LESSONS LEARNT: WATER HYACINYH CONTROL COMPONENT

FINAL DRAFT OF NATIONAL REPORT SUBMITTED

TO

REGIONAL SECRETARIAT OF THE LAKE VICTORIA ENVIRONMENTAL MANAGEMENT PROJECT (LVEMP)

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September, 2005

Executive Summary

The Water Hyacinth Control Component (WHCC) is one of the 10 components of LVEMP. The overrall goal of the components' focus is to control water hyacinth by reducing the weed to a manageable level. The approach chosen was to use a combination of physical methods (manual removal) and biological methods (using insects as bio-agents) in an integrated manner with a strong input of community participation. The WHCC initiated activities in 1997/98 and todate has activities in 5 districts of Kagera region, 7 districts of Mwanza region and 4 districts of Mara region. At the inception of activities in 1997, the water hyacinth occupied over 2000 ha of the Tanzanian part of the Lake. The excessive proliferation of the weed in the Lake interfered with water transport, displaced the natural biodiversity of the Lake, clogged fish landing sites bringing to a halt fishing activities in many affected areas, reduced water quality and supply and harboured increased populations of vectors of diseases such as malaria and bilharzias and other dangerous animals such as hippos, snakes and crocodiles. The WHCC was charged with the responsibility to alleviate problems caused by water hyacinth and arrest further proliferation of the weed to manageable levels.

The WHCC adopted IPM strategies incorporating manual removal and biological methods using two species of Neochetina weevils (*Neochetina eichhorniae* and *N. bruchi*) as natural enemies against water hyacinth and legislation to give the program a legal backing in the efforts to prevent further infestation by the weed. As part of the strategies, the WHCC also embarked on a programe of capacity building for component staff, district staff and policy makers at district and regional levels.

This report is a reflection of WHCC activities after 8 years of activity implementation in the field focussing on lessons-learnt in the control of water hyacinth in Lake basin over the period commencing 1997/98 – 2004/05 and Provide background information in the preparation of Phase II of LVEMP. The study was conducted July-August, 2005 incorporating a review of project progress reports, publications and other relevant literature and a field visit to representative field sites in the three regions, including five Weevil Rearing Units. Focal group discussions were also held with representative stakeholders including CBOs, district and regional authorities.

Generally, the WHCC has made significant contributions towards reducing the impact of the water hyacinth thus contributing towards restoration of the Lake basin environment, biodiversity and livelihoods of the majority population in the area. The success of water hyacinth

management program in the lake area has been the adoption of a strategy based on community participation, capacity building and applying 'science for management' by adopting an IPM approach which was complemented by an on-going research program. The IPM strategy adopted by the WHCC is a combination of manual removal and a strong component of biological control using two weevils species, (*Neochetina eichhorniae* Warner and *N. bruchi* Hystache). Community mobilization was done before the commencement of activities, in the affected areas, to seek concurrence at village, district and regional levels. This paid off in the end as manual removal by communities and a local NGO was successfully implemented on 530 strategic sites. Overall, IPM is credited with 80% reduction of the water hyacinth population which has helped restore use of the lake water resources for fishing, domestic, recreation and travel which impact the overall socio-economic conditions in the lake basin.

Installation of the WRUs within village locations is a good strategy which has helped improve the local communities' understanding of biological control and has helped in having communities accept biological methods as an important component in the overall strategy. A total of 14 WRU (6 in Mwanza region, 3 in Mara region and 5 in Kagera region) were constructed of which 12 are functional and the remaining two others are in the process of being operationalized. Since 1997/98, over 200 million weevils have been reared and released into Lake Victoria and adjoining rivers.

Legislation against the proliferation of water hyacinth has been put in place as an additional tool for fighting water hyacinth. The WHCC played a major role in the preparation and enactment of the "***Plant Protection (Control of Water Hyacinth) Rules***" which were gazetted on 30th November 2001. These rules were made in accordance with Section 3 of the Plant Protection Act of 1997 which is an umbrella law on all plant pests.

Research activities conducted simultaneously with water hyacinth control activities in field sites have contributed towards a better understanding of the weeds' biology and ecology, knowledge that is being used to formulate better strategies for improved control of water hyacinth in the future. In any future activities on water hyacinth and/or other aquatic weeds, research should be given due emphasis.

Despite the successes, recorded, there are a number of challenges which have to be addressed in any future engagement in the area. The major challenges are:

- There are uncertainties, for example, on continued financing and general management of the WRUs once the WHCC activities are concluded. Communities were contacted at the beginning of field activities but the roles and obligations of the communities and that of the WHCC were not made very clear to the communities right from the beginning. The lesson one can draw from this setting is that participatory planning and implementation should be adopted at all stages of project implementation. This is essential for successful project implementation during project life and beyond. The planning should include allocation of responsibilities (eg. financial, technical, social, and general management) such that the roles and responsibilities are clear to both the project staff and to communities.

- Re-surgence of water hyacinth particularly through river Kagera which is estimated to bring in an estimated 2.0 ha/day of water hyacinth 'islands' in addition to the water hyacinth re-establishment noted on other rivers namely Mara, Kanoni and Kahororo which also discharge their waters into Lake Victoria .

- Large water hyacinth seed bank - New populations of water hyacinth are frequently observed to establish themselves on mud deposited on the Lake shores and river banks when water levels fall. These new populations are later on swept back into the Lake or river when water levels rise again during rains. The seed of water hyacinth can retain viability for 15-20 years, the seed bank which is being replenished annually is a great challenge to the current and future attempts need to control water hyacinth.

- Poor weevil establishment on water hyacinth growing in rivers - Poor weevil establishment on rivers such as Kagera and Mara generally hampers the rate of success in the Lake as fresh input of water hyacinth from the rivers into the Lake is discharged from these two rivers without any colonizing weevils.

- Agricultural activities on river banks – this activity is on the increase following frequent droughts experienced in some of the areas. Plots of maize, sweet potatoes, vegetables, etc have been established by local residents and livestock are allowed access to lake beaches leading to a deposition of nutrients that encourage further proliferation of water hyacinth, and

- Enforcement of the Plant Protection (Control of Water Hyacinth) Rules legislated in 2001 probably remains mainly on paper with an insufficient capacity on the ground.

- On the basis of the results recorded so far, the IPM strategy as implemented in the Lake Victoria has potential for replication in other riverine ecosystems (eg. Sigi, Pangani and Kilombero rivers), large manmade water dams and isolated water ponds where water hyacinth may be present together with other aquatic weeds such as water lettuce and *Azolla.*

Recommendations for future engagement

Observations made on the waters and shorelines the Lake and rivers in the area, indicate that other weeds, in addition to the water hyacinth, are on the increase whereas the mandate for the WHCC was only on water hyacinth. In the light of general changes in the vegetation, and particularly weed species composition, future activities targeting the Lake ecosystem must give due consideration to the following issues:

- Monitoring of invasive species should be done on a regular basis so that the significance of any new introductions of invasive plant or animal species is determined as soon as the new species is observed to guide local and central government personnel, politicians and communities, on appropriate actions to preventing such invasive species assuming a dominant position. The national surveillance systems' mandate on water hyacinth should be expanded to include surveillance of aquatic weeds in general.

- Aquatic weed control should take an ecosystem approach which would consider the likely changes in the weed species composition and ecosystem balance when subjected to certain interventions. For example, it is known that when interventions target a single species, other weeds which were not targeted become dominant in the long term. From observations, some of the water are already chocking with weeds such as *Azolla nilotica* while in the waters and shorelines/banks of the Lake and rivers, other weeds eg *Phragmites mauritianus, Trapa natans, Cyperus papyrus, Typha capensis* are becoming the aquatic weeds of the next generation after water hyacinth

- Research to identify complementary/alternative bio-agents should be continued to help speed up the destruction of water hyacinth which, by nature, is a fast growing plant compared to the slow-acting nature of the two weevil species currently used. Current collaboration between WHCC and colleagues in Uganda and Kenya on the search for

additional, and hopefully more efficient, bio-agents to complement the two weevil species currently used should be intensified

- Role of central government, local government and communities should be well defined. Sustainable management of the Lake Victoria ecosystem is a long-term undertaking that requires long term commitment from the central government and local governments in the area. This may require, for example, that water hyacinth control activities be institutionalized into the district extension system with continued involvement of CBOs and NGOs where this is possible.

- Sustainability of WHCC interventions should be made the long term goal of any weed control program. Given the geographical setting of Lake Victoria and surrounding rivers, future efforts at combating the weed must go beyond the East African boarders to include other countries such as Rwanda and Burundi, where water hyacinth occurs and is constantly discharged into Lake Victoria through the Kagera river which originates in Rwanda and passes through Burundi before final discharge in the Lake in Tanzania. Additionally, interventions applied on the lake should be extended to other flowing and satellite water bodies in the area. Sustainability of WHCC activities will be judged by whether the WHCC left behind an institutional setup, including a sustainable financing mechanism, that can facilitate implementation of water hyacinth control activities at the current or higher level.

- Collaboration between components should be nurtured and strengthened especially in situations where activities of the different components could complement each other for better results.

Finally, there must be political commitment to allocate the necessary physical, human and financial resources for water hyacinth control and other relevant activities including public awareness and enforcement of existing legislation.

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Acronyms

ARI	Agricultural Research Institute
BMU	Beach Management Unit
CALDO	Council Agricultural and Livestock Development Officer (formerly DALDO)
DED	District Executive Director
DOE	Division of the Environment (Vice Presidents' Office)
GoT	Government of Tanzania
IITA	International Institute of Tropical Agriculture
IPM	Integrated Pest Management
km	Kilometer
LANESO	Lake Nyanza Environmental and Sanitation Organization
LVEMP	Lake Victoria Environmental Management Project
MAFS	Ministry of Agriculture and Food Security
MWLD	Ministry of Water and Livestock Development
NBCC	National Biological Control Centre
NEMC	National Environmental Management Council
NWHSC	National Water Hyacinth Steering committee
PHS	Plant Health Services
RAA	Regional Agricultural Advisor
RAS	Regional Administrative Secretary
RAS	Regional Administrative Secretary
SUA	Sokoine University of Agriculture
ToR	Terms of Reference
UDSM	University of Dar es Salaam
VEO	Village Executive Officer
WB	World Bank
WHCC	Water Hyacinth Control Component
WRU	Weevil Rearing Unit

1.0 INTRODUCTION

1.1 Environmental issues related to the lake Victoria Basin

Lake Victoria is the second largest fresh water lake in Africa and indeed, the whole world. The Lake Victoria basin (LVB) is an area of great importance to the three East African countries of Tanzania, Kenya and Uganda. About 51% of the Lake is within the borders of Tanzania. Three administrative regions of Mwanza, Kagera and Mara form the core areas of the LVB within Tanzania. The three regions support the livelihood of an estimated 6.34 million people (roughly 19% of Tanzania mainland population – 2002 census), a population which is growing at a fairly high growth rate averaging 3%. The current growth rate has increased from an average of 2.7 in 1988, causing considerable pressure on the natural resources available within the LVB, of which Lake Victoria is a significant component of the ecosystem.

The majority of the LVB, like the rest of the population in Tanzania, depend on agriculture for their livelihood which is highly supported by fishery activities. Lake Victoria is a major source of water for people living around the Lake Basin for a wide range of uses including domestic, livestock, agriculture, reacreation, tourism, and industry particularly fishery and mining. Paradoxically, however, human activities are also blamed for fueling environmental degradation of the LVB by engaging in unsuitable agricultural practices, including farming along river banks and lake shores or applying unsustainable fishing practices. Other activities responsible for degradation of the environment in the Lake Basin are deforestation and discharge of untreated domestic and industrial waste water into the lake.

The invasion of alien plant species, particularly the water hyacinth first reported in Tanzania in 1990, introduced an additional but equally dangerous dimension to the LVB as the weed clogged beaches and water points preventing access to water thereby interfering with many spheres of life and created a multitude of other problems of socio-economic importance to the general population of the area. Environmental degradation within the LVB is a multi-dimensional issue which bears on the livelihood of the majority agricultural and fishing communities of the LVB. Hence, pressure from human activities coupled with the rapid increase in population has put the natural resources of the LVB under great pressure which is believed to contribute significantly to increased poverty in the area.

1.2 About Lake Victoria Environmental Management Project

Lake Victoria Environmental Management Project (LVEMP) is a regional program for the three East African countries of Kenya, Uganda and Tanzania, initiated in 1997, to address environmental and developmental issues in the Lake Victoria Basin. The lake catchment area which covers a surface area of 193,000 km^2 and a shoreline extending roughly 3,500 km, supports approximately one third of the combined populations of the three countries of which the majority (over 70%) is engaged in agriculture. The Lake Basin area has a rapidly growing population (≥ 3%) in an environment threatened by 'pollution hotspots' emanating from industrial, mining, agricultural and human activities thus putting the whole population in the area at risk. LVEMP was conceived to address the negative trends in environmental quality in the Lake Victoria Basin in order to restore the ecological balance of the Lake which supports, directly or indirectly, the livelihood of the majority population in the area. On the Tanzania side, the three administrative regions of Mwanza, Kagera and Mara form the core area of LVEMP activities.

1.3 General context and purpose of the lessons learnt study for the water hyacinth Control component

Excessive proliferation of water hyacinth in Lake Victoria is causing interference with water transport and fishing activities, lowering water quality and supply, providing habitat for dangerous animals such as hippos and snakes and harboring vectors of diseases such as malaria and bilharzias. Consequently, the livelihoods of the population in the area are threatened while biodiversity in the Lake basin is eroded as the water hyacinth and other aquatic weeds dominate the waterscape of the lake and feeder rivers.

The Water Hyacinth Control Component (WHCC) is one of the 10 components of LVEMP. The overrall goal of the components' focus is to control water hyacinth by reducing the weed to a manageable level. The approach chosen was to use a combination of physical methods and biological methods in an integrated manner with a strong input of community participation. The WHCC initiated activities in 1997/98 and todate has activities in all districts of Kagera region, 7 districts of Mwanza region and 4 districts of Mara region. At the inception of activities in 1997, the water hyacinth occupied over 2000 ha of the Tanznian part of the Lake. The excessive proliferation of the weed in the Lake interfered with water transport, displaced the natural biodiversity of the Lake, clogged fish landing sites bringing to a halt fishing activities in many affected areas, reduced water quality and supply and

harboured increased populations of vectors of diseases such as malaria and bilharzias and other dangerous animals such as hippos, snakes and crocodiles.

Hence, the WHCC was charged with the responsibility to alleviate problems caused by water hyacinth and arrest further proliferation of the weed to manageable levels. The WHCC has implemented IPM strategies beginning 1998 to-date incorporating manual removal and release of two species of Neochetina weevils (*Neochetina eichhorniae* and *N. bruchi*) as natural enemies against water hyacinth. As part of the strategies, the WHCC also embarked on a programe of capacity building for component staff, district staff and policy makers at district and regional levels. The WHCC also spearheaded the passage of a legislation known as "*The Plant protection (control of Water Hyacinth) Rules, 2001"* which declared water hyacinth a weed under '*quarantine'* in 23 districts of mainland Tanzania including 15 districts in Mwanza, Mara and Kagera regions.

Water hyacinth control strategies have now been implemented for about 7 years. Progress has been made though the water hyacinth problem is far from over. LVEMP felt it needs to reflect on the past years' activities so as to draw important lessons that can help define any future engagement of LVEMP in the LVB or similar ecoystems. The purpose of this consultancy is to provide an analysis of the activities conducted by the water hyacinth control component with the view of drawing the lessons-learnt which can contribute towards preparations of Phase II of LVEMP.

1.4 The Terms of Reference (ToR)

A lessons learnt report is to be derived from project implementation strategies, approaches, achievements and challenges in line with the detailed ToR for this study as attached (Appendix 1). Presented hereunder is a summary of the consultants interpretation of the major tasks as outlined in the ToR:

- Review the extent to which the component has achieved its objectives using expected output/outcome indicators;
- Assess the project implementation strategies and approaches and propose possible areas of replication of the approaches, methods or technology to other areas within or outside the Lake Basin;
- Review the occurrence of other invasive aquatic weeds and other problems encountered in the implementation of component activities

- Assess the impact of the component in relation to the lake basin environment, community livelihood and stakeholders expectations
- Assess sustainability of interventions in terms of personnel, equipments, institutional setup and financial issues
- Review current research activities and propose area of further research and/or training

1.5 Objectives of the consultancy

i) Prepare a lessons-learnt report in the control of water hyacinth in Lake basin over the period commencing from the beginning of the control efforts in 1997/98 – 2004/05.

ii) Provide background information in the preparation of Phase II of LVEMP.

2.0 BACKGROUND TO LVEMP WATER HYACINTH CONTROL COMPONENT

The water hyacinth, a free-floating fresh aquatic weed of fresh water lakes, rivers and ponds, originates from South America and was first gazetted as a noxious weed in the then Tanganyika when it was first spotted in Tanga region along river Sigi in 1955 and later on river Pangani in 1964 (Lockley and Turner, undated). On the Tanzanian side of Lake Victoria, water hyacinth was first reported in 1990. By 1995, water hyacinth had spread and covered 700 ha of the lake shore line including bays and gulfs known for their abundance of fish resources as well as being used as fish and boat landing sites. Up until then no specific efforts were made to control water hyacinth in the Lake. As a result, the weed continued to prosper and by 1998, an estimated 2000 ha of the Lake was under water hyacinth cover (LVEMP, 1999), threatening the livelihood of many households in the LVB. The water hyacinth is the single most dominant invasive aquatic weed in Lake Victoria and is considered to be the most serious aquatic weed in Tanzania (Ndunguru et al., 2001). The water hyacinth control component is implemented by the Plant Protection Division (PHS) of MAFS.

3.0 APPROACH AND METHODOLOGY

The approach to be followed will involve the following aspects:

3.1 **Desk study**: In order to build an overall picture of the WHCC activities, different documents (project documents, progress reports, previous studies, scientific publications, pamphlets and manuals), stakeholders reports (at village, district and regional levels) and any other relevant publication were reviewed and analysed. The documents consulted are listed in Appendix 6. The desk study was used to establish the existing situation and basis for defining specific questions and issues which were covered during field visits.

3.2 **Field visits to component activity locations**. Representative sites of WHCC activities, chosen at random, were visited. The sites visited included WRUs, beaches and shorelines, fish landing sites, water hyacinth hot spots, river banks (Mara and Kagera rivers), Lake Victoria-river Kagera interphase, isolated ponds and other relevant sites including land adjoining the Lake and/or river banks where agricultural activities are carried out on a regular basis. The original plan was to visit at least 50% of the WRU.

However, this target could not be achieved due to extensive distances involved and the poor road infrastructure. Instead, a total of 5 WRU were visited (two each in Kagera and Mara regions, and one in Mwanza region) out of the 12 functional WRUs located in the three regions (Figure 1). We also took a boat ride to Runkunyu village (at the Tanzania/Uganda border) where river Kagera discharges into Lake Victoria and made observations of the weed composition in different sections of the Lake and discharging rivers.

The consultant reviewed progress reports, discussed extensively with the WHCC staff, district authorities and local communities during field visits. The meetings and discussions held during field visits were used to solicit views about the approaches used by the WHCC team, benefits, constraints and potentials in water hyacinth control in general. Views of the district and regional leaders were also sought. The field visits also availed an opportunity to make a rapid appraisal of the overall impact of WHCC activities on other activities of the stakeholders in the area including other emerging issues arising out of the activities carried out so far. The persons who participated in meetings and discussions with stakeholders generally fit into the following categories:

- Resource persons/staff who are directly involved in the WHCC activities in Mwanza, Bukoba and Musoma,
- Technical and administrative officers at regional and district levels,
- Representatives of local CBOs,
- Representatives of villages, and
- A number of farmers, both women and men,

Discussions were guided by a checklist of questions prepared by the Consultant (Appendix 2). The itinerary for the field visits is attached (Appendix 3) and the persons met are listed in Appendix 7. The findings were summarized in a draft report which was presented at a stakeholders' workshop held 11-12 August, 2005 in Mwanza. Comments from the stakeholders' workshop were incorporated. The first draft of the National Report was submitted to the LVEMP Regional Secretariat in August 2005. The final draft of the National Report was submitted in early September 2005 after a regional working session held at Jinja during the last week of August, 2005.

4.0 FINDINGS OF THE ASSESSMENT

4.1 Project implementation strategies and approaches

At the commencement of the WHCC activities in 1997/98, water hyacinth was estimated to cover approximately 2000 ha of the lake area in Tanzania. In 2001, the WHCC (Tanzania) formulated its Logical Framework to guide its activities. The goal of the WHCC as contained in the Logical Framework was ***'To ensure effective and sustainable control of water hyacinth in lake Victoria and other water bodies (rivers, ponds, and satellite lakes) in the Lake Victoria basin to a level that does not cause socio-economic and environmental problems through an Integrated Pest Management (IPM) strategy.'*** The strategy for achieving this goal was to involve local communities, NGOs, and CBOs in different activities of the WHCC such as sensitization on problems associated with water hyacinth, weevil rearing and release, monitoring of water hyacinth population infestation, manual removal and evaluation of control measures.

4.2 Summary of Achievements of WHCC Interventions Relative to Objectives: 1997/98 – 2004/05

The WHCC set out to achieve six objectives (referred to as '*Project Purpose*' in the Logic Framework). The analysis of the extent to which the objectives have been achieved is summarized below for each project purpose (objective) and expected outputs as per Logical Frame for WHCC (Tanzania) which were formulated in 2001. This analysis incorporates opinions of the consultant, after reviewing the Interim Completion Report (1997/98 – 2004) and annual progress reports, together with the views expressed by the stakeholders met during field visits and observations made by the consultant during field visits.

4.2.1 Project purpose I

Undertake water hyacinth control program based on physical/manual removal method to reduce the water hyacinth infestation to manageable levels.

Expected Project output

By the end of the project all strategic sites (landing beaches, water intake and ferry points and recreation sites) made free of water hyacinth plants through enhanced physical (manual removal of water hyacinth.

Extent to which project purpose has been achieved

Following sensitization by WHCC staff, communities deriving their livelihoods from fishing and/or depend on water from the lake or rivers feeding into the lake were motivated and participated in manual removal of water hyacinth to clear beaches along the lake to increase access to water for domestic and agricultural (small scale irrigation of vegetables and other crops) needs. Physical removal efforts were carried out by communities in close collaboration with a local NGO (LANESO). The activity also involved members of BMUs, a local CBO with membership in villages where fishing is a predominant occupation (eg. Each of the five villages within Chato ward in Biharamulo district have its own BMU). The WHCC, on its part, provided working tools such as wheel burrows, rakes, safety jackets, cutlasses, forks and other small hand tools. Through such efforts, about 530 strategic sites such as landing beaches, water intake and ferry landing points have been cleared of water hyacinth infestation. However, it is difficult to quantify this achievement in the absence of baseline data to show original number of sites that were heavily infested.

1. At the local level, members of BMU were also trained to conduct regular surveillance of the status of water hyacinth in the lake near their homes and working areas. Reports of new water hyacinth establishments were conveyed to the WHCC through caretakers of WRUs who were also authorized to release weevils at the site if this was deemed to be the action required.
2. Visits made by the consultant to a number of beaches, shorelines and river discharge areas which were previously heavily infested including the Emin Pasha Bay at Chato village in Biharamulo district, landing sites along the beach in Musoma municipality, Mwanza city and Shinembo village in Magu district to be clear and local communities were carrying our their activities without any obstruction (Fig. 2). This observation was also corroborated by villagers and representatives of local authorities in the area who were generally satisfied at the extent of water hyacinth control compared to the situation prior to 1997.
3. However, physical removal, on its own, was not credited with the current level of water hyacinth control that has been achieved . Villagers were quick to point out that the level of control of water hyacinth at the current level is largely due to the introduction of weevils which complemented their efforts on physical removal (see purpose 2 below).

4.2.2 Project purpose 2

Undertake water hyacinth control program based on biological control method to reduce the water hyacinth infestation to manageable levels

Expected Project outputs

1. Aquatic systems of the region free from adverse effects of water hyacinth
2. Mass rearing capacity for bio-control agent established and made operational

Extent to which project purpose has been achieved

1. The strength of the WHCC activities lies in its application of IPM approaches incorporating both physical and biological control methods and the latter is the cornerstone of the success recorded in the fight against the weed. Physical methods, particularly manual removal, were significantly complemented by biological control methods based on the destruction of the weed by two species of beetles; *Neochetina eichhoeniae* and *N. bruchi.* The weevils were suppled by IITA at their Cotonou center in Benin (West Africa) and reared at the NBCC located at the ARI, Kibaha (Coast region). Collaboration between the WHCC and the NBCC continues to-date as the latter still maintains the parent stock of the weevils for purposes of multiplication.

2. Twelve (12) WRU (5 in Mwanza region, 3 in Mara region and 4 in Kagera region) were constructed and made operational (Fig 1) while two newly constructed WRUs at Nyakalilo in Sengerema district and Rubafu in Bukoba rural district are not yet operational. The weevils are reared in 500-litre plastic water tanks cut open at the top. Each of the WRUs is fitted with a minimum of 24 to a maximum of 50 such tanks. Most of the WRUs are located within communities either within primary school compounds or on land allocated by village authorities. All the WRUs visited were in good working condition.

3. The WHCC staff estimate that between the time of inception of weevil rearing activities, in the Lake Victoria area, in June 1998 and June 2005, approximately 200 million weevils have been multiplied and released onto 93 affected areas of the lake basin.

The integrated approach to water hyacinth control and in particular, the biological control component, is greatly credited for reducing the water hyacinth coverage by 80% compared to the weed coverage as of 1998.

4.2.3 Project purpose 3

Involve communities in both physical (manual) and bio-control of water hyacinth

Expected Project output

A well informed community that participates in the management of water hyacinth

Extent to which project purpose has been achieved

1. All the communities visited during the study were well aware of problems associated with water hyacinth and activities being undertaken by the WHCC in combating the weed. The communities did participate in the physical removal of the weed. The community representatives who participated in discussions during the site visits, acknowledged awareness about activities going on at the WRUs and appreciated the role of the 'insects' (weevils) in bringing down water hyacinth population in their areas. However, it was also evident that community participation in the day-to-day running of the WRU has been limited. Village governments identified appropriate locations for the WRUs and allocated village land for that purpose and also nominated, from among its inhabitants, a caretaker to work with the WHCC staff. Once these basic requirements were fulfilled, the WRU caretaker communicated directly with the WHCC and were not obliged to report progress to the village governments.

2. One would have expected, for example, that at this time when WHCC activities are nearing conclusion, the village government through its chairperson or VEO would have already taken charge of all activities connected with the running of the WRUs. To the contrary, 10 out of 12 functional WRUs and are still directly managed by WHCC. The exceptions are Shinembo WRU (Magu district) which has been handed over to LANESO and Buyagu WRU (Sengerema district) which has been handed over to the local community. During focal group discussions, the village participants generally felt that the management of WRUs is vested within the WHCC and hence it was expected that WHCC would continue to run the WRUs for as long the WRUs

are needed . This notion is re-enforced by the fact that the caretakers of WRUs are paid employees of the WHCC and they are answerable to the WHCC management. from discussions with community representatives at Kyaka, Chato and Shinembo villages, the general impression derived was that:

- The WRUs '*belonged*' to the WHCC, and
- Communities are not prepared to take over management of WRUs partly because they were not aware that they would have to take over WRU activities and/or they lack the necessary financial resources to keep a WRU operational. It implies, therefore, that communities were not informed about this expectation right from the beginning of the activity

3. The arrangement of having a caretaker on the payroll of the WHCC partly alienated the village authorities and other members of the community from full participation in the activity. I was informed, for example, that whereas a boat for moving weevil inoculated plants from the WRU to sites of release in the lake could be available free of charge, all caretakers indicated that they have no choice other than to motivate a few colleagues with token payments to offer assistance with weevil release to affected areas.

4.2.4 Project purpose 4

Monitor water hyacinth distribution and identify its effects on the environment and the communities around the lake Victoria

Expected Project outputs

1. Distribution and abundance of water hyacinth in Lake Victoria monitored using aerial and ground surveys at regular intervals
2. Impact of water hyacinth infestation and the control strategies established at regular intervals
3. Socio-economic impact of water hyacinth infestation determined at regular intervals

Extent to which project purpose has been achieved

1. **Ground and aerial surveys** - Several ground and aerial surveys of water hyacinth distribution and coverage have been carried out in the Lake Basin area. The last intensive ground survey carried out in October 2003, revealed the proliferation of the weed in specific locations of the lake, and rivers flowing into the lake. There are 17

such areas which are regarded as the water hyacinth "hot spots" found in certain bays, gulfs, river and lake shorelines and lake-river inter-phase areas in all the three regions.

2. **Surveillance for water hyacinth** - In the WHCC Interim Completion Report (1997/98 – 2004), it has been reported that 'a network of stakeholders has been identified for reporting any changes in water hyacinth infestation levels'. A total of 47 data collectors from Mwanza, Mara and Kagera regions incorporating collaborators from NGOs and CBOs have been trained to undertake the surveillance. Reporting is done through a protocol developed by the WHCC staff of Kenya, Uganda and Tanzania. For its use in Tanzania, the protocol has been translated into Kiswahili "*Dodoso la Ukusanyaji wa Takwimu Ngazi Ya Wananchi*" which is attached here as appendix 5. The Consultant was also informed that the Regional Surveillance System for water hyacinth has been developed though it has not been made operational.

   In villages where BMUs exist, members of these CBOs have made it their responsibility to report on new arrivals of water hyacinth in order to alert the villagers as well as the WHCC so that appropriate actions can be taken. Reports of new arrivals and extent of coverage of the weed are similarly reported using the same reporting protocol (Appendix 5)

3. From stakeholders' testimony in the locations visited, great appreciation was expressed on the benefits derived from arresting water hyacinth proliferation. Four major socio-economic impacts were frequently cited in most of the villages visited. These are;

- fishing as a viable occupation regained its original glory following clearing and/or reduction of water hyacinth population,
- opening up water points and availability of 'clean' water for domestic and other uses,
- decline in disease incidences, and
- decline in accidents from encounters with wild animals (snakes, crocodiles, hippos, etc) which often took cover under thick water hyacinth mats.

4.2.5 Project purpose 5

Undertake capacity building at community and national levels in aquatic weeds management

Expected Project outputs

1. Well trained staff in place
2. Capacity of local communities and other beneficiaries in water hyacinth control improved

Extent to which project purpose has been achieved

1. The academic standing of the core WHCC staff is one PhD, two MSc, 2BSc and one diploma. WHCC core staff trained through the component include one staff currently undertaking studies leading to a PhD and two other staff who were trained and completed MSc degrees. The third MSc sponsored through the WHCC was undertaken by a collaborator from the local governement and is not a core staff of WHCC. The core staff has also participated in numerous national and international meetings as well as study tours which have all helped widen the staffs' understanding of water hyacinth and aquatic weeds in general. However, given the magnitude of the water hyacinth in the lake area and the distances involved, the staff available can hardly cover the vast target area in the Lake basin.

2. Efforts to engage communities in formal training were limited. A summary drawn from data provided in the Interim Completion Report and other sources indicate the training targeting local communities was as follows:

- Two persons, in each village or location where a WRU is placed, was trained on care and maintenance of WRU, weevil rearing, weevil release techniques and related activities. One of those trained was eventually recruited as caretaker for the BMU within their village
- Only one out of five (20%) study visits made, was devoted to local community participants in which 28 people participated in a study tour to Kenya and Uganda
- Two out of 15 (about 13%) awareness workshops/seminars and meetings facilitated by the WHCC, were organized specifically for local communities
- 47 data collectors were trained on surveillance of water hyacinth

3. On public awareness and information dissemination, the WHCCs' accomplishments are quite impressive based on the production of a variety of publicity materials, the most

significant of which include 10 radio programs, 6 TV programs, 10 articles in newspapers, 2 posters, and awareness campaign workshops involving at least 400 persons. However, in the absence of any specific studies on the influence of these publicity efforts, it is difficult to determine to what extent these publicity materials have impacted on water hyacinth control in the Lake Basin and Tanzania in general.

4.2.6 Project purpose 6

Undertake water hyacinth control programme based on enforcement of water hyacinth regulations

Expected Project outputs

1. Implementable water hyacinth quarantine regulations in place
2. Behaviour change of people on spread of water hyacinth to un-infested areas

Extent to which project purpose has been achieved

1. As an extra measure to curb further introduction and spread of water hyacinth in Tanzania, the WHCC played a major role in instituting the "***Plant Protection (Control of Water Hyacinth) Rules***" which were gazetted on 30th November 2001. These rules were made in accordance with Section 3 of the Plant Protection Act of 1997. The rules state, among other things, that '*No person shall import, plant, grow or propagate water hyacinth in Tanzania*'. These rules are well elucidated but the extent to which these rules have so far assisted in curbing the proliferation of water hyacinth in Tanzania is not yet documented. Under these rules, 23 districts in mainland Tanzania, including 15 districts in the Lake Victoria area, have been declared 'Quarantine districts'. Enforcement of the rules is expected to contribute to peoples' behavior change on water hyacinth spread.

2. The rules are not likely to bring significant change in the manner in which water hyacinth is introduced into lake Victoria due to the following facts:
    - It is documented that most of the new introductions of water hyacinth into the Lake float over river Kagera which originates in Rwanda. Rwanda is a sovereign country and not bound to observe the Plant protection (Control of Water Hyacinth) Rules. River Mara (shared with Kenya) is another source of

water hyacinth infestation into the Tanzanian side and Kenya is, like Rwanda, not bound by the same rules.

- Water hyacinth is a free-floating aquatic weed which implies that the weed can move on its own without necessarily being assisted by human activities.
- Enforcement of such rules over a vast area requires considerable physical, financial and human resources. Since inception in 2001, there is no documented evidence to indicate to what extent the rules are being observed. On the contrary, water hyacinth is now observed to have spread beyond its traditional habitat (the lake and its adjoining rivers) into ponds which were previously clear of the weed.

Rwanda being the source of river Kagera requires more attention and inclusion into future activities targeting water hyacinth and other aquatic weeds. Rwanda is not a beneficiary of LVEMP and may therefore not have the necessary motivation to enforce the required measures against water hyacinth. Initial contacts with the authorities in Rwanda have been made but her long term commitment to the control of water hyacinth is yet to be determined. Future activities should consider including Rwanda as a partner.

5.0 LESSONS LEARNT, CHALLENGES AND KEY EMERGING ISSUES

The WHCC interventions were geared towards 'sustainable management of water hyacinth through integrated pest management'. On talking to stakeholders both at district and village level, there is a great sense of relief and satisfaction that the interventions undertaken by the WHCC have been their 'savior' and have made it possible, to once again, engage in activities that had become impossible prior to the WHCC activities prior to 1997. Thus, to a large extent, stakeholder expectations of reducing the water hyacinth population to manageable levels have been met. Based on the what the WHCC has implemented in the area and reported in various documents, discussions with stakeholders and observations of some of the field activity sites, the lessons learnt are based on impressions developed from information made available to the consultant. Important lessons are drawn on best practices, experiences gained, challenges for the future and issues emerging as a result of the WHCC engagement in the area since 1997.

5.1 BEST PRACTICES

5.1.1 Project introduction into target areas

At the initial stages of WHCC activities, the project team selected activity sites and made visits to the sites, through the district offices, to make initial contacts first with the local leaders and later on with communities at large. These contacts helped communities understand the significance of the interventions for their own livelihood and environmental status of the Lake area in general. Hence the WHCC did not encounter resistance from communities and Communities actually participated in water hyacinth control activities particularly in manual removal of the weed.

5.1.2 Applying science for management

The success of water hyacinth management program in the lake area has been the adoption of IPM as a strategy with a strong component of biological control using two weevils species. The weevils (*Neochetina eichhorniae* Warner and *N. bruchi* Hystache) currently used in biological control activities in the Lake area and elsewhere in Tanzania, have been used world-wide for similar activity. IPM approaches are generally preferred to single method approaches, and in this case, the use of biological methods has made significant contributions towards reducing the impact of the water hyacinth thus contributing towards restoration of the Lake basin environment, biodiversity and livelihoods of the majority population in the area. In the process, a number of positive aspects that can be extended elsehere have emerged. These include the following:

- The IPM package adopted; a combination of physical removal and biological control with natural enemies, is an environmental friendly approach that does not bear the negative effects of pollution as would have been the case if chemicals were used. The inclusion of biological control in the package also ensures sustainable control over a long period of time since the bio-agents, once introduced, can sustain themselves over time.
- Biological control is an approach that can be used safely to control aquatic weeds growing in other water bodies, including water bodies that are used as sources of water for domestic use or for livestock
- Installation of WRUs at village sites was a plausible idea which has helped improve the understanding of the local communities what biological control is all about, and hence increased stakeholders' willingness to appreciate the use of the method.

- The fact that the bio-agents successfully cleared heavily infested areas using biological methods supplemented by manual removal is testimony of the significance of applying 'science for management'.

The introduction of the weevils into the Lake area has gone hand in hand with further research to address other specific issues as they emerged. For instance, additional research activities initiated in 2003 looked at the effect of silt on weevil establishment and performance in river Kagera and the effect of nutrients on establishment of the weevils. Research of this nature is considered crucial in helping to improve our understanding of the behavior of the weevils used for the purpose of improving performance in the entire ecosystem

5.1.3 Documentation of research results

Results of research work have been presented in national and international workshops. In addition, the results have also been documented in workshop Proceedings (eg The LVEMP – Tanzania 2001 Scientific Conference held in Mwanza, Tanzania, Global Working Group for the Biological and Integrated Control of Water Hyacinth held in 2000 in Beijing, China), thus contributing to knowledge and exposing the water hyacinth problem in Tanzania to the rest of the world. Documented research results from the WHCC research work are summarized in (Appendix 4)

5.1.4 Capacity building

The WHCC staff composition is comprised of Tanzanian nationals. This team has been working in close collaboration with other staff at district level. Through involvement in the WHCC activities, a lot of capacity has been built, from within, on understanding the biology, ecology and management requirement for water hyacinth which could be of use when tackling other aquatic weeds within the Lake Basin.

5.1.5 Legislation

Having legislation against the proliferation of water hyacinth, or for that matter any weed, is an additional step towards reducing the manifestations of the weed. The WHCC facilitated the enactment of the "***Plant Protection (Control of Water Hyacinth) Rules***" which were gazetted on 30th November 2001. These rules were made in accordance with Section 3 of the

Plant Protection Act of 1997. The rules state, among other things, that '*No person shall import, plant, grow or propagate water hyacinth in Tanzania*'. If enforced, this legislation can help reduce water hyacinth infestation in the area. This 'best practice', however, comes with the challenge of enforcement. For the legislation to be effective, it must be enforced by the rule of law.

5.2 EXPERIENCES

5.2.1 Allocation of responsibilities

Even though communities were contacted from early on, the roles of the communities were not clear to the communities themselves and a particular point in mind is the role of the communities in the management of the WRU, a key ingredient to continued control of water hyacinth using biological methods. What we have experienced from the current set up is that participatory planning is essential to successful project implementation during project life and beyond. In the planning process all issues including technical, financial, socio-economic and cultural as well as allocation of responsibilities should be considered

5.2.2 Impact of the WHCC interventions in relation to the lake basin environment, community livelihood and stakeholders expectations

Prior to commencement of activities, water hyacinth was the single most dominant aquatic weed in the Lake and its adjoining rivers, which seriously affected other biodiversity (plant and animal) and resulted in the stoppage of various activities. A study which assessed the effect of water hyacinth on the socio-economy of Riparian communities revealed that some basic activities such as fishing and accessing water for domestic use could not be implemented due to water hyacinth infestation. Small-scale fishermen and women depending on small manual-operated boats had to abandon this activity in some areas, due to excessive water hyacinth growth on landing sites and beaches, resulting in loss of income. The introduction of weevils through 92 release sites has helped to reduce the water hyacinth populations in many parts of the Lake and making it possible to resume fishing activities.

Experience: The WHCC interventions have helped restore the fishing industry, which employs a considerable population of the lake Basin and supports the livelihood of both rural and urban households either directly or indirectly.

5.2.3 Techniques for surveying water hyacinth

From the results obtained using different survey techniques, the use of aerial survey to estimate water hyacinth was useful in providing information on the general cover. However, there are some uncertainties as to the accuracy of aerial surveys in as-far-as distinguishing between water hyacinth and other aquatic weeds in the final output. Furthermore, water hyacinth has the tendency to break into islands which then float away, making it difficult to relate survey results with the actual situation at a later time. There is need to encourage more interaction between experts in aerial surveying with the WHCC practitioners in order to resolve the questions being asked. Nevertheless, the nature of the water hyacinth biology and ecology require that surveys are conducted on a regular basis in order to obtain near-accurate estimations of the lake cover by water hyacinth.

5.3.4 Differential perception of importance of water hyacinth

At the beginning of WHCC project activities, communities residing and conducting agricultural and other activities along the rivers did not have the same perception of water hyacinth as a serious weed. The general perception was that the water hyacinth was a problem 'in the lake' and was therefore a problem for the communities which depend on the lake for their economic activities rather than the rivers which eventually discharge into the lake. Through efforts by the WHCC to raise awareness on the water hyacinth, using various media, the original perception has been corrected to the extent that communities that depend on river water and those which depend on water from the Lake view water hyacinth as a problem for both communities. Unpublished data from a socio-economic assessment of water hyacinth in the Riparian districts of Kagera, Mwanza and Mara conducted in 2001 by Onyango, *et al*. showed about 80% of respondents drawn from communities along the lake and rivers indicated to have been affected by water hyacinth.

5.3 CHALLENGES

5.3.1 Re-surgence of water hyacinth especially along river Kagera

Despite the efforts devoted to the control of the water hyacinth, fresh establishments of water hyacinth continue to be cited. Even though river Kagera is estimated to contribute only 7% of the total water inflow into the Lake, this river is believed to be the major source of water hyacinth re-infestation in Lake Victoria. Estimates indicate that about 2.0 ha equivalent of water hyacinth vegetation floats along river Kagera in the form of floating masses of weeds (islands). River Kagera originates in the highlands of Rwanda and flows along the Tanzania-

Burundi border before finally discharging into Lake Victoria. In addition, water hyacinth re-establishment has also been noted on other rivers namely Mara, Kanoni and Kahororo which also discharge their waters into Lake Victoria .

5.3.2 Large water hyacinth seed bank

New populations of water hyacinth are frequently observed to establish themselves on mud deposited on the Lake shores and river banks when water levels fall. These new populations are later on swept back into the Lake or river when water levels rise again during rains. The implication is that there is a large water hyacinth seed bank in the mud on shorelines which replenishes the population on the lake waters on a regular basis. Given the fact that the seed of water hyacinth can retain viability for 15-20 years, the seed bank which is being replenished annually is a great challenge to current and future attempts to control water hyacinth.

5.3.3 Poor weevil establishment on water hyacinth growing in rivers

It has been observed that establishment of weevils on water hyacinth infesting rivers is poor compared to establishment of weevils on water hyacinth growing in the Lake itself. In their research activities, the WHCC scientists have observed that weevil establishment on water hyacinth established on muddy shores is very poor which implies most of the water hyacinth plants established on muddy shorelines are swept back into the lake or rivers without any established weevils on them. Consequently, the overall success of biological control is reduced and this a challenge for any future activities in the area. The poor weevil establishment on rivers such as Kagera and Mara generally hampers the rate of success in the Lake as fresh input of water hyacinth from the rivers into the Lake is discharged from these two rivers without any colonizing weevils.

5.3.4 Agricultural activities on river banks – nutrient enrichment

Currently there is a lot of crop cultivation along river banks and very near the beach on some parts of lake Victoria. On the visit to Kyaka village, we observed crop production activities along all workable riverbanks of the Kagera (see Figures 3). During the field visits we also observed livestock leaving the beach at the Emin Pasha bay in Chato village after being brought to drink water (see Figure 4). Both activities are potential sources of nutrients entrance into the water either as industrial fertilizers or decomposing crop residues, the latter often pushed back into the lake water and left to rot thus facilitating the proliferation of water

hyacinth. The water hyacinth is very responsive to nutrients (especially nitrogen and phosphorus) and high growth rates are always associated with eutrophic, nutrient-rich conditions (CABI, 2003). Agricultural activities are a challenge not only for water hyacinth control but also for soil and water management in general

5.3.5 Enforcement of Plant Protection (Control of Water Hyacinth) Rules

The piece of legislation declaring water hyacinth a quarantine weed apply only to Tanzania. In view of the discussion presented in section 5.3.1 on the role of the Kagera river, the rules have placed a lot of emphasis on restricting the movement of water hyacinth through human activities. This, notwithstanding, the consultant did not observe any signboard warning the general public, as required by the Rules [Part 3 Section 13 (2)], at any of the beaches and shorelines visited.

As discussed in section 5.3.1, river Kagera which originates in Rwanda is an important source of water hyacinth conveyance into the Lake. Rwanda is a sovereign country and not bound to observe the Plant protection (Control of Water Hyacinth) Rules. River Mara (shared with Kenya) is another source of water hyacinth infestation into the Tanzanian side and Kenya is, like Rwanda, not bound by the same rules. The challenge ahead is to widen the scope in which the rules are applicable by convincing the Rwandese authorities to share the same vision as that of Tanzania (and Kenya and Uganda) so that it would be possible to join forces in the fight against water hyacinth and other aquatic invasive weeds in future.

Since the legislation was past only recently (2001), it is too early to tell whether there have been any significant changes, in the manner in which water hyacinth is introduced into lake Victoria. The following factors are additional challenges in relation to the Rules:

- Water hyacinth is a free-floating aquatic weed which implies that the weed can move on its own without necessarily being assisted by human activities.
- Enforcement of such rules over a vast area requires considerable physical, financial and human resources. Since inception in 2001, there is no documented evidence to indicate how the rules have helped make water hyacinth control activities easier.

5.3.6 Sustainable financing for water hyacinth control activities

The financing of WHCC is almost wholly donor-dependent. The central government and the local authorities made contributions in kind by providing office space and paying salaries for

MAFS and district staff working under the WHCC. It can therefore be concluded that the WHCC activities are almost wholly funded by donor funds through LVEMP.

Attempts were made to determine the current thinking, at district level and village level, on plans for sustaining WHCC activities in the event the LVEMP came to a conclusion. The general thinking was that 'it is about time' to start planning for such eventuality. Which implies that the stakeholders have not yet taken any steps to institutionalize water hyacinth control activities within the district/regional operational plans. Amongst the districts visited, none has set aside a budget line item for WHCC activities for the current financial year (2004/05) which just got under way. Furthermore, at the village level, the lack of preparedness to take over WHCC activities was evident as stakeholder representatives who participated in the discussions were surprised to learn that LVEMP activities were about to be concluded and openly wondered on what would happen next – 'another LVEMP'?.

The challenge ahead is for the districts to come up with a mechanism for sustainable financing to support water hyacinth control and aquatic weed control, in general. Almost all activities implemented so far have been funded by donor funds and central government (counterpart funds). For long term maintenance of the environment in the Lake area and other aquatic systems, mechanisms must be put in place by the GoT, at national and district level, to support research and extension activities.

5.4 EMERGING ISSUES

5.4.1 Increase in incidence of other aquatic weeds

In addition to water hyacinth, the other commonly observed aquatic weeds in the area are presented on Table 1. The reduction in water hyacinth populations is evident in many locations that we visited. In a mixed weed species situation, weed succession is a common phenomenon if control methods applied target only a specific weed species. In the case of WHCC, only water hyacinth was targeted. Hence The reduction and/or elimination of water hyacinth has given way to other, previously minor, weeds to flourish in succession to water hyacinth. Other invasive aquatic weeds are taking the space left open by water hyacinth and/or sometimes growing together with water hyacinth (see Figures 5). Other weeds such as *Trapa natans* (Figure 6) which is usually submerged, may not be noticed until it has reached alarming proportions. Generally, however, whether growing on the Lake or river, weeds facilitate excessive water loss through evapotranspiration from leaf surfaces. In satellite

ponds and other isolated water bodies, weeds such as *Azolla* form a complete cover of the water surface limiting access to users and creating unfavourable conditions for other organisms below the water surface. Such satellite water bodies, possibly also serve as weed seed banks for re-infestation of the Lake.

Immediate actions are required to mitigate the actions of invasive species as soon as they are noted. Informed decisions on appropriate mitigating factors should be made using scientific knowledge on growth, development, reproduction and survival mechanism of any such invasive species.

Emerging issue: In future, aquatic weed control should take an ecosystem approach which would consider the likely changes in the weed species composition and ecosystem balance when subjected to certain interventions. For example, it is known that in a mixed population of weeds, any interventions that target one or two weed species would allow succession by other, previously minor weeds, to take over.

5.4.2 Search for complementary/alternative bio-agents

Water hyacinth is characterized by fast growth compared to slow-acting nature of the bioagents used in biological control activities. Water hyacinth is a fast growing plant which is favoured by optimum temperature for its growth in the range of 25-30^{o}C which is prevalent in the Lake Basin area. World wide data summarized by CABI (2003) indicates that water hyacinth is capable of increasing in biomass by up to 12% per day and double in number in 6 to 15 days. Research results reported by the WHCC (Proceedings of the LVEMP – Tanzania 2001 Scientific Conference), indicated that it took up to 7 months of weevil feeding to reduce the water hyacinth from an average 90 plants/m^2 to 15 plants/m^2. At this slow rate of water hyacinth destruction by the weevils compared to its fast growth rate and productivity estimated at 1000-5000 kg/ha per day or 400-1700 t/ha per year.

Emerging issue: the weed multiplies at a much faster rate than it is being destroyed by the weevils creating an imbalance in favour of continued proliferation. Current collaboration between WHCC and colleagues in Uganda and Kenya on the search for additional, and hopefully more efficient, bio-agents to complement the two weevil species currently used should be intensified

5.4.3 Role of central and local governments

The central government was the major implementing partner through MAFS. On the other hand, normal extension activities are administered at district level. The activities carried out by the WHCC were almost wholly funded by finances to LVEMP from the World Bank and the majority employees of WHCC are paid by LVEMP. The lifespan of the WHCC is depended on the existence of LVEMP as a project, which like other projects, has a limited lifespan. Even though a lot has been achieved through activities of the WHCC, the water hyacinth problem is not over yet and that, in addition, there are threats of other invasive aquatic weeds. The roles of central and district governments, in conjunction with communities, should be to sustain the momentum initiated through WHCC activities.

Emerging issues:

i) Sustainable management of the Lake Victoria ecosystem is a long-term undertaking that requires long term commitment from the central government and local governments in the area.

ii) Water hyacinth control should be institutionalized into the district extension system – this would require extensive sensitization and training of the extension workers in the area. Collaboration with CBOs and NGOs should be sought where this is possible.

iii) Central legislation on control of water hyacinth should be reviewed on a regular basis to include newly infested area. The legislation can be enhanced by enactment of community by-laws.

5.4.4 Research and training needs

Research needs fro the future can be derived from what is happening today. It is a known fact that biological control methods are sustainable, over the long term, but characteristically, they are slow acting methods or methods with a long incubation period. When dealing with a fast growing weed such as water hyacinth, which is an annual and yet able to reproduce both sexually by seed and also asexually by stolons, the problem of the weed is magnified several folds. In addition, there is the dimension of nutrient loads being introduced by agricultural (crop production) activities very close to the Lake shore and/or river banks, particularly along river Kagera.

Emerging issues:

1. **Research** needs for the future would require a comprehensive approach to the entire Lake Basin ecosytem, incorporating other satellite water bodies, where the water hyacinth and other aquatic weeds have begun to establish and are likely to spread to other water bodies outside the Lake basin area. Specific areas of research for the future need not only focus on scientific issues, rather, the research should include studies on other socio-economic conditions that may have a bearing on how communities respond and participate in any introduced interventions, Illustrative examples are given hereunder:
    - Aquatic weed mapping on riverine and lake ecosystems
    - Partnership roles (central government, local government, communities and NGO/CBOs) in aquatic weed management
    - Sustainable financing mechanism for aquatic weed management
    - Studies on biology and ecology of the weevils to determine threshold weevil populations for effective control including environmental factors affecting weevil reproduction and establishment

2. **Training:** For research results to be used effective, the findings have to be effectively disseminated to the general public. Such research results should be translated into training material, for other stakeholders in the ecosystem (extension, communities, policy makers). Training modules whould have a wide coverage with a bearing on the ecosystem rather than targeting a single component. Possible areas of training could include sustainable land and water resources management, aquatic weed management and environmental degradation. Efforts to produce mass communication training materials (radio programmes, posters, leaflets and newsletters should be contiued

5.4.5 Monitoring of invasive species

Initiatives to control the water hyacinth came into effect in 1997/98, with the onset of WHCC through LVEMP, about seven years after the first reporting of the appearance of water hyacinth in Tanzania in 1990. Efforts to control water hyacinth were not initiated until the weed had gotten out of control and was threatening the livelihood of millions of people in the Lake Basin area. Based on the experience with the water hyacinth, changes in biodiversity of Lake Victoria should be monitored on a continuous basis.

Emerging issues:

1. The significance of any **new introductions of invasive plant** or animal species should be determined as soon as the new species is observed to guide policy makers and the communities alike, on appropriate actions to preventing such invasive species getting out of hand.
2. The **national surveillance** systems' mandate should be expanded include surveillance of aquatic weeds in general. To completer national efforts the regional surveillance system should be made operational to facilitate exchange of information.

5.4.6 Sustainability of WHCC interventions in the Lake Basin

5.4.6.1 Control interventions:

The efforts directed at reducing the infestation level of the original target weed (water hyacinth) have been successful, to a large extent, but the threat from the weed has not been eliminated. The remaining 20%, which looks like a small figure, is a in real terms quite a formidable task that remains to be done. The ability of the weed to float freely on water surfaces implies that the weed does not recognize any borders. Hence future efforts at combating the weed must go beyond the East African boarders to include other countries such as Rwanda, where water hyacinth is known to occur where the Kagera originates. A recent survey by the WHCC also revealed at least 17 other water bodies heavily infested by water bodies.

The WHCC adopted an IPM approach combining manual removal with biological control. Sustainability of WHC implies maintaining the activities being implemented at their current level over an extended period in the future. In the long term, therefore, the sustainability of WHCC activities will be judged by whether the WHCC left behind an institutional setup that can implement water hyacinth control activities at the current or higher level.

To sustain the introduced interventions, some of the **emerging issues** are as follows:

- **Stakeholder ownership** - communities should be empowered to participate in all stages of activity implementation and hence able to implement the interventions on their own and would sustain the initiated activities even after, the project comes to close;
- Water hyacinth control activities should be **integrated/institutionalized into the local extension** system (now operated at district level);
- **Sustainable financing mechanism** is put in place at the grass-root level (village and district level) to cater for water hyacinth control activities It follows, therefore, that particular attention must be paid to personnel, institutional setup and financing.

Hence, there must be political commitment to allocate the necessary physical, human and financial resources for water hyacinth control and other relevant activities, public awareness and enforcement of existing legislation

5.4.6.2 Personnel and institutional setup

The core staff for the WHCC are comprised of five persons; the Coordinator, a senior employee of MAFS, who oversees activities implemented on the ground by three other staff, three stationed at the Mwanza office and one at the Bukoba (Kagera region) office. Apart from the Coordinator only one of the four core staff members is paid by MAFS while the other three are employed and paid by LVEMP. This level of staffing, at most, provides only a small proportion of the personnel requirement for a problem of the nature of an invasive specie. At the district level eg Musoma and Bukoba districts, only one person each has been assigned (by the district authorities) to work with the WHCC team. At the village level, only one person was trained in techniques for weevil rearing and general maintenance of a WRU. During discussions both at Chato and Shinembo villages, villagers were not clear as to how and/or whether they were expected to take charge of the WRUs in their locations. These events seem to suggest lack of concerted efforts, at the district and village level, to create a critical mass of persons well versed with water hyacinth control. The district authorities met at Bukoba and Musoma also confirmed that water hyacinth control activities have never been budgeted for implying a continuation of the current status quo with no plans on taking over WHCC activities in the near future.

Efforts to transfer at least two of the WRU from direct control by the WHCC to communities have been initiated. However, many questions still remain. For example at Shinembo

village (Magu district) where apparently the WRU has been transferred to LANESO (an NGO with head offices in Mwanza), villagers were unclear about the arrangement and it remains to be seen how the arrangement will work out between the village and LANESO. Another WRU at Buyagu village (Sengerema district) has been handed over to communities. It would be of interest to compare the performance of these WRUs under the different management systems without WHCC playing a major role.

Emerging issue: The **roles of the community** and that of the project should be stated clearly at the beginning of the activities, i.e from planning through to implementation and monitoring. Issues of financing of activities during project life and beyond should be clearly sorted out early in the project life

6.0 CONCLUSIONS

6.1 The WHCC has been very instrumental in reducing the water hyacinth population on Lake Victoria but success has been limited for water hyacinth is found infesting rivers and other isolated water bodies;

6.2 Research, along side field activities, made significant contributions towards realizing the WHCC objectives;

6.3 IPM strategies were well received by local communities and have helped reduce environmental degradation in the Lake Basin;

6.4 Other invasive weeds, which are rapidly increasing in population, pose additional threat to the environmental health of the ecosystem; and

6.5 Participation of local communities at all stages of project implementation is crucial for ownership and sustainability of activities initiated under WHCC.

7.0 WAY FORWARD AND RECOMMENDATIONS FOR THE FUTURE

7.1 Research on management of water hyacinth should continue but the coverage be widened to include other aquatic weeds assessed to be of importance to the ecosystem. As a matter of urgency, MAFS and other relevant ministries such as the MWLD, should work out a mechanism to strengthen capacity for aquatic weed research and control.

7.2 The success achieved by employing IPM strategies to manage water hyacinth in Lake Victoria, could be replicated in riverine ecosystems such as rivers Sigi and Pangani where water hyacinth is e present and on other rivers such as Kilombero, where other

aquatic weeds such as water lettuce can be found. A similar approach could similarly be employed to manage aquatic weeds in large water dams (examples – Mindu in Morogoro region and Nyumba ya Mungu in Kilimanjaro region) which are used for supply of water for domestic, industrial, agricultural , fishing and other economic activities and which are threatened by other aquatic weeds such as *Ceratophllum dermesum* and *Typha capensis.* The approach and methodologies could also be extended for application in isolated/scattered water ponds such as the ones found heavily infested with aquatic weeds along the Dar es salaam-Tunduma highway and other parts of the country, which in many cases, are the major sources of water for domestic and livestock use. Weeds such as the water lettuce, water fan and Azolla can be observed in water bodies of this nature.

Integrated pest management strategies, along the lines executed in the Lake Basin, are advocated for replication in these areas because they are environmentaly-friendly, encourage community participation and they are self-sustaining in the longterm provided steps are taken right at the beginning to raise awareness, impart expertise and ensure community ownership of the activities.

7.3 Collaboration between components should be strengthened to facilitate handling of common problems in a coordinated manner. For instance, the problem of nutrient enrichment in the lake and rivers, as a result of agricultural activities, would require close collaboration between the Land use (soil and Water)Conservation Component and the WHCC.

7.4 The tripartite (Uganda, Tanzania and Kenya) agreements on research to identify other more potent bio-agents be pursued and the collaboration expanded to include Rwanda. The regional approach should be continued and expanded to include Rwanda so that water hyacinth can be tackled at the source as well as at the receiving end, i.e Lake Victoria

7.5 Institute multi-sectoral forums drawing experts from agriculture, industry, mining, policy makers and local communities to set strategies to reduce nutrient inflow into the lake

7.6 Installations deemed necessary for project activity implementation, eg the WRUs should, as soon as possible and well in advance of project activity termination, be handed over to communities after sensitization so that communities would have a sense of ownership. Project staff can continue to backstop with necessary technical input.

7.7 Communities be sensitized well in advance on ownership and expectations of project outcomes including division of responsibilities. Due emphasis should be placed on taking responsibilities to manage such installations. However, training mechanisms for generating funds from within should be incorporated into the general training programs.

7.8 Intensify use of 'science for management' with greater collaboration between relevant ministries and departments (eg. MAFS, MWLD, NEMC, DOE), institutions of higher learning (eg. UDSM, SUA) and other institutions be organized into a network such as an '*Aquatic Weed Research Group'* for systematic studies on thematic areas.

7.9 All activities conducted, in the Lake Basin, on water hyacinth and other aquatic weeds conducted should be coordinated at district level in close collaboration with the WHCC to facilitate exchange of information and avoid duplication of efforts.

7.10 Districts should initiate plans to raise own funds and allocate adequate resources (human, physical and financial) for the control of water hyacinth and other aquatic weeds which are now gaining dominancy in the Lake Basin. This effort would require commitment from policy makers.

7.11 Other countries in the region be advised to put in place legislation similar to the Plant Protection (Control of Water Hyacinth) Rules in Tanzania (if this has not yet been done) and the GoT be committed to allocate sufficient resources for enforcement.

8.0 Acknowledgement

Many individuals have provided useful information and views for this evaluation through discussions. Special thanks go to the WHCC staff led by the Component Coordinator, Mrs Katagira, the Task leader, Mr Mjema and the component staff comprised of Dr Ndunguru, Mr Rajabu, Mr Mbwambo and Mr Sombe, The Coordinator of the WHCC and her entire team of scientists from Mwanza, and Bukoba provided mw with a abundant literature and reports on their activities, made arrangements for field visits , accompanied me throughout the field visits in the project area and actively participated in many hours of discussion sharing with me their first hand knowledge of the WHCC activities.

I'm also grateful to all the representative stakeholders and policy makers, in the areas visited, who provided valuable information and insights for the study. These include village leaders and village representatives of Kyaka, Chato and Shinembo villages, the Acting RAS for Mara region and a member of the National Water Hyacinth Steering Committee, the Acting DED for Musoma district, CALDO for Bukoba rural district and the RAA for Kagera region.

All the resource persons, whose assistance made the preparation of this report possible, are listed in Appendix 7 of this report.

I thank you all.

Table 1: Other invasive weeds* found on lake Victoria and rivers banks

Scientific name	**Common name**	**Leaf type**	**Type**
Cyperus papyrus L.	Matende	Sedge grass	Emergent macrophyte
Typha capensis Rohrb	Mahuhi	Grass	Emergent macrophyte
Azolla nilotica	-	Algae	Surface floating macrophyte
Pistia stratiotes L.	Vinete	Broadleaf	Surface floating macrophyte
Trapa natans L.	Sikio la tembo	Broadleaf	Submerged macrophyte
Phragmites mauritianus	Matete	Grass	Emergent macrophyte
Pennisetum purpureum	Elephant grass	Grass	Emergent macrophyte

*A complete list can be derived after a detailed survey

Map 1: Water hyacinth weevil rearing units around Lake Victoria and Kagera river.

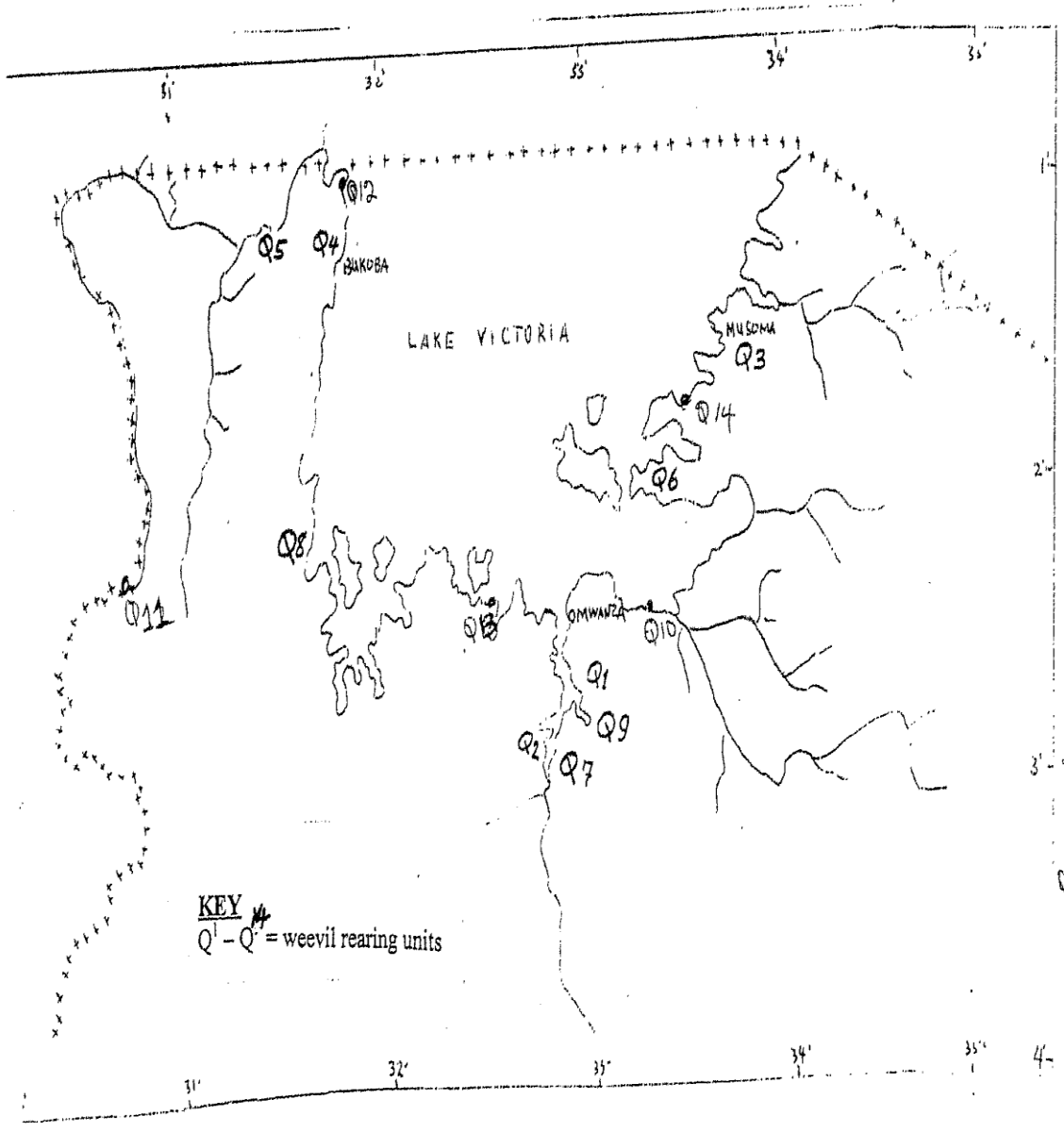

Figure 2a: Weevil rearing facility at Chato village

Figure 2b:Weevils and damage caused on water hyacinth

Figure 2c: Beach on Lake Victoria at Chato village cleared of water hyacinth

Figure 3: Maize plot close to river Kagera bank at Kyaka

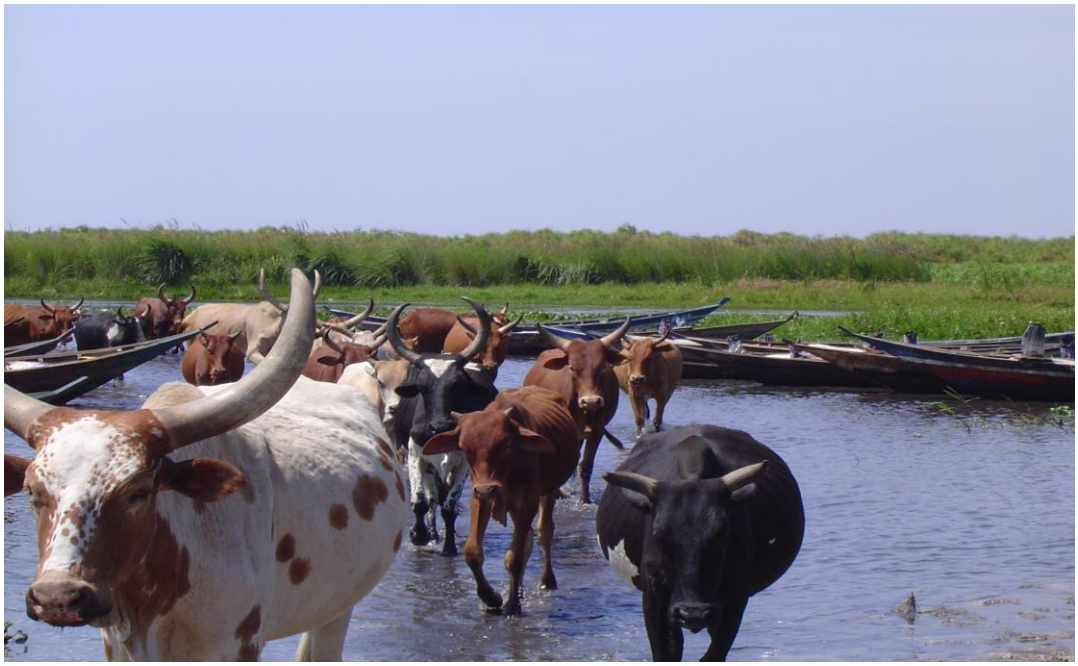

Figure 4: Cattle leaving Lake Victoria beach after watering at Chato village

Figure 5. *Phragmites mauritianus* growing together with water hyacinth

Figure 6: *Trapa natans*, a submerged aquatic weed - Emin Pasha Bay near Chato village

Figure 7: Tomatoes in the forefront and a water pond covered with Azolla in the background

10. APPENDICES

Appendix 1: Terms of Reference

1. Back ground to the project Component

Water hyacinth control component is one of the 10 components of the Lake Victoria Environmental management Project (LVEMP). The component focus on control water hyacinth by reducing the weed to manageable

Excessive proliferation of water hyacinth in Lake Victoria interfered with water transport, biodiversity, fishing activities, water quality and supply and harbours dangerous animals such as hippos, snakes etc. The weed has also caused increased populations of vectors of diseases such as malaria and bilharzias.

Due to the magnitude of the problems caused by water hyacinth it was imperative to arrest further proliferation of the weed and reduce it to manageable levels. Integrated Pest Management (IPM) Strategies were used to control water hyacinth. IPM strategies implemented by the component include: Biological control using two species of Neochetina weevils (*Neochetina eichhorniae* and *N. bruchi*), Physical/manual removal of water hyacinth, quarantine regulations and capacity building. Other control strategies such as chemical and mechanical methods were not used. Chemical method was banned due to its prolonged negative effect on the environment and a mechanical method was due to high cost of buying and operating the machines.

Following implementation of the control strategies the weed has been reduced 80% and normal uses of the lake water resources has resumed. Inspite of this success the component has experienced challenges in the control process. These include: input of fresh water hyacinth into Lake Victoria through river Kagera, re-growth of water hyacinth from seed bank, persistence of water hyacinth in some areas, failure of weevil establishment in riverine systems and infested ponds in the basin.

2. Objectives of the consultancy

Water Hyacinth Control Component is seeking a consultant to prepare a lesson-learnt report in the control of water hyacinth in Lake basin since 1997 at the beginning of the control

efforts. This report will provide background information in the preparation of Phase II of LVEMP.

3. Scope of work (Specific tasks)

- **i.** Review the extent to which the component has achieved its objectives
- **ii.** Assess the project implementation strategies and approaches
- **iii.** Review achievements made by the component (use output/outcome indicators)
- **iv.** Assess the impact of the component in relation to the lake basin environment, community livelihood and stakeholders expectations
- **v.** Assess sustainability of interventions in terms of personnel, equipments, institutional setup and financial issues
- **vi.** Review problems encountered in the implementation of component activities
- **vii.** Produce lesson learnt report derived from project implementation strategies, approaches, achievements and challenges
- **viii.** Propose possible areas of replication of the approaches, methods or technology to other areas within or outside the Lake Basin and why
- **ix.** Review the occurrence of other invasive aquatic weeds
- **x.** Revisit water hyacinth research need and review other research issues
- **xi.** Propose for further studies/training
- **xii.** Prepare a presentation to water hyacinth control

4. Methodology

The consultants will;

i) Carry out desk review of the available information
ii) Interview key persons
iii) Conduct field visits
iv) Produce an inception report
v) Present the report
vi) Undertake the main task of analyzing the collected information
vii) Submit draft final report for comment
viii) Submit the final report

ix) Present the final report to a National stake holder meeting

5. Time frame

The consultant shall prepare a time frame of all activities with a maximum of thirty (30) days.

6. Outputs and deliverables

The expected output shall be:

4 Inception report

5 Draft final report

6 National workshop report

7 Final report

7. Qualification/experience

- Minimum qualification is MSc. in relevant disciplines e.g. environment science, weed biology, agricultural entomology etc.

Appendix 2: Checklist

1. What is your general opinion about the water hyacinth component
2. What was the situation of water hyacinth prior to 1997
3. What do you know about the water hyacinth control activities taking place in your area
4. How did you get involved in water hyacinth control activities
5. What is your role in the water hyacinth control activities
6. What changes have occurred as a result of the activities of the water hyacinth control activities in your area (at community/village/district/regional level)
7. What do you consider as the major impact of water hyacinth control activities
8. Can you mention up to 5 major benefits to your community as a result of the activities related to water hyacinth control
9. Can you mention up to 5 major problems against activities targeting control of water hyacinth
10. If the activities were to wind up now, would you be able to carry out the activities on your own? - sustainability
    - do you have the personnel
    - equipment
    - have the activities been institutionalized
    - can you meet the financial requirements?
11. What is your overrall opinion about the water hyacinth control activities in your area

    (attempt to find out if communities generally have a positive view or negative view?)
    - approaches used
    - implementation strategies
    - participation (by gender)

12. If this activity were to be continued in your areas, should it be done in the same way or what should be changed?
    a. what should be improved,
    b. what should be removed
    c. what new should be brought in

Appendix 3: Itinerary for Field Visits

Date	Activity
3rd July, 2005	• Travel by road Morogoro to Daer es Salaam
4th July, 2005	• Fly Dar es Salaam - Mwanza - Bukoba • Drive to Kyaka WRUfor site visits • Discussion with farmers
5th July,2005	• Boat ride to Runkunyu village (Uganda) to visit Kagera river mouth • Discussions with Bukoba CALDO and assistants
6thJuly, 2005	• Drive to WRU at Chato village in Biharamulo district • Visit beach/landing site at Chato Mkuyuni village • Discussion with farmers and representatives of BMU • Visit landing beach at Chato Muungano village • Drive to Mwanza
7thJuly, 2005 (Public holiday)	• Visit Kisorya WRU (Bunda district) with overnight stay in Musoma •
8thJuly, 2005	• Visit Musoma WRU • Discussion with Agricultural Advisor to RAS • Discussion with Acting DED for Musoma district • Visit water hyacinth hotspot along river Mara • Visit WRU at Shinembo village in Magu district • Overnight stay in Mwanza
9thJuly, 2005	• Working session with component staff - re-cap on field observations and site visits • Fly back to Dar es Salaam
10th July 2005	• Drive back to Morogoro

Appendix 4: Publications From Research Conducted by the WHCC Staff

Mallya, G., Mjema, P and Ndunguru, J. 2001. Water hyacinth control through integrated weed management strategies in Tanzania. *In*: Julien, M. H, Hill, M.P., Center, T.D and Ding Jianqing (Eds). Proceedings of the Second Meeting of Global working Group for the Biological and Integrated Control of Water hyacinth. pp: 120-122. Beijing, China, 9-12 October 2000.

Rajabu, C.A., Ndunguru, J., Mjema, P., Katagira, F. 2001. Water hyacinth (*Eichhonia crassipes*) management in Lake Victoria: updates on infestation levels. Regional Lake Victoria Environmental Management Project Scientific Conference. 3rd –7th December 2001. *Book of Abstract* pg. 16. Kisumu, Kenya.

Ndunguru, J., Mjema, P., Rajabu, C.A and Katagira, F. 2001. Water hyacinth infestation in ponds and satellite lakes in the Lake Victoria basin in Tanzania: status and efforts to tame it. Regional Lake Victoria Environmental Management Project Scientific Conference. 3rd –7th December 2001. *Book of Abstrac*t pg. 15. Kisumu, Kenya.

Ndunguru, J., Rajabu, C.A., Mjema., P., Mallya, G., Katagira, F., R. Lugayila and Dohoyi, R. M. 2001. Demonstration of the effects of water hyacinths' weevils (*Neochetina eichhorniae* and *N. bruchi* (Coleoptera: Curculionidae) in the management of water hyacinth in Tanzania. In: Proceedings of the LVEMP- Tanzania 2001 Scientific Conference 6-10th August 2001, BOT Training Institute, Mwanza, Tanzania. Pp.275-282).

Appendix 5: DODOSO LA UKUSANYAJI WA TAKWIMU NGAZI YA WANANCHI

(Kiswahili version) = Water hyacinth surveillance reporting format

1. Taarifa zimekusanywa na :

1.1 Shirika/kikundi husika……..

	Siku	Mwezi	Mwaka		Saa	Mchana/Jioni
2. Tarehe				Muda		

3.Sehemu:

3.1Mahali……Tarafa…….Wilaya……

3.2 Mwalo ulio karibu zaidi……..Kijiji……..Mji……..Soko……

Umbali…… (Katika Kilometa)

4.Mwinuko.

Mita……Toka usawa wa bahari

Nyuzi(Kaskazini…….Kusini…….)kama zipo

5.Eneo lililovamiwa na gugumaji:

Mita za eneo…….Kilomita za mraba……...hektari……

Uwiano wa gugumaji ambalo halisambai na maji……%

Uwiano wa gugumaji ambalo linasafiri na maji/visiwa vinavyoelea……%

6.Ngazi ya kuzaliana:Weka vema

Machipukizi/mbegu: % ya kuchanua maua

Uwiano wa ukubwa-urefu wajani,weka vema

Urefu>sentimeta 60;Ukubwa wa kati sentimeta 40-60;Fupi sentimeta20-40

Uliovia<sentimeta20

Hali ya afya:weka vema

Ulio stawi sana/Wenye afya nzuri/Wakijani

Uliovia /Ulioathiriwa/wa kahawia.

7.Mwelekeo wa upepo……..toa maoni

8.**Mwelekeo wa gugumaji wiki iliyo pita…….**

……..

9.Chanzo cha karibu cha machafuzi/Umbali kwa (km)

Kundi (weka vema) km

Kiwanda cha madawa ….

Kiwanda cha samaki …..

Kazi za usafishaji wa majitaka …..

Nyinginezo,taja……

……..

10.**Kijito cha karibu/Mto na Umbali**

Kijito……..Umbali……..(km)

Kuwepo/kutokuwepo kwa gugumaji (kwenye kijito/mto)

Gugu ambalo halihami……..meta……..

Linalosafiri na maji,lililoletwa na mto.

11.Shughuli za kilimo,weka vema,Elezea……

karibu na ufukwe

kwenye kingo za mto.

Upande wa juu wa mto.

Upande wa chini wa mto.

12.Udhibiti uliochukuliwa(weka vema)

Kibiolojia(kuzalisha mbawakavu)

Kuondoa kwa kutumia mikono

Nyinginezo ,taja…….

13.Kuwepo kwa gugumaji na kusambaa kwa muda.

Taja maeneo ambayo gugumaji limeonekana Leo……. Wiki iliyopita…….. Mwezi uliopita…….
14.Kuwepo kwa gugumaji kwa kipindi kirefu Ni kipindi kipi cha mwaka gugumaji linakuwepo,taja miezi
15.Kiwango cha athari ya uvamizi wa gugumaji Nikwa muda gani gugumaji limekuwepo,na ni kwa vipi limeathiri shughuli za uchumi?

KWA MATUMIZI YA OFISI

16.Takwimu zimewakilishwa: Tarehe…….mwezi…….Mwaka

Afisa aliyepokea:…….

Cheo ……

Sahihi……

Appendix 6: References and Other Documents Consulted

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3. CABI. 2003. Crop Protection Compendium. 2003 Edition. CABI International

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13. URT (United Republic of Tanzania). Population and Housing Census. 2002. General Report. National Bureau of Statistics. Government Printer. Dar es Salaam. Tanzania. 203 pp.

Appendix 7: List of persons Met for Discussions

PERSONS	GENDER	POSITION/LOCATION
Peter Mjema	M	Task Leader, WHCC, Mwanza
Fransisca Katagira	F	Component Leader, WHCC, MAFS-Dar es Salaam
Joseph Ndunguru	M	Senior Research Scientist, WHCC, Mwanza office
Enrisha Mbwabwo	M	Scientist, WHCC, Mwanza office
Aloyse Rajabu	M	Scientist, WHCC, Bukoba office
Dedan Sombe	M	Senior field officer for WHCC, Bukoba office
D.R. Mabugo	M	Regional Agricultural Advisor to RAS, Kagera
Rukia Saidi Mbeo	F	Farmer along Kagera river, Kyaka, Karagwe district
Yazidi Chatuka	M	Farmer along Kagera river, Kyaka, Karagwe district
Sifa Kagaju	F	Farmer along Kagera river, Kyaka, Karagwe district
Zuberi Kagaju	M	Farmer along Kagera river, Kyaka, Karagwe district
R. Kagega	M	Caretaker of WRU at Kyaka village, Karagwe district
Lutgarda F. Sesabo	F	CALDO, Bukoba rural district
Jonathan rutashobya	M	Principal Field Officer, Research/extension Liaison Officer also responsible for irrigation, Bukoba rural district
Lawrence Bwire	M	Caretaker of WRU at Chato Mkuyuni village, Biharamulo district
Samwel Madudo	M	Village Executive Officer, Chato, Biharamulo district
Mugete Chumbula	M	Fisherman and Chairman of BMU, Chato, Biharamulo district
Didas Seremani Mbuje	M	Farmer and Chair of village security committee, Chato, Biharamulo district
Vedasto Karokola	M	Fisherman at Chato, Biharamulo district
Samwel bigambo	M	Fisherman and member of BMU
Edward Kavula	M	Farmer at Chato, Biharamulo district
Hulu Selemani	M	Farmer and village Chairman, Mkuyuni –Chato village
Samwel Selemani	M	Farmer at Chato, Biharamulo district
Joseph Lucas	M	Farmer at Chato, Biharamulo district

PERSONS	GENDER	POSITION/LOCATION
Nesphory Moya	M	Caretaker of WRU at Kisorya village, Bunda district
John J.M. makongo	M	Principal Agricultural Field Officer also O/I of WRU at Musoma
Samwel Sassi	M	RAA to Mara RAS
Elizabeth Bwana	F	Acting District Executive Director for Musoma district (previously DALDO for Musoma district
Daniel charles	M	Caretaker of WRU at Shinembo village, Magu district
Helena Samson	F	Farmer at Shinembo village, Magu district
Deticia Matogolo	F	Farmer at Shinembo village, Magu district
Lois Zephania	F	Farmer at Shinembo village, Magu district
Mashauri Mahangila	M	Farmer at Shinembo village, Magu district
Samson M. Mahebe	M	Farmer and former village Chairman, Shinembo village, Magu district
Mussa K. Maghale	M	Farmer at Shinembo village, Magu district
Janeth Timoteo	F	Farmer at Shinembo village, Magu district
Maguhwa Mshibwa	M	Village Chairman and farmer, Shinembo village, Magu district
Yusuph Nyakunga	M	Assistant Director, Plant Protection Services, MAFS, Dar es Salaam.