S	F					√	√		√		√	
Fabaceae	*Cassia mimosoides*	F	R					√						
Fabaceae	*Cassia occidentalis*	S	O								√		√	
Fabaceae	*Cassia siamea**	T	R											√
Fabaceae	*Cassia spectabilis**	T	O					√			√			√
Ulmaceae	*Celtis africana*	T	R	√		√								
Ulmaceae	*Celtis mildbraedii*	T	R											√
Ulmaceae	*Celtis wightii*	T	R											√

Family	Species	Habit	Abund ance	Previous survey [a]	Immediate Impact zone							Itanda/Kalagala offset		
					Buj	Buj Islands	Dumbl Island	Kiku	Nmy	Nmz Island	Nmz	Ita/Kala Island	Kala FR	N. Bank FR
Umbelliferae	*Centella asiatica*	F	F		√			√	√				√	
Ulmaceae	*Chaetacme aristata*	S	F			√	√					I	√	√
Poaceae	*Chloris gayana*	G	O		√			√					√	
Poaceae	*Chloris virgata*	G	R					√						
Vitaceae	*Cissus oliveri*	L	R			√								
Vitaceae	*Cissus rotundifolia*	L	F	√			√			√		√	√	
Rutaceae	*Citrus limonii**	T	O							√		√		√
Rutaceae	*Clausena anisata*	S	O	√							√	√		
Verbenaceae	*Clerodendrum fuscum*	L	R										√	
Rubiaceae	*Coffea robusta**	T	F		√		√	√			√	√		
Sterculiaceae	*Cola gigantea*	T	F			√	√	√		√		√		
Combretaceae	*Combretum collinum*	T	R										√	
Combretaceae	*Combretum paniculatum*	L	F		√		√					√	√	
Commelinaceae	*Commelina africana*	F	D	√	√	√	√	√		√	√	√	√	√
Commelinaceae	*Commelina benghalensis*	F	A	√	√			√		√	√	√		√
Nyctaginaceae	*Commicarpus plumbagineus*	F	O							√		√		√
Asteraceae	*Conyza floribunda*	F	F		√			√	√		√			√
Zingiberaceae	*Costus afer*	F	R			√								
Asteraceae	*Crassocephalum vitellinum*	F	O		√			√						
Fabaceae	*Crotalaria aculeata*	S	R					√						
Fabaceae	*Crotalaria brevidens*	S	O					√			√			
Fabaceae	*Crotalaria sp.*	S	O		√				√					
Fabaceae	*Crotalaria spinosa*	S	R								√			
Euphorbiaceae	*Croton macrostachyus*	T	R		.						√			
Araceae	*Culcasia falcifolia*	F	O				√					√	√	
Araceae	*Culcasia sp. (crop)**	F	O				√					√		
Araliaceae	*Cussonia arborea*	F	R			√								
Amaranthaceae	*Cyathula achyranthoides*	F	R											√
Poaceae	*Cynodon dactylon*	G	O	√				√	√					√
Cyperaceae	*Cyperus articulatus*	F	O							√		√		
Cyperaceae	*Cyperus cyperoides*	F	A		√			√	√		√		√	√
Cyperaceae	*Cyperus denudatus*	F	O				√					√		
Cyperaceae	*Cyperus distans*	F	O							√		√		
Cyperaceae	*Cyperus maculatus*	F	O		√	√	√							
Cyperaceae	*Cyperus papyrus*	F	O	√			√					√		
Vitaceae	*Cyphostemma adenocaule*	L	R	√	√									
Fabaceae	*Desmodium ramosissimum*	S	R					√						
Fabaceae	*Desmodium setigerum*	F	R					√						
Fabaceae	*Desmodium sp.*	F	O		√						√			
Fabaceae	*Desmodium tortuosum*	F	F					√	√		√			√

					Immediate Impact zone							Itanda/Kalagala offset		
Family	**Species**	**Habit**	**Abundance**	**Previous survey** [a]	**Buj**	**Buj Islands**	**Dumbl Island**	**Kiku**	**Nmy**	**Nmz Island**	**Nmz**	**Ita/Kala Island**	**Kala FR**	**N. Bank FR**
Fabaceae	*Desmodium velutinum*	F	R										√	
Dichapetalaceae	*Dichapetalum ugandense*	L	F				√					√	√	√
Fabaceae	*Dichrostachys cinerea*	T	O					√			√			√
Poaceae	*Digitaria abyssinica*	G	F		√			√	√		√		√	
Poaceae	*Digitaria longiflora*	G	R											√
Poaceae	*Digitaria velutina*	G	O		√						√			
Sterculiaceae	*Dombeya mukole*	T	R											√
Dracaenaceae	*Dracaena fragrans*	S	F		√			√	√			√		
Caryophyllaceae	*Drymaria cordata*	F	R		√									
Euphorbiaceae	*Drypetes gerrardii*	T	O			√	√							
Acanthaceae	*Dyschoriste radicans*	F	F					√	√		√		√	√
Asteraceae	*Eclipta alba*	F	O		√				√		√			
Pontederiaceae	*Eichhornia crassipes**	F	R	√								√		
Asteraceae	*Emilia integrifolia*	F	O		√						√			
Fabaceae	*Entada abyssinica*	T	O								√			√
Poaceae	*Eragrostis tenuifolia*	G	O	√				√	√		√			
Fabaceae	*Eriosema psoraleoides*	F	R								√			
Euphorbiaceae	*Erythrococca trichogyne*	S	R		√									
Erythroxylaceae	*Erythroxylum fischeri*	S	R									√		
Orchidaceae	*Eulophia sp.*	F	R			√								
Euphorbiaceae	*Euphorbia heterophylla*	F	F	√	√		√	√			√	√		
Euphorbiaceae	*Euphorbia hirta*	F	F		√			√	√		√			
Euphorbiaceae	*Euphorbia teke*	S	F			√	√					√	√	
Moraceae	*Ficus asperifolia*	T	R											√
Moraceae	*Ficus conraui*	T	O			√							√	
Moraceae	*Ficus cordata*	T	O			√							√	
Moraceae	*Ficus cyathistipula*	T	O							√		√		
Moraceae	*Ficus exasperata*	T	A		√	√			√	√	√	√		√
Moraceae	*Ficus mucuso*	T	A	√	√			√		√	√	√		√
Moraceae	*Ficus natalensis*	T	A	√	√	√		√	√	√	√		√	
Moraceae	*Ficus ottoniifolia*	T	R			√								
Moraceae	*Ficus ovata*	T	A	√	√	√	√					√	√	√
Moraceae	*Ficus platyphylla*	T	A				√	√	√	√		√	√	
Moraceae	*Ficus pseudomangifera*	T	A		√	√	√	√				√	√	
Moraceae	*Ficus saussureana*	T	F		√	√				√		√	√	
Moraceae	*Ficus sur*	T	O	√	√	√								√
Moraceae	*Ficus sycomorus*	T	O				√					√	√	
Moraceae	*Ficus thoningii*	T	F		√		√			√		√		
Moraceae	*Ficus vallis-choudae*	T	A	√	√			√	√	√		√	√	
Euphorbiaceae	*Flueggea virosa*	S	F		√			√	√		√			√

Family	Species	Habit	Abundance	Previous survey [a]	Immediate Impact zone							Itanda/Kalagala offset		
					Buj	Buj Islands	Dumbl Island	Kiku	Nmy	Nmz Island	Nmz	Ita/Kala Island	Kala FR	N. Bank FR
Asteraceae	*Galisonga parviflora*	F	R		√									
Fabaceae	*Glycine wightii*	L	O					√			√			
Tiliaceae	*Glyphaea brevis*	S	O							√		√		
Tiliaceae	*Grewia mildbraedii*	S	O	√				√						√
Tiliaceae	*Grewia trichocarpa*	S	O	√		√		√					√	
Asteraceae	*Gynura scandens*	F	F			√	√					√	√	
Simaroubaceae	*Harrisonia abyssinica*	T	R											√
Rhamnaceae	*Helinus mystacinus*	L	R			√								
Malvaceae	*Hibiscus diversifolius*	F	R	√								√		
Malvaceae	*Hibiscus sp.*	F	R										√	
Malvaceae	*Hibiscus surattensis*	F	R			√								
Ulmaceae	*Holoptelea grandis*	T	F				√					√	√	√
Labiatae	*Hoslundia opposita*	S	R					√						
Umbelliferae	*Hydrocotyle mannii*	F	R					√						
Poaceae	*Hyparrhenia rufa*	G	R					√						
Labiatae	*Hyptis sauveolens*	S	R	√				√						
Poaceae	*Imperata cylindrica*	G	O					√	√		√			
Fabaceae	*Indigofera arrecta*	S	O					√			√			
Fabaceae	*Indigofera spicata*	F	F	√				√	√		√		√	
Convolvulaceae	*Ipomoea batatus**	Cr	O	√						√		√		√
Convolvulaceae	*Ipomoea cairica*	Ra	O	√				√	√		√			
Convolvulaceae	*Ipomoea wightii*	Ra	F			√	√	√	√					
Oleaceae	*Jasminium eminii*	L	R										√	
Oleaceae	*Jasminum floribundum*	L	R										√	
Oleaceae	*Jasminum fluminense*	L	R			√								
Euphorbiaceae	*Jatropha curcas**	T	F	√	√	√		√	√					√
Acanthaceae	*Justicia flava*	F	O	√									√	√
Cyperaceae	*Kyllinga alba*	F	O					√					√	√
Cucurbitaceae	*Lagenaria sphaerica*	L	R	√	√									
Anacardiaceae	*Lannea schweinfurthii*	T	R											√
Anacardiaceae	*Lannea welwitschii*	T	F			√		√		√		√		√
Verbenaceae	*Lantana camara**	S	D	√	√	√	√	√	√	√	√		√	√
Verbenaceae	*Lantana trifolia*	S	O					√	√					
Urticaceae	*Laportea ovalifolia*	F	R		√									
Sapindaceae	*Lecaniodiscus fraxinifolius*	T	R			√								
Lemnaceae	*Lemna sp.*	F	R	√								√		
Labiatae	*Leonotis nepetifolia*	S	O	√					√		√			
Labiatae	*Leucas sp.*	F	R		√									
Celastraceae	*Loeseneriella africana*	L	O				√					√	√	
Cucurbitaceae	*Luffa cylindrica*	L	R	√	√									

Family	Species	Habit	Abundance	Previous survey [a]	Immediate Impact zone: Buj	Buj Islands	Dumbl Island	Kiku	Nmy	Nmz Island	Nmz	Itanda/Kalagala offset: Ita/Kala Island	Kala FR	N. Bank FR
Solanaceae	*Lycopersicum sp.*	F	O				√					√		
Capparaceae	*Maerua duchesnei*	S	O			√	√							√
Myrsinaceae	*Maesa welwitschii*	L	O				√					√		
Rhamnaceae	*Maesopsis eminii*	T	D	√	√	√		√		√	√	√	√	√
Anacardiaceae	*Mangifera indica**	T	O						√		√			√
Euphorbiaceae	*Manhot esculentus (Cassava)**	S	F		√				√		√			√
Sapotaceae	*Manilkara obovata*	T	O			√							√	
Marantaceae	*Marantochloa sp.*	F	O				√					√	√	
Bignoniaceae	*Markhamia lutea*	T	D	√	√	√	√	√	√	√	√	√	√	√
Celastraceae	*Maytenus heterophylla*	T	O			√	√						√	
Celastraceae	*Maytenus senegalensis*	S	R									√		
Celastraceae	*Maytenus undata*	S	R										√	
Asteraceae	*Melanthera scandens*	F	F			√	√	√				√		
Poaceae	*Melinis repens*	G	O					√	√					
Moraceae	*Milicia excelsa*	T	D	√	√	√		√	√	√		√	√	√
Fabaceae	*Mimosa pigra*	S	O	√					√				√	
Fabaceae	*Mimosa pudica*	S	R	√				√						
Sapotaceae	*Mimusops bagshawei*	T	O									√	√	√
Nyctaginaceae	*Mirabilis jalapa*	F	R	√	√									
Cucurbitaceae	*Momordica foetida*	L	F		√	√	√	√						
Rubiaceae	*Morinda lucida*	T	O							√			√	√
Moraceae	*Morus mesozygia*	T	F			√				√		√		√
Cucurbitaceae	*Mukia maderaspatana*	L	R					√						
Musaceae	*Musa paradisiaca**	F	R		√									
Musaceae	*Musa sapientum**	F	A	√	√			√	√	√	√	√		
Celastraceae	*Mystroxylon aethiopicum*	S	R										√	
Ochnaceae	*Ochna schweinfurthiana*	S	R									√		
Oxalidaceae	*Oxalis corniculata**	F	F		√			√			√		√	
Rubiaceae	*Oxyanthus troupinii*	S	O				√					√	√	
Polygonaceae	*Oxygonum sinuatum*	F	O		√						√			√
Poaceae	*Panicum maximum*	G	D		√	√	√	√	√		√	√		√
Poaceae	*Panicum trichocladum*	G	O					√	√		√			
Fabaceae	*Parkia filicoidea*	T	O							√		√	√	
Poaceae	*Paspalum conjugatum*	G	O					√	√				√	
Poaceae	*Paspalum scrobiculatum*	G	F					√	√		√			√
Passifloraceae	*Passiflora edulis*	L	R			√								
Rubiaceae	*Pavetta oliveriana*	S	O				√					√	√	
Poaceae	*Pennisetum thunbergii*	G	R					√						
Lauraceae	*Persea americana**	T	O		√				√					
Palmae	*Phoenix reclinata*	T	O			√				√		√		

Family	Species	Habit	Abundance	Previous survey [a]	Immediate Impact zone: Buj	Buj Islands	Dumbl Island	Kiku	Nmy	Nmz Island	Nmz	Itanda/Kalagala offset: Ita/Kala Island	Kala FR	N. Bank FR
Poaceae	*Phragmites mauritiana*	S	O	√	√					√		√		
Euphorbiaceae	*Phyllanthus amarus*	F	R			√								
Euphorbiaceae	*Phyllanthus leucanthus*	F	O		√			√			√			
Euphorbiaceae	*Phyllanthus nummulariifolius*	F	R						√					
Euphorbiaceae	*Phyllanthus ovalifolius*	S	R		√									
Euphorbiaceae	*Phyllanthus pseudoniruri*	F	O		√								√	
Phytolaccaceae	*Phytolacca dodecandra*	F	O	√	√			√						
Urticaceae	*Pilea angolensis*	F	R					√						
Pinaceae	*Pinus caribea**	T	R	√									√	
Plumbaginaceae	*Plumbago dawei*	S	O				√					√	√	
Verbenaceae	*Premna angolensis*	T	O				√						√	√
Verbenaceae	*Priva flabelliformis*	F	R		√									
Anacardiaceae	*Pseudospondias microcarpa*	T	O			√				√		√		
Myrtaceae	*Psidium guajava**	T	O					√	√					√
Rubiaceae	*Psychotria kraessneri*	S	R										√	
Pteridaceae	*Pteris preussi*	F	R			√								
Myrsticaceae	*Pycnanthus angolensis*	T	R			√								
Cyperaceae	*Pycreus mundtii*	F	R	√								√		
Cyperaceae	*Pycreus polystachyos*	F	R										√	
Palmae	*Raphia farinifera*	T	O				√					√	√	
Vitaceae	*Rhoicissus tridentata*	L	R										√	
Anacardiaceae	*Rhus natalensis*	S	O			√	√							
Anacardiaceae	*Rhus natalensis*	S	R										√	
Fabaceae	*Rhynchosia ferruginea*	L	R					√						
Euphorbiaceae	*Ricinodendron heudelotii*	T	R											√
Euphorbiaceae	*Ricinus communis*	S	O		√									√
Violaceae	*Rinorea ilicifolia*	T	O			√							√	
Rubiaceae	*Rothmannia longiflora*	T	R											√
Poaceae	*Rottboellia cochinchinensis*	G	F		√			√	√		√			
Apocynaceae	*Saba comorensis*	L	O				√					√	√	
Celastraceae	*Salacia elegans*	L	R									√		
Celastraceae	*Salacia erecta*	L	O			√	√							
Dracaenaceae	*Sansevieria intermedia*	S	O			√	√						√	
Euphorbiaceae	*Sapium ellipticum*	T	O	√	√	√		√						
Amaryllidaceae	*Scadoxus multiflorus*	F	R			√								
Asclepiadaceae	*Secamone africana*	L	R	√									√	
Asclepiadaceae	*Secamone sp.*	L	O			√						√	√	
Pedaliaceae	*Sesamum angustifolium*	F	R								√			
Fabaceae	*Sesbania sesban*	S	O		√	√						√		
Poaceae	*Setaria sp.*	G	R			√								

					Immediate Impact zone							Itanda/Kalagala offset		
Family	Species	Habit	Abundance	Previous survey [a]	Buj	Buj Islands	Dumbl Island	Kiku	Nmy	Nmz Island	Nmz	Ita/Kala Island	Kala FR	N. Bank FR
Poaceae	*Setaria sphacelata*	G	R					√						
Malvaceae	*Sida rhombifolia*	F	F	√	√			√			√		√	√
Asteraceae	*Sigesbeckia orientalis*	F	O			√	√							
Solanaceae	*Solanum mauritianum*	S	O		√			√						
Solanaceae	*Solanum nigrum*	F	R		√									
Asteraceae	*Sonchus bipontini*	F	O					√	√					
Poaceae	*Sorghum arundinaceum*	G	F		√			√	√		√			
Bignoniaceae	*Spathodea campanulata*	T	A		√			√	√	√	√	√		√
Poaceae	*Sporobolus pyramidalis*	G	R	√					√					
Sterculiaceae	*Sterculia dawei*	T	F	√		√	√			√		√		
Loganiaceae	*Strychnos usambarensis*	L	R										√	
Asteraceae	*Synedrella nodiflora*	F	F	√	√			√	√		√			√
Myrtaceae	*Syzygium guineense*	T	R											√
Dichapetalaceae	*Tapura fischeri*	T	F			√	√			√		√		√
Rutaceae	*Teclea nobilis*	T	R			√								
Fabaceae	*Teramnus uncinatus*	L	R						√					
Combretaceae	*Terminalia iverensis*	T	O		√									√
Euphorbiaceae	*Thecacoris lucida*	S	R			√								
Euphorbiaceae	*Thevetia peruviana**	S	R											√
Acanthaceae	*Thunbergia alata*	F	R										√	
Euphorbiaceae	*Tragia brevipes*	L	O					√	√					
Ulmaceae	*Trema orientalis*	T	R	√				√						
Rubiaceae	*Tricalysia bagshawei*	S	R										√	
Rubiaceae	*Tricalysia niamniamensis*	S	R										√	
Meliaceae	*Trichilia dregeana*	T	O							√		1		
Meliaceae	*Trichilia prieuriana*	T	R	√									√	
Asteraceae	*Tridax procumbens*	F	O	√	√			√						
Tiliaceae	*Triumfetta macrophylla*	S	O							√		√	√	
Tiliaceae	*Triumfetta rhomboidea*	F	O		√			√			√			
Typhaceae	*Typha domingensis*	F	O				√					√		
Malvaceae	*Urena lobata*	S	F	√				√			√		√	√
Urticaceae	*Urera trinervis*	L	F			√	√					√	√	
Rubiaceae	*Vangueria apiculata*	T	R										√	
Asteraceae	*Vernonia amygdalina*	S	A	√	√			√	√		√		√	√
Asteraceae	*Vernonia auriculifera*	S	O					√			√			
Fabaceae	*Vigna luteola*	F	R	√								√		
Fabaceae	*Vigna parkeri*	F	R						√					
Fabaceae	*Vigna sp.*	F	R					√						
Fabaceae	*Vigna unguiculata*	F	R								√			
Verbenaceae	*Vitex ferruginea*	T	O										√	√

					Immediate Impact zone							Itanda/Kalagala offset		
Family	**Species**	**Habit**	**Abundance**	**Previous survey** [a]	**Buj**	**Buj Islands**	**Dumbl Island**	**Kiku**	**Nmy**	**Nmz Island**	**Nmz**	**Ita/Kala Island**	**Kala FR**	**N. Bank FR**
Poaceae	*Vossia cuspidata*	G	O	√		√				√		√		
Canellaceae	*Warburgia ugandensis*	T	R										√	
Acanthaceae	*Whitfieldia longifolia*	S	F			√	√					√	√	√
Poaceae	*Zea mays**	G	O								√			√
	Grand Total				**88**	**81**	**61**	**101**	**56**	**46**	**69**	**91**	**104**	**85**

Appendix B1. LAND BIRDS of the BUJAGALI DAM SITE AREAS. Species are listed in the order, and using names from, the Uganda Bird Atlas (Carswell *et al* 2005). For 2006 site, the boxes in the headers group similar sites. In both years, the 'overall' column is the mean score for the 3 sites common to both years.

			1998 RESULTS				2006 RESULTS						
Atlas No.	Name	Red Data status and specialism[a]					Nany	Kiku	Naz	Buj	Overall	Forest Reserves	
							Regeneration						
			Kiku*	Naz	Buj	Overall		1998 Comparison				Kalagala	Itanda
									Small farms				
17	Cattle Egret *Bubulous ibis*	G	1.8	1.4	4.4	2.5	1.0		1.0	2.0	1.5	2.3	2.7
26	Black-headed Heron *Ardea melanocephala*	w		0.4		0.1	1.7	0.3	1.0		0.4	3.0	0.3
30	Open-billed Stork *Anastomus lamelligerus*	A,w,G					4.3	1.5	2.8		1.4	4.0	2.7
36	Marabou Stork *Leptoptilos crumeniferus*	w					0.3					1.0	
38	Hadada Ibis *Bostrychia hagedash*	w	0.4		1.2	0.5	1.0	0.8		1.7	0.8		
71	Honey Buzzard *Pernis apivorus*	P,F							0.8		0.3		
73	Black-shouldered Kite *Elanus caeruleus*						P[b]					0.7	0.3
75	Black Kite *Milvus migrans*	pA			0.6	0.2	3.0	3.8	1.5	3.3	2.9		1.0
77	Palm-nut Vulture *Gypohierax angolensis*							1.5			0.5	2.0	
80	Hooded Vulture *Neophron monachus*	f	0.2			0.1		1.5			0.5	1.7	
86	Brown Snake Eagle *Circaetus cinereus*	R-NT		1.0		0.3							0.7
90	African Harrier Hawk *Polyboroides typus*	f		0.8	0.2	0.3	1.7	1.3	0.3	3.0	1.5	2.0	
93	African Marsh Harrier *Circus ranivorus*	R-NT, W	p0.6[c]			p0.2							
98	African Goshawk *Accipiter tachiro*	F		0.4		0.1		0.3		2.0	0.8		
100	Shikra *Accipiter badius*	F	1.2	1.2		0.8	1.0			2.0	0.7		
109	Lizard Buzzard *Kaupifalco monogrammicus*	F			3.0	1.0	2.0	0.8	0.5	3.3	1.5	1.3	0.7
116	Tawny Eagle (including Stepple Eagle) *Aquila rapax*											1.7	
117	Wahlberg's Eagle *Aquila wahlbergi*	A,f						1.3	1.5		0.9		
122	Long-crested Eagle *Lophaetus occipitalis*	F	1.8			0.6			2.6		0.9		P

* Kiku = Kikubamutwe Naz = Namizi Buj = Bujagali village Nany = Naminya (north of)

Atlas No.	Name	Red Data status and specialism[a]	1998 RESULTS				2006 RESULTS						
							Nany	Kiku	Naz	Buj	Overall	Forest Reserves	
							Regeneration						
			Kiku[*]	Naz	Buj	Overall		1998 Comparison				Kalagala	Itanda
									Small farms				
137	African Hobby *Falco cuvieri*	F											2.0
155	Scaly Francolin *Francolinus squamatus*	F											2.7
250	Common Sandpiper *Actitis hypoleucos*	P,W											1.2
268	African Green-pigeon *Treron calva*	F			1.4	0.5		0.3	0.8		0.4	2.0	
270	Tambourine Dove *Turtur tympanistria*	F	1.8			0.6		1.5		2.0	1.2	1.3	
271	Blue-spotted Wood-dove *Turtur afer*	F	3.2	1.6	2.8	2.5	2.7	3.0	3.5		3.2		
283	Red-eyed Dove *Streptopelia semitorquata*	f	1.4	4.4	2.6	2.8	2.7	1.8	5.8	0.2	2.6	3.0	2.7
289	Laughing Dove *Streptopelia senegalensis*		1.2			0.4		0.5	2.3		0.9		
292	Brown Parrot *Poicephalus meyeri*	p								0.3	0.1		
296	Great Blue Turaco *Corythaeola cristata*											6.0	
302	Ross's Turaco *Musophaga rossae*	F	0.4		1.2	0.5			1.5	0.3	0.6	0.7	
305	Eastern Grey Plantain Eater *Crinifer zonurus*		2.8	1.0	0.4	1.4	3.7	4.5	5.8	4.7	5.0	5.3	1.0
309	Red-chested Cuckoo *Cuculus solitarius*	A,F							P				
319	Klaas's Cuckoo *Chrysococcyx klaas*	f			2.6	0.9			1.0		0.3		2.3
320	Didric Cuckoo *Chrysococcyx caprius*						2.3					1.3	
323	White-browed Coucal *Centropus superciliosus*			0.6	2.8	1.1		1.0	3.8		1.6		
358	African Palm Swift *Cypsiurus parvus*		1.2	1.8		1.0	3.0		1.5	0.7	0.7	2.0	2.0
369	Speckled Mousebird *Colius striatus*		2.8	3.6	3.0	3.1	5.3	2.3	1.5		1.3	3.3	2.7
375	Woodland Kingfisher *Halcyon senegalensis*	A		1.0	1.4	0.8			1.5		0.5	4.3	1.7
378	African Pygmy Kingfisher *Ispidina picta*	f,w		0.4	0.4	0.3			0.8		0.3		
390	White-throated Bee-eater *Merops albicollis*	A,f,Ae	0.8	4.6	0.4	1.9							
392	Blue-cheeked Bee-eater *Merops persicus*	P,Ae		1.0		0.3							
394	Eurasian Bee-eater *Merops apiaster*	P,f,Ae						4.5	1.8		2.1	1.0	
401	Broad-billed Roller *Eurystomus glaucurus*	A,f,w		1.8	0.4	0.7			1.0		0.3	5.7	
418	Pied Hornbill *Tockus fasciatus*	F											1.0

			1998 RESULTS				2006 RESULTS						
Atlas No.	Name	Red Data status and specialism[a]					Nany	Kiku	Naz	Buj	Overall	Forest Reserves	
							Regeneration						
			Kiku[*]	Naz	Buj	Overall		1998 Comparison				Kalagala	Itanda
									Small farms				
419	Crowned Hornbill *Tockus alboterminatus*	f		1.2		0.4						1.7	
422	Black and White Casqued Hornbill *Ceratogymna subcylindricus*	F							1.5	1.3	0.9	0.7	
426	Speckled Tinkerbird *Pogoniulus scolopaceus*	F					0.3						
431	Yellow-rumped Tinkerbird *Pogoniulus bilineatus*	F					2.0	4.8	3.3	4.0	4.0	2.7	
433	Yellow-fronted Tinkerbird *Pogoniulus chrysoconus*	f	1.2		3.6	1.6	2.3	3.3	2.3	4.7	3.4	1.7	
443	Double-toothed Barbet *Lybius bidentatus*	f			1.2	0.4			0.8		0.3		
445	Yellow-billed Barbet *Trachyphonus purpuratus*											p2.0	
477	Grey Woodpecker *Dendropicos goertae*	f		p0.2		p0.1						3.0	
498	White-headed Saw-wing *Psalidoprocne albiceps*	R-RR, f,Ae		1.0	0.4	0.5		1.3	1.5		0.9	1.7	
500	Sand Martin *Riparia riparia*	P,W,Ae					6.0	5.5	4.5	2.3	4.1	5.7	6.0
512	Angola Swallow *Hirundo angolensis*	w,Ae	1.2			0.4			3.8	0.7	1.5		0.7
513	Barn Swallow *Hirundo rustica*	P,w,Ae	0.2	1.4	0.8	0.8	2.7	1.5	1.8		0.8		3.3
515	Yellow Wagtail *Motacilla flava*	P,w,G					1.7	1.5	1.3		0.9	1.0	5.7
520	African Pied Wagtail *Motacilla aguimp*	w			1.4	0.5							0.7
538	Little Greenbul *Andropadus virens*	F					4.0	2.8			0.9		
562	Common Bulbul *Pycononotus barbatus*	f	6.0	6.0	6.0	6.0	5.7	6.0	6.0	6.0	6.0	6.0	6.0
576	White-browed Robin Chat *Cossypha heuglini*	f								1.0	0.3		
578	Snowy-headed Robin Chat *Cossypha niveicapilla*	F,w						2.0			0.7		
589	White-browed Scrub Robin *Cercotrichas leucophrys*						4.3	0.8	1.8		0.9		
593	Whinchat *Saxicola rubetra*											1.0	
612	African Thrush *Turdus pelios*	f		0.8	0.6	0.5	3.0		4.0	4.3	2.8	4.0	4.7
621	Moustached Warbler *Melocichla mentalis*						2.0				0.1	2.0	
624	Sedge Warbler *Acrocephalus schoenobaenus*	P,w					p4.0	p0.5			p0.2		p2.0
638	Red-faced Cisticola *Cisticola erythrops*	w	4.2	5.6	4.8	4.9	5.7	5.0	0.3	1.3	2.2	1.3	5.3
647	Winding Cisticola *Cisticola galactotes*	w	1.4			0.5	4.3	2.5	0.5		2.4	3.0	1.3

Atlas No.	Name	Red Data status and specialism[a]	1998 RESULTS				2006 RESULTS						
							Nany	Kiku	Naz	Buj	Overall	Forest Reserves	
							Regeneration						
			Kiku*	Naz	Buj	Overall		1998 Comparison				Kalagala	Itanda
									Small farms				
650	Croaking Cisticola *Cisticola natalensis*	G					0.3						
658	Tawny-flanked Prinia *Prinia subflava*	fw	4.8	4.0	4.8	4.5	1.7	2.0	5.0	1.3	2.8	2.0	3.3
661	White-chinned Prinia *Prinia leucopogon*	F		0.6		0.2							
677	Grey-backed Camaroptera *Camaroptera brachyura*	f	5.6	4.8	5.6	5.3	5.3	5.8	5.8	6.0	5.9	5.7	4.7
691	Red-faced Crombec *Sylvietta whytii*	F			p0.2	p0.1							
695	Willow Warbler *Phylloscopus trochilus*	P,f						2.3	2.8	3.3	2.8	3.3	5.3
701	Grey-capped Warbler *Eminia lepida*	R-RR, fw	0.4	0.6	2.6	1.2	1.7	1.8	0.3		0.7	1.7	0.7
703	Garden Warbler *Sylvia borin*	P,f					2.0	p2.0			p0.7		
704	Blackcap *Sylvia atricapilla*	P,F						1.3			0.4		
713	Northern Black Flycatcher *Melaenornis edoliodes*			0.2		0.1						2.3	1.7
720	Swamp Flycatcher *Muscicapa aquatica*	W		0.6	2.2	0.9		0.6			0.2		
732	African Blue-flycatcher *Elminia longicausa*	f		3.2	2.2	1.8		0.5	2.5	5.3	2.8	4.0	1.0
739	African-Paradise-flycatcher *Terpisiphone viridis*	f	0.8	1.0		0.6			0.5		0.2		1.3
740	Red-bellied Paradise Flycatcher *Terpsiphone rufiventer*	F						3.0	2.8	0.3	2.0		
742	Black and White Flycatcher *Bias musicus*	f								2.0	0.7		
746	Brown-throated Wattle-eye *Platysteira cyanea*	f	1.8	1.2	3.8	2.3	1.0	5.5	2.8	4.3	4.2	4.0	
761	Brown Babbler *Turdoides plebejus*						2.7						
771	Black Tit *Parus leucomelas*	f			0.6	0.2				0.7	0.2		0.3
773	African Penduline Tit *Anthoscopus caroli*	f					1.0						
781	Green-headed Sunbird *Chalcomitra verticalis*	F	0.8			0.3				2.0	0.7	1.0	
787	Scarlet-chested Sunbird *Chalcomitra senegalensis*	f	2.2	3.0	1.8	2.3	4.7	1.0	3.5	4.0	2.8	4.7	1.7
796	Olive-bellied Sunbird *Cinnyris chloropygia*	F	2.5	4.0	0.8	2.4			1.8	1.7	1.2	1.4	0.3
802	Marico Sunbird *Cinnyris mariquensis*		0.6			0.2			1.8		0.6		0.7
803	Red-chested Sunbird *Cinnyris erythroceria*	R-RR, W	6.0	5.8	5.6	5.8	6.0	6.0	4.3	5.7	5.3	5.7	3.3
808	Variable Sunbird *Cinnyris venusta*	f							1.3		0.4	1.7	

Atlas No.	Name	Red Data status and specialism[a]	1998 RESULTS				2006 RESULTS						
							Nany	Kiku	Naz	Buj	Overall	Forest Reserves	
							Regeneration						
			Kiku*	Naz	Buj	Overall		1998 Comparison				Kalagala	Itanda
									Small farms				
809	Superb Sunbird *Cinnyris superba*											0.3	
810	Copper Sunbird *Cinnyris cuprea*	f,w	0.8	1.4	0.4	2.6	1.3	1.5			0.5		0.7
811	Yellow White-eye *Zosterops senegalensis*	f	4.6	1.4	4.0	3.3	1.3	5.3	4.0	3.3	4.2	4.3	1.0
831	Brown-crowned Tchagra *Tchagra australis*		1.4	0.4	2.0	1.3		0.3	0.3		0.2		1.0
836	Northern Puffback *Dryoscopus gambensis*	F	1.2	1.2		0.8			0.8	1.0	0.6		0.3
841	Tropical Boubou *Laniarius aethiopicus*	f					1.7		0.8		0.3	1.7	
843	Black-headed Gonolek *Laniarius erythrogaster*	f					0.7						
855	Pied Crow *Corvus albus*								0.3		0.1		
871	Splendid Starling *Lamprotornis splendidus*	F	1.0	1.5	1.0	1.2			0.5		0.2	5.7	2.3
872	Ruppell's Long-tailed Glossy Starling *Lamprotornis purpuropter*											1.0	
881	Grey-headed Sparrow *Passer griseus*		1.0			0.3		0.8	4.3	1.0	2.0		0.3
893	Baglafecht Weaver *Ploceus baglafecht*	f							1.5		0.5		
894	Slender-billed Weaver *Ploceus pelzelni*	f,W		3.2	3.2	2.1							2.7
895	Little Weaver *Ploceus luteolus*											1.7	
897	Spectacled Weaver *Ploceus ocularis*	f	1.0		0.8	0.6		1.5		2.0	1.2	0.3	
907	Vieillot's Black Weaver *Ploceus nigerrimus*	f		0.6		0.2				1.3	0.4	0.7	3.3
908	Black-headed Weaver *Ploceus cucullatus*		3.6	3.6	2.4	2.8							
910	Yellow-backed Weaver *Ploceus melanocephalus*	W	1.0	1.0		0.7	3.3	2.0	4.5		2.2	2.7	4.0
911	Golden-backed Weaver *Ploceus jacksoni*	R-RR,w					2.3	1.3		1.3	0.9	2.0	1.0
924	Red-headed Quelea *Quelea erythrops*	A							0.5		0.2		
927	Black Bishop *Euplectes gierowii*	w	0.6			0.2							
932	Fan-tailed Widowbird *Euplectes axillaris*	w					1.0	1.0			0.3		
937	Grosbeak Weaver *Amblyospiza albifrons*	f,W	0.6			0.2							
939	Grey-headed Negrofinch *Nigrita canicapilla*	F	0.4			0.1							
959	Red-billed Firefinch *Lagonosticta senegala*		1.2	1.4	0.8	1.1	1.0	1.5	1.5	0.7	1.2	0.7	3.7

Atlas No.	Name	Red Data status and specialism[a]	1998 RESULTS				2006 RESULTS						
							Nany	Kiku	Naz	Buj	Overall	Forest Reserves	
							Regeneration						
			Kiku*	Naz	Buj	Overall		1998 Comparison				Kalagala	Itanda
									Small farms				
963	African Firefinch *Lagonosticta rubricata*						1.3						
969	Waxbill *Estrilda astrild*	w,G								1.7	0.8		
970	Black-crowned Waxbill *Estrilda nonnula*	f	4.2	2.8	1.8	2.9	1.0		2.8	1.7	1.5	2.0	
974	Red-cheeked Cordon-bleu *Uraeginthus bengalus*				1.0	0.3		1.5		1.0	0.8	1.0	3.7
980	Bronze Mannikin *Lonchura cucullata*	f	1.6	0.8	4.2	2.2	5.3	3.3	4.5	3.3	3.7	2.7	2.7
981	Black and White Mannikin *Lonchura bicolor*	f	4.4		1.0	1.8	0.3	1.3	1.8		1.0		
984	Red-billed Firefinch Indigobird *Vidua chalybeata*								1.3		0.4		
985	Pin-tailed Whydah *Vidua macroura*											4.7	2.0
991	African Citril *Serinus citrinelloides*	f	4.4	0.8	0.8	2.0	2.7		1.8		0.6		0.3
995	Yellow-fronted Canary *Serinus mozambicus*		1.0			0.3	5.0	3.3	2.3	3.7	3.1	1.7	
1005	Golden-breasted Bunting *Emberiza flaviventris*												0.7
	Mean numbers of species per count		24.4	22.8	23.8		34.7	29.5	32.5	26.3		37.3	30.7

Notes: a as listed in B2.
b P indicates presence outside the time of the count
c p0.6 indicated that the birds identification was not quite certain

Appendix M1. Mammal species recorded of reported to have existed in the areas around the Proposed Dam Site and the Kalagala offset sites.

Taxonomic Group	Common name	Species	Typical/ Preferred Habitat	Status	Nature of record	Dam East	Nile Bank FR	Kalagala FR	Falls East	Dam west	Bujagali Islands	Falls West	Dumbbell Island	Itanda/Kalagala Island
Artiodactyla	Bush pig	*Potamochoerus porcus*	F & Wd		I	√*								
	Bushbuck	*Tragelaphus scriptus*	F & Wd		I	√*								
	Bush Duiker	*Sylivicapra grimmia*	Wd		I	√*								
	Buffalo	*Syncerus caffer*	F, Wd &Gg		I	√*								
	Hippopotamus	*Hippopotamus amphibius*	W		I									√*
Carnivora	Spot Necked Otters	*Lutra maculicollis*	W	Vu	I & O	√	√	√	√		√		√	√
	Marsh Mongoose	*Atilax paludinosus*	M		I & Sc			√		√	√			
	Side Striped Jackal	*Canis adustus*	F & Wd		I			√*						
	Striped Hyaena	*Hyaena hyaena*	GG & Wd		I	√*								
	Leopard	*Panthera pardus*	F & Wd		I	√*								
	Slender Mongoose	*Herpestes sanguineus*	F & Wd		I & Sc						√			
Insectivora	African Hedgehog	*Atelerix albiventris*	GG & Wd		I				√					
Megachiroptera	Little Epauletted Fruit Bat	*Epomophorus labiatus*	Wd		N & O				√	√	√			
	Straw coloured fruit Bat	*Eidolon helvum*	F & Wd		I & Sk				√	√	√			
	Bocage's Fruit Bat	*Rousettus angolensis*	F & Wd		N					√				
Microchiroptera	Banana Bat	*Pipistrellus nanus*	Go		N					√				
	Hairy slit faced Bat	*Nycteris hispida*	Wd		N						√			
	Little Free tailed Bat	*Chaerophon pumila*	Go		O				√					
Primates	Red tailed Monkey	*Cercopithecus ascanius*	F		O	√	√		√	√		√	√	√
	Baboon	*Papio anubis*	F & Wd		I	√*	√*	√*						
	Vervet Monkey	*Cercopithecus aethiops*	Wd		I	√								

Proboscidea	Elephant	*Loxodantra africana*	F & Wd	Vu	I	√*								
Rodentia	Alexander's Tree Squirrel	*Paraxerus alexandri*	F & Wd		O	√	√		√	√				√
	Red legged Sun Squirrel	*Heliosciurus rufobrachium*	F		O				√					
	African Giant Rat	*Cricetomys gambianus*	F & Wd		I	√			√	√				√
	Common thicket Rat	*Grammomys dolichurus*	F & Wd		Sk				√	√				
	Common striped grass Rat	*Lemniscomys striatus*	Gg		T				√	√				
	Nile grass rat	*Arvivanthis niloticus*	Gg		Sk				√					
	Shaggy Marsh Rat	*Dasmys incomtus*	M		Sk				√	√	√			√
	Pygmy Mouse	*Mus minutoides*	F & Wd		P	√			√					
	Grey bellied Pygmy Mouse	*Mus triton*	Gg		P	√			√					
	Cane rats	*Thryonomys gregorianus*	Gg		I & Fs	√		√	√	√				√
	Striped Ground Squirrel	*Xerus erythropus*	Go		O	√								
	Eastern Brush furred Rat	*Lophuromys flavopunctatus*	F & Wd		T	√				√				√
	Common brush furred Rat	*Lophuromys sikapusi*	Gg & Wd		T	√				√				√
	Northern Savanna Multimammate Rat	*Mastomys hildebrandti*	W		T	√				√				
	African Common Dormouse	*Graphiurus murinus*	F & Wd		P	√								
	Kaiser's Bush Rat	*Aethomys kaiseri*	Gg		T					√				
	Tropical Groove toothed Rat	*Otomys tropicalis*	F & Wd		T					√	√			√
	Jackson's soft furred Rat	*Proamys jacksoni*	F		P						√			
	Crested Porcupine	*Hystrix cristata*	F & Wd		I									√
	Brush tailed Porcupine	*Atherurus africanus*	F		I									√

Key to acronyms in table:
Gg – Generalist in Savannas, Wd – Wooded savannas, F – Forest, Go – Generalist Open habitats, NS – Northern Savannas, W – Water, M – Marshes
I – Interview, O – Observed, Sc – Scat/faecal material, Sk – Skeletal Material, N – Netted, T – Trapped, Fs – Feeding signs, P – Probable
Vu – Vulnerable
√ - signifies record of presence of a species
* - Signifies extirpated species